Handbook of Research on Interactive Information Quality in Expanding Social Network Communications

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A volume in the Advances in Social Networking and Online Communities (ASNOC) Book Series

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In the chapter "Lookable User Inerfaces and 3D," its author, Alan Radley, considers the computer not as a tool, or as a bicycle-for-the-mind, but simply as self. In this research, Radley has viewed computers as potentially beneficial to society, but as not necessarily so. Machines have always held a janus-like prospect. They magnify human potential with magical and transformative powers, but on the other hand, they sometimes bring anti-social, destructive, and/or dehumanizing forces into society. Perhaps the current chapter raises more questions than it answers. He carries out a detailed study of the past/present/future of human-computer interactions/relationships, from the theoretical-technical point of view. Finally, we can find the results of testing a new type of electronic mail, named KeyMail.

In the chapter "Time-Windows Reconnecting the Window-Metaphor of the GUI to Real Space," the author, Andreas Kratky, presents a first interation of the Time-Windows set-up. He focuses on the observation of users and the behavioral patterns they displayed in the interaction with the screens. In other words, the study observes user behavior and interactions with a set of large-format touchscreens in order to assess users' abilities to integrate their interpretations and operations with the displayed information across multiple, spatially distributed screens. In the study, the accurate bidirectional interrelations among the following main subjects can be appreciated: GUI (Graphical User Interface), screen, windows, metaphor, interactive design, and heuristic evaluation. The conclusions allow the detection of all the theoretical and practical activities made by Andreas Kratky, collaborators, participants, etc. in the heuristic evaluations, for instance, as well as the future lines of research.

In the chapter "Practical Metrics for Error Assessment with Interactive Museum Installations," the authors, Andrea Albarelli, Luca Cosmo, and Filippo Bergamasco, present a metric and a practical setup that can be adopted to evaluate a wide range of viewer-dependent displays. The research describes a simple yet effective approach to build a view-dependent stereoscopic display and to evaluate its performance. In other words, they proposed to study separately the repeatability of the pose estimation (with the pose accuracy) and the compliance of the observed scene with the virtual one (with the reprojection accuracy). In addition, this latter measure is able to capture in a quantitative manner the difference between the scene that the system expects the user to view and what he actually perceives. The figures that accompany the text allow a more detailed view of the research, developed step by step by the authors.

In the chapter "Improved Interaction for Mid-Air Projection Screen Technology," the authors presents a Microsoft Kinect-based 2D and 3D tracking for mid-air projection screens. Kinect cannot track through the fog screen due to disturbances caused by fog. In addition to robust tracking and lower cost, the custom Kinect tracking also brings along other advantages such as possibilities for projector's hotspot removal, ballistic tracking, multi-user, multi-touch and virtual reality setups, and novel user interfaces. In addition, more main aspects of the research are revealed, which can be summed up in the following way: improved interaction for mid-air screen (i.e, touch screen functionality, zero latency gaming interface, tracking for virtual reality, removal of the hotspot of a projector, volumetric mid-air displays), tactile feedback for mid-air screens, and novel mid-air user interfaces. There is also an interesting bibliography, which may be looked up by those interested in widening the concepts that the authors present in the chapter.

In the research called "Methodology for Transformation of Behavioural Cues into Social Signals in Human-Computer Interaction," its authors, Tomaž Vodlan and Andrej Košir, analyze a methodology for transformation of behavioural cues into Social Signals (SSs) in human-computer interaction. The present methodology consists of three main steps: behavioural cues acquisition, manual and algorithmic pre-selection of behaviour cues, and classifier selection. In addition, and according to the experimental design, the authors present an example of behavioural cues that describe the SS class {hesitation, no hesitation}. The figures are comparative data and tables with the reached results, which will considerably facilitate the quick understanding of the current research work.

The author of the chapter, "Methods of Skull Implants Modeling with Use of CAx and Haptic Systems," is Marek Wyleżoł. He presents four exemplary and original methods of virtual skull implant modeling. In this bioengineering research, the time of the virtual model developed is very short compared to use of only one of standard engineering CAx systems, for instance. Wyleżoł predicts that more and more often these implants (also the all skeletal system) will be performed with the use of generative technologies. The author also provides that in the near future there will be significant growth in the production of implants matched for a particular patient. The experiments have been very comprehensive and wide, since the author has examined the proposal from several points of view to reach a novel conclusion in the context of bioengineering, resorting to several environments of graphic computing, biology, mathematics, and others.

In the work titled “Efficient Prefix Scan for the GPU-Based Implementation of Random Forest,” the author, Bojan Novak, discusses the random forest ensemble learning with the GPU version of prefix scan method. The content of the text starts with a study of the state of the art and the motivations of the current research work. In addition, more main aspects of the research are revealed, which can be summed up in the following way: the differences between the CPU and the GPU arhitectures, prefix scan, random forest tuned for the GPU implementation, and future research directions. The algorithms and tables with the reached results will considerably facilitate the quick understanding of the current work.

In the chapter “The Future of Supercomputers and High-Performance Computing,” the author, Domen Verber, describes a complete state-of-the-art and a possible future of HPC (High Performance Computing). The main focus of the research work is on different hardware architectures for High-Performance Computing and some particularities of HPC programming. More main aspects of the research are revealed, which can be summed up in the following way: first generation of supercomputers – customized hardware solution for SIMD (Single Instruction Multiple Data); multi-processor and multi-core architectures; coprocessors and accelerators; supercomputers on our desktops and in our pockets; HPC in embedded computer systems; alternative computational architectures; and programmable hardware. In short, some alternatives to traditional computational models are given. At the end, some replacements for semiconductor technologies of modern computers are debated, too.

In the chapter “Lookable User Interfaces and 3D,” the author, Alan Radley, illustrates a new philosophy of user interface design, the “Lookable User Interface” (LUI). The approach is based on the concept of a Personal Reality (PR) system. LUI affords the maximum degree of visual accessibility to digital content. The author examines the results of testing a Lookable User Interface. The development of the main and secondary goals of the chapter are coupled with congruent and excellent examples, which support the reading of the proposal, including a set of experiments, results, conclusions, and future lines of action in research (the results and conclusions are presented in a detailed way). In addition, the author presents Spectasia as one example of a Personal Virtual Reality (PVR) that can be used to visualize links between universals and particulars within digital worlds.

In the chapter “Microblogging as an Assisted Learning Tool in Problem-Based Learning (PBL) in Bahrain: The Edmodo Case,” the authors study the use of social media tools in higher education. In particular, they investigate the students’ level of familiarity, engagement, and frequency of use of social media technologies. Vasileios Paliktzoglou and Jarkko Suhonen analyze the experiences of using the Edmodo tool to support PBL. In addition, they relate participants’ opinions regarding the use of the tool. The results indicate that Edmodo has a positive reception as learning tool in blended learning to support PBL. The current proposal of research is complemented with the results of experiments made among professors and students in the use of microblogging. The results denote that social media tools, and more specifically Edmodo, can support social-constructivist models of pedagogy and, more specifically, blended-learning courses using PBL.

In this chapter, ubiquitous learning is introduced and characterized, the challenges that must be faced by those in charge of designing and developing such applications are reviewed, and the state of the art of this recently initiated line of research at the informatics and information systems is shown. In addition, several models have been proposed to represent various aspects of a u-learning environment, such as learning contents and strategies, devices, and communication networks, that can be used by the student as well as individual and environmental parameters so that the system can provide the student personalized support. The real-world observation and the problem-solving abilities of the students can be trained and evaluated in a context-sensitive environment.

In the chapter “Data Mining Applications in Computer-Supported Collaborative Learning (CSCL),” the author discusses those data-mining applications that assist in the learning process. The work describes the phases and tasks involved in the entire process of knowledge discovery, and also presents some research applying data mining to process the contributions of students and teachers in collaborative-learning environments. In addition, the author makes an interesting and detailed analysis to complete the overall vision of the current research. In other words, the integration of techniques of data mining within online learning environments, in particular with the environments of CSCL, is incipient.

In the work titled "Model for Effective Collaborative Learning in Virtual Worlds with Intelligent Agents," the authors explore information about virtual worlds, collaborative knowledge management, intelligent agents, etc. The main goal of this research is to demonstrate the relation between the collaborative logic based on software agents and a virtual words platform in order to build effective results. In addition, the present chapter proposes a model through which to demonstrate how the interaction with intelligent agents allow the achievement of an effective collaborative learning into a controlled distributed computer environment using the platform Second Life. The reader will find among the pages a careful description of the main concepts, the techniques, and the goals targeted in the generation of the model.

In the chapter "Quality Analysis of VoIP in Real-Time Interactive Systems over Lossy Networks," the authors developed a VoIP voice conferencing test-bed based on the Adobe Flash Media server that utilizes the Real-Time Media Flow Protocol and the Speex multi-rate voice codec. In the work research, interesting real examples are shown and several experiments were conducted on several voice files over different packet losses, concluding the best combination of parameters in low, moderate, and high packet loss conditions to improve the performance of voice packets measured by the Perceptual Evaluation of Speech Quality (PESQ) values. The conclusions and implications of the developed work allow us to point out new roads for future investigations in the context of Quality Analysis of VoIP.

In the chapter "An Integrative Method for the Evaluation of Network Attack Effectiveness Based on Grey System Theory," the authors, Pengfei Wang, Wentao Zhao, Fan Zhang, and Zimei Peng, present an integrative method for the effectiveness evaluation of network attacks. The new method provides a solution to the problem of accuracy drop seen in prevailing grey evaluation methods when the clustering coefficients exhibit no significant difference. This excellent research work is organized as follows: a state of the art, the basic concepts of the grey systems theory, the description of the integrated grey clustering evaluation model and the experiments verification, and talks about the future trends.

In the chapter "Vision of Best Practices for IMS Implementation," the authors, Daniel Biga, Horacio Del Giorgio, Fernando Dufour, and Ariel Serra, discuss different perspectives around a framework architecture for delivering IP multimedia services, which allows voice and multimedia applications to communicate from multi-access scenarios (i.e., wireless), thus allowing the convergence of fixed and mobile networks. They have carried out a research into the current state of the art of this technology (software and hardware), focusing on its architecture, operating principles, and especially, in the current state of development in Argentina.

The chapter "The Role of Electronic Commerce in the Global Business Environments" presents the role of electronic commerce in the global business/marketing environments, thus explaining the overview of e-commerce, a set of the categories of e-commerce, the main strategy of e-commerce, the applications of e-commerce, and the barriers to e-commerce adoption. In addition, the value chain of e-commerce and the benefits of information technologies in business are shown. This kind of information could then be used, as the author claims, to find some "orientations" for global business.

In the chapter "Software and Emerging Technologies for Education, Culture, Entertainment, and Commerce," the author makes a description of a set of topics which have been interrelated for a long time but which have acquired a special attention in the context of computer science, computer graphics, computer animation, textile managing, and productive computing, and the human factors that prevent boosting online sales. The author uses a set of techniques of software engineering, social sciences, and linguistics/semiotics to decipher some of the main problems through which these interrelations are going in the textile sector (South of Europe), for instance, e-commerce, marketing, on-line hyperemdia systems, textile industry, education, work and human/social factors imposed by a eternal and recurrent parochialism, showing some conclusions that may constitute future lines of research.

Do not regard as valuable anything that can be taken away. -Seneca (c. 4 B.C.E. –65)

Preface

One of the current dilemmas in the context of the expansion of the social networks is keeping and increasing the quality of communication between the users and the new technological devices. That is, we are in front of a quantitative-qualitative relationship. In that equation, the society and/or producers of goods/services in the field of the new technologies include the time factor and the cost factor. Consequently, it is about offering goods and/or quality services with reduced costs in the least possible time, and in relation to the greatest number of potential users of the new technologies. Accordingly, those four words—quality, quantity, time, and cost—are cornerstones of the following pages.

An axis of actions that transits and underpins any anlysis (in a context of great changes in the sciences) is the complex factors stemming from the change of century and millennium. Historically, a change of century has always meant for humanity great technological advances in daily life, especially since the ever-increasing momentum behind the global village of communications. These changes theoretically were supposed to be exponential and expansive to all the inhabitants of the planet. However, with the passing to the new millennium, a reduction of positive effects has been seen, due to myriad factors and variables. One of those factors is the digital divide. A great part of the members of the current societies do not have guaranteed a constant qualitative access to the digital world, and accordingly, with reduced costs to the multimedia mobile information, those daily advances, theoretically for the common good of humanity, have slowed down considerably. These are some of the negative financial variables present in the first decade of the new millennium, which in fact originated in tiny sectors of the summit of the population.

It is necessary to make clear that not only economic are those elements that generate that paralysis of growth and dissemination of scientific knowledge in the base of the population pyramid. For instance, there are the human factors in the educational field. These human factors, if unchecked, can completely disarticulate the notion of quality, not only in the presence of the current networks but also in terms of the immediate future, as well as in the long run. The negative influence of the power groups is easily detected in the analysis of the contents of the mainstream media, such as the online digital press, which can be simultaneous, whether it is in a reduced format (or similar), or alternatively to the publication of less-than-rigorous academic materials in analogical or paper support, for instance. These are publications with great national and international circulation. So much so that a Spanish language newspaper based in Madrid, Spain (El País – www.elpais.es), announced a change of the interactive design (10.01.2014), placing in the first page the scientific information.

A priori and inarguably, it is good news, but automatically, the day after the change, a false news item appears, according to which the foremost Spanish university appears in the ranking of the 200 best universities in the world (http://politica.elpais.com/politica/2014/10/01/actualidad/1412182471_480752.

html). Oddly enough, the university that is mentioned, which is based in Barcelona (Spain), founded in the 90s, has the greatest index of negative human factors, if the field of the new technologies is analyzed in detail, where expressions, such as bossing, mobbing, academic stalking, endogamy, among so many, are the common denominator in the daily actions of corruption and destruction of the local and global educational system. Actions which are repeated in each one of the centres with which they keep bidirectional relationships, can be the alleged collaboration agreements for research and student interchange between European universities and those of the rest of the world. That is, university educational centres, which are apparently public (the main source of financing stems from the taxes that the European citizens pay), neverthless offer lifelong functionaries in the role of professors, chiefs of departments, faculty deans, faculty directors, etc., and all apparently, and by the aforemntioned actions, are devoted to slowing down the advance of the sciences. All of that is due to the fact that their daily deeds escape, or blatently depart, from the sciences of the various areas of knowledge and towards the wild educational mercantilism plus an immutable exercise in the control of the freedom of expression. Ever a bastion of humanism, freedom of expression, one of the most important benefits of social mass media from the point of view of the zones that are covered by its distribution, does have an element of democracy, but there are limits in terms of truth and academic forthrightness and just plain honesty.

Unfortunately, a mercantilism stalks and avails itself of all the tools of the current social networks. A key priority and initial goal is to increase its presence and power (democracy, but not in the worng way), such as can be the control they exert in the sciences and education section of the Spanish newspaper previously mentioned. Evidently, that is a small example, but it is a modus operandi, which can be easily detected in the European south, where the human factors turn into social factors. The social factors are due to the fact that those people who have and exercise the unlimited power over computer science education, the systems and architecture of information, software engineering, multimedia engineering, telecommunication engineering, and a long etcetera are themselves inside the ICTs (Information and Communication Technologies). They are responsible for the deviations. Deviations where the future professionals of the sector, even if they have a brilliant academic/working record, with an excellent capacity, competence, and knowledge in the new technologies, end up unemployed or carrying out any task for daily survival in the, technologically speaking, developed societies.

The origin of the problem of the human and social factors that may well seriously damage the sciences of the future lies partially in the ways and methods by which academic titles have been obtained in the last decades of the 20th century. Focusing on the map of the European Mediterranean and considering the wild mercantilism of the education, it is feasible to observe that those who manage the harmful power have obtained their titles in a record time, in private or religious institutions, or with political institutions of a hybrid type, that is, universities financed by the citizens but ruled by small groups of great power and with international ramifications. It is they who often decide the timing in which the students will finish the studies of a doctorate, those who will get a job akin to what they have studied, those who will get a scholarship once finished and/or an opportunity to continue their studies abroad, those who will be favoured by a high and continuous attendance of the potential participants to certain congresses, symposiums, workshops, those who will decide the contents to be promoted in the social mass media, whether it is in analogical or digital support, those who will determine in the mid- and long-term the lines of research within and without the borders of a country, etc.

This is a short description of the chaos for the future of the sciences, where their mentors and promoters have obtained titles of the highest educational level thanks to their friends/colleagues and who today are giving back those favours to their relatives and friends, making up an endless spiral with the passing of time. A simple way to verify it is the scientific publications, where the candidates to a doctorate do not even have a logical modicum of scientific publications, in an autonomous or individual way, in prestigious associations such as ACM (Association for Computing Machinery – www.acm.org) and IEEE (Institute of Electrical and Electronics Engineers – www.ieee.org), to mention a couple of examples. There are also the databases where the amount of yearly publications of some writers is such that not even a humanoid robot, gifted with the best artificial intelligence, can reach those fake numbers of authorships in the scientific publications. In few words, we have described a second coming together, or crossroads, of the current book: education, research and development, new technologies, and human/social factors.

Fortunately, somewhat larger, more free, and in front of the chaos in certain places, there is the cosmos of other places on the planet, with the constant advance of microcomputing, the quanta computers, the wireless telecommunications, the dynamic and static means of interactive communication, the interactive design in the social networks, etc. With a set of rhetoric questions, such as we suggest and exemplify here, not only can the reader draw the contents of the main and secondary topics of the current book, but the readere can also orient themselves towards the third and last group of four components that interrelate with each other. The main questions are: What are the trends of R&D in the short-, middle-, and long-term? Towards what new era is communicability heading? What aspects of the graphic software and hardware will draw more attention of the so-called digital native users? How can the hardware be optimized for the programs of the graphic software 2D/3D and vice versa? What is the role of graphic computing in the dissemination of the cultural and natural heritage? What kind of installations boost the interaction with the contents in real and/or virtual museums? What new techniques and/or methods are possible to measure the errors at the moment in which the user interacts with a multimedia system? What links are there between biocomputing and 3D graphics? What are the new horizons in the realism of the 3D applied to medicine? What is the future of super computers? Where is the research in high-performance computing heading? What is humanistic computing? What essential elements of online digital safety will have to be foreseen for the communications among the users, in view of the constant advance of the mobile multimedia devices? What are the new frontiers in e-commerce? Are there still limitations in the sale of online products/services? What are the advantages of the videogames to establish links among users of different ages and cultures? What elements of design have stayed in the hypertext, multimedia, and hypermedia systems with regard to video games? What is the role of the narration and playability in the video games of the new generations of users? Why is the diachronic analysis important in the evolution of interactive design? Where can we find good examples of information in the social networks? Why is the Web 2.0 turning into a kind of social antimodel? What are the main characteristics of the metaphors of the current interfaces aimed at the real spaces? What is a lookable user interface? Where are the 3D user interfaces evolving? How can the interaction with the mid-air projection screen technology be improved? What strategies can be used in the voice and multimedia applications to communicate from multi-access scenarios? How can a quality analysis of Voice over Internet Protocol in real time be made? What are the new educational models for the professionals of the mid-current century? What are the challenges for the designers of computer applications in ubiquitous learning? Why is data mining important in computer-supported collaborative learning? How is it possible to reach an effective collaborative learning in virtual worlds with the use of intelligent agents? Is the use of microblogging possible as an assisted-learning tool? What new frontiers of R&D are opening in the human-computer interaction, through the transformation of the social communication media and the social networks? What are the social signals in human-computer interaction? What new roles will the evaluators of communicability have in view of the evolution of the hardware? Will the auditing of quality in the interactive systems become a new subject in the programs of teaching of engineering or computer science majoring? Resorting to the set of rhetoric questions, we generate our last set of four components: the users, the design, the human-computer interaction, and the software/hardware.

These questions denote a 360-degree vision of the content of the current work. In addition, many of them have been asked directly by their authors in the following conferences and/or symposium and/or workshops (2013 and/or 2014): ADNTIIC (Advances in New Technologies, Interactive Interfaces, and Communicability), SETECEC (Software and Emerging Technologies for Education, Culture, Entertainment, and Commerce), HIASCIT (Horizons for Information Architecture, Security, and Cloud Intelligent Technology), HCITISI (Human-Computer Interaction, Telecommunications, Informatics, and Scientific Information), CCGIDIS (Communicability, Computer Graphics, and Innovative Design for Interactive Systems), HCITOCH (Human-Computer Interaction, Tourism, and Cultural Heritage), and MSIVISM (Multimedia, Scientific Information, and Visualization for Information Systems and Metrics).

It is a 360-degree vision derived from the formal and factual sciences. Through the three axes, whose components are in a constant bidirectional relationship, the main and secondary topics are established, which are presented in a kind of inverted pyramid, that is, from greater to lesser extension of contents. That dynamism between the formal and factual sciences makes the current book a very novel proposal, since they try to solve the open questions, which have been generated through the use of rhetoric. In addition, in that 360-degree movement attention is given to certain fields of scientific knowledge, which are treated in detail and masterfully in each one of the research works submitted by the different authors. At the start of those works there is a brief state of the art, which describes the importance of the main/secondary topics that are approached, as well as the existing interconnections with the structure of technological knowledge, whether it is from a theoretical and/or practical perspective.

These interconnections make a constant reference to the three central axes of the book. In addition, in the works is verified a gradual development of the issues tackled at the start, until we reach the conclusions, whilst learned lessons and future lines of research for further elaboration and development. Consequently, it is a book which is unique, not only at the moment of understanding each one of the issues dealt with, but also as a source of consultation for the future, starting always from a careful look at artificial intelligence, audio-visual communication, computer animation, computer graphics, computer science, computer-aided design, cyber behaviour, data mining, electronic learning, ergonomics, global business, Internet, multimedia, open source software, quality attributes in the interactive systems, quality metrics, robotics, semiology, social psychology, sociology, software engineering, telecommunications, ubiquitous computing, usability engineering, virtual societies, wireless and mobile computer science, etc. Disciplines/skills of great topicality and impact are explored, since through them human beings can potentially generate *avant-garde* contents in realistic 3D, the last generation of interactive systems, to mention an example. An extensive listing connotes and reflects the requirement and also skill necessary to find interaction zones of the disciplines among the different domains, fields, and specialities, which at the same time potentially boosts and merges the formerly different scientific views. In short, the intersection of the formal and factual sciences has generated a 360-degree vision of the original content of the pages.

Contents which are organized in a pedagogical way, which is easy to understand, denoting that the current book is advisable for the following readers: students and computer sciences professors, systems, multimedia and graphic computing, consultants and analysts of online and offline interactive systems, interactive designers, programmers, analysts and application engineers for the social networks, ICT technicians, professionals of the social sciences, experts in the new technologies in the real and virtual communities, among others. It is also advisable for those readers in general who feel attracted by the past, present, and future of the *avant-garde* technological revolution and its main derivations in daily life. Finally, the didactic character of the contents makes the book an interesting and reliable resource as a compendium of reference for the researchers.

The book is organized into 20 chapters and 2 appendices. We briefly present each one of the research works developed by their authors:

Chapter 1, "Phaneroscopy for Video Games," is the title with which the authors of the research, Francisco V. Cipolla-Ficarra and Jacqueline Alma, present a first study for the classification of the video games from a synchronic and diachronic perspective, in relation to the notion of phaneroscopy. In the current research, a correct phaneroscopy is that which focuses on the contents of the videogames. It is also feasible to carry out semiotics analysis regarding these interactive systems as an intersection of dynamic and static means, and not as a union.

In Chapter 2, "Synechism in the Video Games Design," the authors, Francisco V. Cipolla-Ficarra, Jacqueline Alma, and Alejandra Quiroga, present an analysis of the first set of elements belonging to the interactive design categories, layout (naturalness of metaphor) and content (storytelling), which make up synechism in the video games design, since the 1990s. In short, the possibility of establishing links with those elements of interactive design that do not change with the passing of time is positive for communicability.

In Chapter 3, "Lookable User Inerfaces and 3D," Alan Radley considers the computer not as a tool, or as a bicycle-for-the-mind, but simply as self. In this research, Radley has viewed computers as potentially beneficial to society, but as not necessarily so. We can also find the results of testing a new type of electronic mail named KeyMail.

In Chapter 4, "Time-Windows Reconnecting the Window-Metaphor of the GUI to Real Space," Andreas Kratky presents a first interation of the Time-Windows set-up. He focuses on the observation of users and the behavioral patterns they displayed in the interaction with the screens. In other words, the study observes user behavior and interactions with a set of large-format touchscreens in order to assess users' abilities to integrate their interpretations and operations with the displayed information across multiple, spatially distributed screens.

In Chapter 5, "Practical Metrics for Error Assessment with Interactive Museum Installations," the authors, Andrea Albarelli, Luca Cosmo, and Filippo Bergamasco, present a metric and a practical setup that can be adopted to evaluate a wide range of viewer-dependent displays. The research describes a simple yet effective approach to build a view-dependent stereoscopic display and to evaluate its performance. In other words, they proposed to study separately the repeatability of the pose estimation (with the pose accuracy) and the compliance of the observed scene with the virtual one (with the reprojection accuracy).

In Chapter 6, "Improved Interaction for Mid-Air Projection Screen Technology," the authors presents a Microsoft Kinect-based 2D and 3D tracking for mid-air projection screens. Kinect cannot track through the fog screen due to disturbances caused by fog. In addition to robust tracking and lower cost, the custom Kinect tracking also brings along other advantages such as possibilities for projector's hotspot removal, ballistic tracking, multi-user, multi-touch and virtual reality setups, and novel user interfaces.

In Chapter 7, "Methodology for Transformation of Behavioural Cues into Social Signals in Human-Computer Interaction," Tomaž Vodlan and Andrej Košir analyze a methodology for transformation of behavioural cues into Social Signals (SSs) in human-computer interaction. The present methodology consists of three main steps: behavioural cues acquisition, manual and algorithmic pre-selection of behaviour cues, and classifier selection.

The author of Chapter 8, "Methods of Skull Implants Modeling with Use of CAx and Haptic Systems," is Marek Wyleżoł. He presents four exemplary and original methods of virtual skull implant modeling. In this bioengineering research, the time of the virtual model developed is very short compared to use of only one of standard engineering CAx systems, for instance. Wyleżoł predicts that more and more often these implants (also the all skeletal system) will be performed with the use of generative technologies.

In Chapter 9, "Efficient Prefix Scan for the GPU-Based Implementation of Random Forest," the author, Bojan Novak, discusses the random forest ensemble learning with the GPU version of prefix scan method. The content of the text starts with a study of the state of the art and the motivations of the current chapter.

In Chapter 10, "The Future of Supercomputers and High-Performance Computing," the author, Domen Verber, describes a complete state-of-the-art and a possible future of HPC (High Performance Computing). The main focus of the research work is on different hardware architectures for High-Performance Computing and some particularities of HPC programming. In addition, some alternatives to traditional computational models are given.

In Chapter 11, "Lookable User Interfaces and 3D," the author, Alan Radley, illustrates a new philosophy of user interface design, the "Lookable User Interface" (LUI). The approach is based on the concept of a Personal Reality (PR) system. In addition, the author presents Spectasia as one example of a Personal Virtual Reality (PVR) that can be used to visualize links between universals and particulars within digital worlds.

In Chapter 12, "Microblogging as an Assisted Learning Tool in Problem-Based Learning (PBL) in Bahrain: The Edmodo Case," the authors, Vasileios Paliktzoglou and Jarkko Suhonen, study the use of social media tools in higher education. In particular, they investigate the students' level of familiarity, engagement, and frequency of use of social media technologies. In addition, the authors analyze the experiences of using the Edmodo tool to support PBL.

Elena B. Durán and Margarita Álvarez are the authors of Chapter 13, "Ubiquitous Learning Supporting Systems: A Challenge for Computing Software Designers." In this chapter, ubiquitous learning is introduced and characterized, the challenges that must be faced by those in charge of designing and developing such applications are reviewed, and the state of the art of this recently initiated line of research at the informatics and information systems is shown.

In Chapter 14, "Data Mining Applications in Computer-Supported Collaborative Learning (CSCL)," the author, Rosanna Costaguta, discusses those data-mining applications that assist in the learning process. The work describes the phases and tasks involved in the entire process of knowledge discovery, and also presents some research applying data mining to process the contributions of students and teachers in collaborative-learning environments.

In Chapter 15, "Model for Effective Collaborative Learning in Virtual Worlds with Intelligent Agents," the authors, Max Ugaz and Augusto Bernuy Alva, explore information about virtual worlds, collaborative knowledge management, intelligent agents, etc. The main goal of this research is to demonstrate the relation between the collaborative logic based on software agents and one virtual words platform in order to build effective results.

In Chapter 16, "Quality Analysis of VoIP in Real-Time Interactive Systems over Lossy Networks," the authors, Maha Ziad Yousef Mouasher and Ala' Khalifeh, developed a VoIP voice conferencing test-bed based on the Adobe Flash Media server that utilizes the real-time media flow protocol and the speex multi-rate voice codec. The implications of the developed work allows us to point out new roads for future investigations in the context of Quality Analysis of VoIP.

In Chapter 17, "An Integrative Method for the Evaluation of Network Attack Effectiveness Based on Grey System Theory," the authors, Pengfei Wang, Wentao Zhao, Fan Zhang, and Zimei Peng, present an integrative method for the effectiveness evaluation of network attacks. The new method provides a solution to the problem of accuracy drop seen in prevailing grey evaluation methods when the clustering coefficients exhibit no significant difference.

In Chapter 18, "Vision of Best Practices for IMS Implementation," the authors, Daniel Biga, Horacio Del Giorgio, Fernando Dufour, and Ariel Serra, discuss different perspectives around a framework architecture for delivering IP multimedia services, which allows voice and multimedia applications to communicate from multi-access scenarios (i.e., wireless), thus allowing the convergence of fixed and mobile networks.

In Chapter 19, "The Role of Electronic Commerce in the Global Business Environments," Kijpokin Kasemsap presents the role of electronic commerce in the global business/marketing environments, thus explaining the main strategy, the applications, and the barriers to e-commerce adoption, etc. This kind of information could then be used, as the author claims, to find some "orientations" for global business.

In Chapter 20, "E-Commerce for Italian Textile Manufacturers: Limitations and Human Factors," the author, Francisco V. Cipolla-Ficarra, makes a description of a set of topics which have been interrelated for a long time but which have acquired a special attention in the context of computer science, computer graphics, computer animation, textile managing, and productive computing, and the human factors that prevent boosting online sales.

In Appendix 1, "Social or Anti-Social Networking?" the authors present some negative examples of the adverse use of the social networking and/or Internet. The examples are 100% true and stem from digital newspapers, entrepreneurial websites, personal messages, etc. The authors make a wide-ranging reflection about the learned lessons signaling the negative aspects of the used technology.

Appendix 2, "A Set of the Good Online Information," releases the results of an analysis applying communicability into Social Web. In addition, it opens new horizons in the next years, thanks to the advance of the hardware, software, and the researches into the present bibliography, for instance. Along with this, the authors introduce technological aspects of interactive design. The examples, which go with the text, illustrate the correct explanation of the developed introduction.

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Introduction

The quality of the communication among human beings has been and will be a decisive factor in all those media which tend to reduce the digital gap among the users and maintain the horizontality in the free access to the information which currently circulates in the social networks. The momentum of the social networks in the era of the expansion of communicability entails implicitly a set of elements related to the design categories of the new devices many are not aware this factor (Cipolla-Ficarra, 2013). In some products and services, once the pertinent evaluations are made, they show that the lack of knowledge encompasses all the members of the production process and use of said devices. The consequences of this not-knowing, voluntary or not, may be negative from the point of view not only of communicability, but also from the current economic-financial aspect, especially in the software sector and the hardware of the interactive systems, whose contents are aimed at the future generations of multimedia goods and services.

In the current book we are trying to present the main elements in the computer and training for social networks context, as well as the factors that boost communicability with the purpose that the democratic spirit of the Internet survives. This main goal is coupled with a set of scientific, theoretical and practical services. In each one of them the most relevant and avant-garde aspects of the new technologies aimed at the social networks are approached, such as the education and the human and sociological factors. That is to say, the books will present previously unseen content which may serve as a kind of compass for the next decade, avoiding to make the classical mistakes in the current multimedia/hypermedia systems that stem from the lack of quality in the interactive communication.

The necessity for this book comes from the fact that currently a set of non-democratic elements deriving from the automatic information systems exists in the social networks, which, although they were born democratic and horizontal for all human beings, little by little have left horizontality behind and have created an elitist summit which tends to increase the digital gap among the users. This is particularly the case in the educational environment, as well as in the economical aspect and in the technological one. Therefore, the education of computer science in the era of the expansion of communicability will be one of the cornerstones and the common denominator of the works that make up the book. Besides, the works aimed at the social networks will have to follow the epistemological parameters of the social sciences leaving aside the mercantilist or statistic aspect of little veracity of the information sources. Moreover, one of the implicit goals of the current proposal is to eliminate the technological mirages to avoid irreparable damages to the future generations of experts in the field of ICT (Information and Communication Technologies).

In our days quality in communication is the main goal of software and hardware of ICT devices, and especially since democratization of the production of the multimedia/hypermedia contents on line is assumed for present and future generations, and is rightly taken for granted. However, that preexistence is missing in a myriad cases due to human and/or technical factors.

In the second decade of the new millennium, discussion surrounding social networks is widespread; in terms of means that we are referring among other applications relating to Facebook, Twitter, Google+,YouTube, Linkedin, Instagram, Conference Blog, etc., each of of these different systems and has both its positive and negative aspects, which are explored in later chapters and with examples given in the annexes 1 and 2. Now the denominations of those programs, mostly belonging to the category of free software, and have in many cases entered into the daily vocabulary of millions of users of interactive systems, whether establishied throiugh a communication with the traditional computers, or the more recent technological generation multimedia devices. Aside from the cost of those devices and/or the ease or not in their use, the end goal is always the same: communication.

Communication has been the cornerstone of the activities of the human being since prehistory. That is, human communication has its remote origins in the evolution of the daily coexistence of the human beings, especially in the need of getting in touch with "the other". Gestures, sounds, onomatopoeias, etc., make up the basis of the alphabets of the diverse civilizations that have peopled our planet across the millennia. Those alphabets of life can be examined in detail and with a masterful richness in the exceptional compendium of Professor Kim Henry Veltman "Alfabets of Life" (Veltman, 2014).

In that yearning to communicate with the other, exists little by little, the technological breakthroughs deriving from the industrial revolution for communications, the theories of social communication, and the traditional mass media (that is, the press, cinema, radio and television), and which taken together are witnesses to a great (r)evolution in human communication along the 20th century.

The stories of the "War of the Worlds" by Herbert George Wells (Gorey & Wells, 2005) and the radio broadcast of the 30th October 1938 by George Orson Welles laid the basis of the notions published in "The Global Village" by Marshall McLuhan (McLuhan & Powers, 1989). A global village was envisaged where face-to-face communications among humans would be through the computer screens and multimedia mobile phones; in a only a few short decades these would come to pass, thanks to the democratic expansion of the digital contents in the internet: text, audio, pictures, computer animations, etc. Once again the natural or artificial context where the human being is inserted would accomplish a fundamental role in the communication process.

Soon after arrived the so-called traditional media of audiovisual communication: cinema, radio, television, etc. There were moments of grouping of those inhabitants, in the face of the technological devices whose initial costs were not affordable for the great majority of the population in the 20th century. That is, there was a concentration of people in a same space and time, whether to watch a film at the cinema, listen on the radio to a presidential speech or watch the sports news on television, for instance.

Those are uses that have turned into habits in certain nations in view of certain contents of the traditional media of social communication. In some cases and geographical places, those uses and/or habits have completely disappeared. In other places they still persist and resist the passing of time, and the constant advance of the "New" Technologies of Communication and Information (NITC). These initials need a greater accuracy. Currently, instead of talking of "new", we might perhaps speak of latest technologies, bearing in mind the great advances achieved minute by minute in all of the serious research and development labs across the planet.

Simultaneously, a strategy had to be sought so that at least the main contents (i.e. reserach results) were quickly at the disposal of the great majority of the population pyramid, until they could purchase those goods and/or digital services. In few words, to decrease partially and momentarily the digital divide. Aside from these remarks, the truth is that nowadays the social networks have not only changed the habit of group communication, that is, face-to-face, towards the individual and isolated data from the real context, even inside the same family, sharing under the same roof, but they are also at the service of those who foster the chaos of tyranny versus the cosmos of democracy.

A negative and easily verifiable example in the scientific publications of the sector, is how little or nothing has been done (in a particular sense) by the university researchers of the mathematic, computer science, economic environment, etc., and specifcially to face the greatest financial crisis in the history of contemporary human kind. Simultaneously, establishing strategies to prevent other similar phenomena (which are cyclically repeated) from occurring the financial-economic context, would seem to be essential. Instead of finding original solutions to the crisis or presenting creative proposals towithin and for society, from which they get their lifelong salaries, as is the case of Spanish, Italian, Portuguese, French, etc. (nations where they are perennial civil servants of the public administration). Many of them Catalans or Lombards in the last three decades and in the European south have devoted themselves to "invent the garlic soup" (Romero, 2000), or "changing everything so that nothing changes" –leopardism (Di-Lampedussa, 2007). A couple of popular Spanish and Italian sayings, respectively, denote a sad reality, but for a few exceptions. The high unemployment rates make apparent that the educational system of those nations hasn't worked, –nor will it work in the future (from the perspetive of improved life-chances etc). The negativity towards the future, in the short, middle and long term is (in part) because in those communities of the old continent (i.e., Aalborg, Aarhus, Barcelona, Bari, Bergamo, Bilbao, Bolzano, Brescia, Como, Crema, Cremona, Donostia, Graz, Koblenz, Leipzig, Lisboa, Lugano, Lèrida, Gerona, Madeira, Madrid, Mannheim, Milan, Oporto, Palma of Mallorca, Pisa, Rome, Salerno, Saragossa, Tampere, Tarragona, Trento, Turin, Twente, Udine, Valencia, Venice, Vic, Zürich, etc.) those who allegedly work on the technological solutions, transfer from the university to society and/or vice versa, research, teaching, etc., are some of the origins of the current problems. Besides, the future generations of professionals have trained in public, private, hybrid universities, under lax norms for the obtainment of academic titles.

A phenomenon which has been a factor tending to increase the statistical number of the university degree holders in the EU, but who haven't received training of an especially gainful human, formative, theoretical and practical quality. In short, they have generated poorely educated people with limited vocabularies, outlooks, perspewctves, which may have atendency to deform (or limity the otlooks and capabilities) of the future generations. The social networks are a good indicator of those deformations through examples of cyberbehaviour/bullying lowest common denominator comunications/fight to the bottom etc. Cyber behaviours which go beyond the limits of the set of rules that make up legality and come fully in the set of criminal acts.

In their utopian thinking, some bureaucrats and technocrats believe that just with the social networks, the ICTs and the reduction of the digital divide they will generate great qualitative changes in daily life. However, it is necessary to remember that education, together with health care, are the two mainstays of any developed society. The educational sector is unfortuentely one of the sources of the current problems, especially in terms of the low life chances/possibilities experienced through unemployment that millions of citizens are suffering in our days. Education does not happen only at university, traditionally it was after leaving university that a professional began his/her professional training and learned his/her

Figure 1. The use of comic in the digital newspaper to draw the attention about unemployment in Spain (the official number of unemployed people reached almost 6.1 million) –www.elpais.es, 09.01.2013

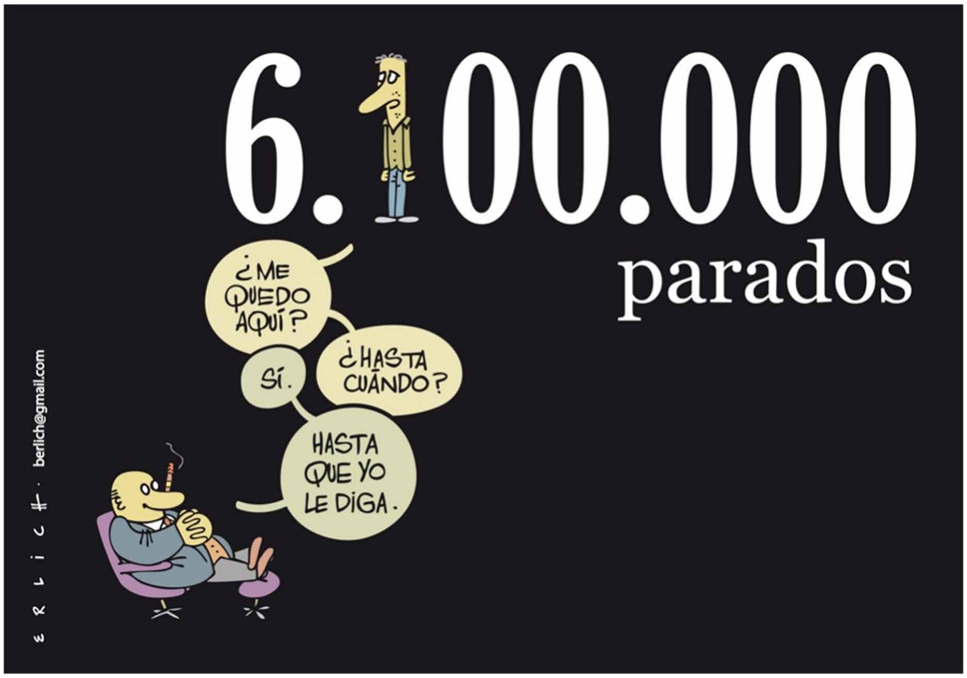

Figure 2. Growing abandonment of the population in the countries of the south of Europe. For instance, the Spanish youth migrate towards emerging countries in the Americas, Asia and Oceania –www.elpais.es (06.30.2014).

EL PAÍS IN ENGLISH

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Exit of immigrants sees Spain's population fall for second year in a row

- A total of 547,890 people left the country in 2013, of whom 79,306 were Spaniards

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The number of people in Spain has declined for the second year running for the first time since the current statistical series began in 1971. One of the main reasons for the fall is the lower number of foreigners living in the country. A total of 547,890 people left Spain during 2013, of whom 79,306 were Spanish, according to a report released by the National Statistics Institute (INE) on Monday.

During 2013, the number of foreigners living in the country fell 7.8% to 4,676,022 as a result of the combined effect of emigration and people acquiring Spanish nationality.

The migratory balance – i.e. the difference between the number of people who arrived in Spain and those who left – was negative, coming in at 256,849. A total of 291,041 people arrived in Spain last year from abroad, while 547,890 left. That figure was up 80.2% on last year.

A total of 291,041 people arrived in Spain last year from abroad, while 547,890 left

LATIN AMERICA

"The borders are the cemeteries of immigrants"
The mother of a missing Salvadoran man has founded an NGO to help search for migrants who have disappeared

Maduro facing rebellion within Chavista movement
Venezuelan leader can no longer conceal the internal rift, as the nation questions his leadership abilities

craftt for real. Unfortunately, the educational directors cannot see that they are training people to enter professions that do not exist, or else thathave changed so much that there training is entreily out of step with reality. Many individuals will have to create their own jobs, and be entraprenatural; because the Jobs lost in the West to the East wre not coming back any time soon. Educators sometimes who can't even sell a kind pf publicity spot of a few seconds, claim that the solutions go through just knowing how to use the new technologies and participating actively in the social networks.

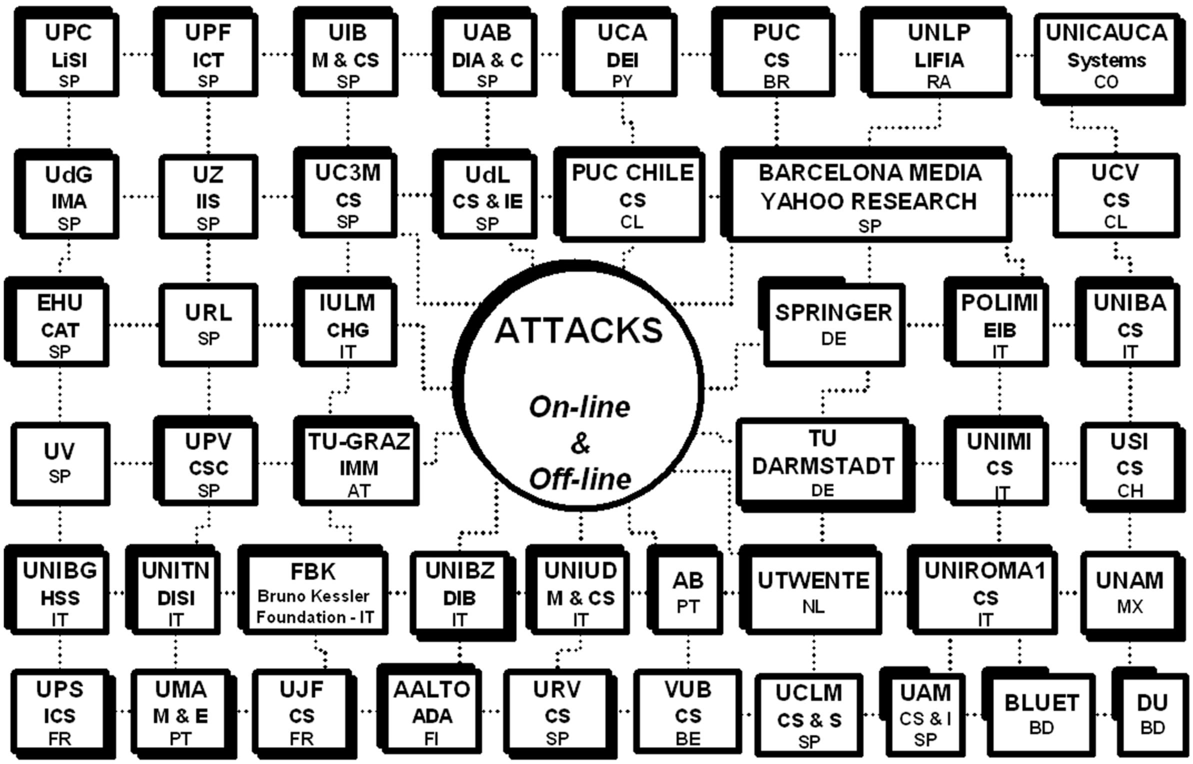
Today through the social networks it is very easy to see how graduates, engineers, doctors, etc., in mathematics, nuclear sciences, physics, chemistry, audiovisual, computer science, etc., are not prepared to seriously face the issue of the disabled, the education of children, the interactive games for the elderly, etc. Those are individuals who intermingle and interrelate in the scientific programs of the conferences, workshops, seminars, etc., both national and international, to keep on exerting an infinite pressure, manifest or latent, on the rest of the scientific community. They do it through very well planned attacks and disguised from the groups where they belong. Now one of the advantages of the social networks is the possibility of carrying out methodologies and analysis techniques to detect them, although the temporal variable still remains the weak point of these methods to prevent them.

Besides, it is not feasible to eradicate them (cyber destructors), because the current legislation in cybernetic issues is slow and even inexistent. Consequently, the application of cybernetic justice in many places of the so called "developed" countries is virtual. In other words, they enjoy total immunity. The absolutism of that immunity reminds us of the advance of the totalitarian systems in the Europe of the first decades of the 20th century. In front of the totalitarian invaders, the scientific sector kept on working for them as if nothing had happened. Once again we realize the importance of the words of the author of the Quixote (De-Cervantes-Saavedra, 2005), Don Miguel Cervantes de Saavedra, when he spoke of history as "... a rival of time, storehouse of deeds, witness for the past, example and counsel for the present, and warning for the future" (De-Cervantes-Saavedra, n.d.). That is, those who are not concerned by the current crisis (i.e., adult employement and/or neet –not in education, employment, or training; is equat to wild marketing/commercial online, in education sector) and they will not change their modus operandi thanks to the financial resources they have available and the libertinage. In other words, the social networks inside the current global village, are like the social communication of the 80s, the multimedia/hypermedia in the 90s, the virtual reality in the late 90s, etc. and are fated to have two big groups among the potential users, which following the traditional division by Umberto Eco we could call integrated and apocalyptic (Eco, 2001). That is, positive and negative aspects.

In the global village of the 20th and 21st centuries, there is an eternal and constant communicative dynamic persuasion by a few (Cipolla-Ficarra, 2010), which contradicts and attempts against the democratization of microcomputing, the hypermedia systems, telecommunications, nanotechnology, robotics, etc., and in terms of in (what should be) an the era of unprecidented expansion of communicability, and with the end-goeal set on the transition towards the era of autonomous nanotechnology communicability (the quality of the communication among the human beings, self-sufficient automats and nanotechnology devices).

Every time that there is a democratization process in terms of computer science services on wide-area networks such as the internet, a co-evolutionary process towards occurs towarsd the basis of the pyramid of the population the reappearance of the same power and pressure groups takes place. That power and pressure is exerted in order to diminish the quality and the potentiality of the multimedia services which can be obtained with the social networks. An excellent example in the last quarter of a century is the drop in the costs of international phone calls down to (effectively if one ignored elec-

Figure 3. Map obtained from the analysis of the social networks to determine the interrelations of the online and off-line attacks aimed at destroying international events through corrupt employees in European scientific publishers, students and university professors, etc. (the acronyms are equal to university, departament and country) In few words, the parochialism of the Garduña (Cipolla-Ficarra, 2013).

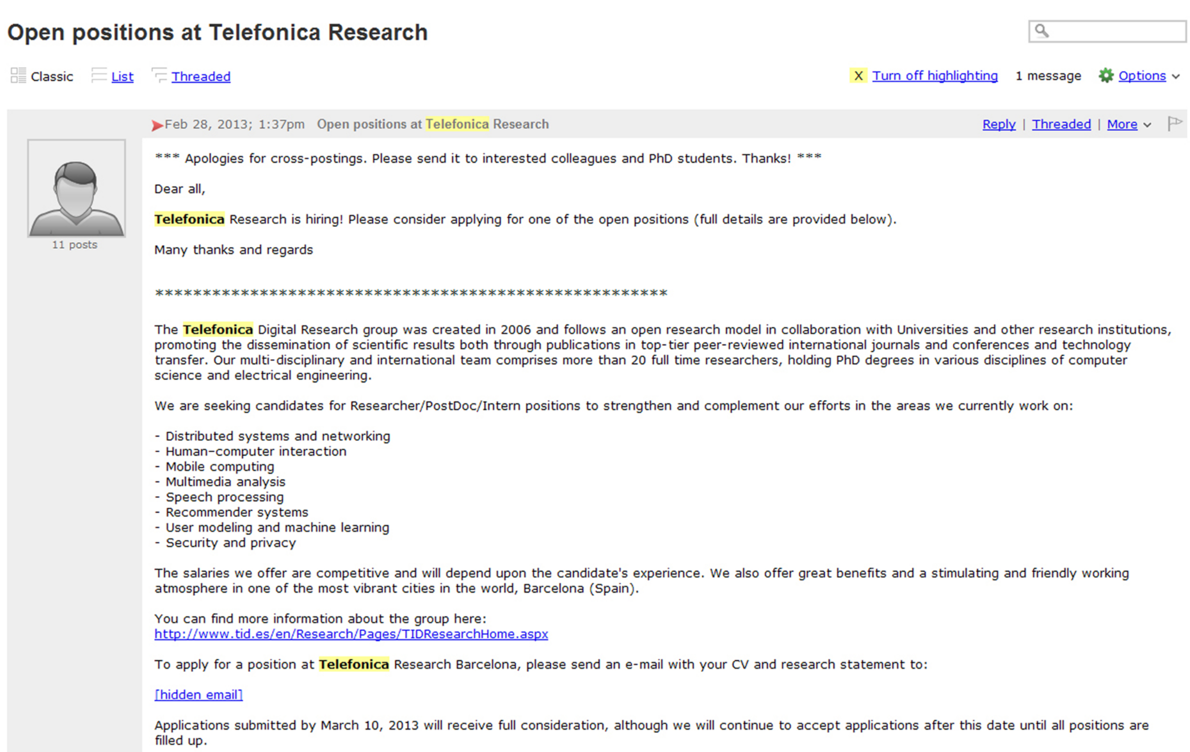


tricty, network connection costs, computer/mobile costs, etc.) to free videoconferences, and through the personal computer. Undeniably these scientific advances contradict the financial interests of the state monopolistic firms of the European telecommunications, for instance (or do they –the telcos still get paid by internet traffic in one way or another –and according to volume no less –the Internt is not really free!). Those interests favour said companies since in the 90s the costs for services of international phone in Spain (Telefonica –www.telefonica.com) were the highest in the areas that spread between Lisbon and Moscow (Barnes & Meyers, 2011). The same would happen later on with mobile phones, where the telephonic entrepreneurial monopoly applied a high commission every time that the user bought a reload of the mobile phone calls.

The consequences of all those deviations nowadays make up a part of the working place reality of those countries through the statistic data of the unemployed and the youth who migrate from their countries of origin because of the lack of jobs. However, thanks to the social networks it is easy to detect the metamorphosis of those telecommunications ventures, through R&D activities and with the support of universities, foundations or other kind of organizations, where workers are requested for international projects when legally and physically tyhey are to be found in countries with over 6 million unemployed, as is the case of Spain. Oddly enough, in those countries there are hundreds of thousands of engineers in telecommunications, computer science graduates, programmers of applications for web 2.0 and web 3.0 etc, capable of holding those posts and who are looking for a job.

In countries with an unemployment rate over 6 million of unemployed there must surely be specialized professionals in new technologies to cover those posts. However, this is a small example of how the social networks are used with the purpose of deceitful publicity. Another picaresque example is the online self-promotion that the alleged heads of departments, research programmes, etc. make in the hybrid universities (apparently with a public or secular structure but controlled by religious groups) with the subsidies obtained from the EU or the banks drawing the attention of the future students or rather clients who sooner or later will join the ranks of the unemployed or the masses who choose to emigrate. Thanks to that information it is easy to detect the corruption and/or psychiatric problems (bipolar disorder, for instance) of those characters who manipulate the social networks, the total lack of controls in the centers where they perform their services as in the figure 5, where banks are mentioned to draw the attention, when popularly they are loathed by a great part of the population due to the damage caused to the productive tissue of goods and services and therefore to the labour market of all those who must pay the registration fees of the graduate courses, engineering, masters, PhDs, etc. The current problem is the poor training that the users of the social networks have to quickly detect those mermaid songs,

Figure 4. Use of university portals in the USA and/or EU (i.e., dbworld jobs announcement –https://research.cs.wisc.edu/dbworld) to foster mobility in scientific context resorting indirectly to boost the illegal migration and/or the rubbish contracts in the EU (a contract is called rubbish contract when the conditions that are legislated in the contracts are miserable or with leonine conditions favouring the employer).



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like Ulysses, in the classic literary work, “The Odyssey” (Evslin, 1969). Some mermaid songs originate from the educational institutions, others in the traditional media, and thanks to the control exerted by those educational institutions, in the traditional mainstream media, and whether it is for technical issues (providers of technicians and specialists for the functioning of those media: sound engineers, audiovisual technicians, videocamera operators, etc) or political (main source to pay the salaries of the employees in those universities), just to mention some examples.

The concentration of power at the summit of those educational structures contradicts the foundations of the democratic system of a nation allegedly free and sovereign. Such a centralisation of power already avails itself of the applications of the social networks; not only to maintain it, but also to replicate it, transform it, multiply it, and prolong it through the decades. A way to detect them is through the online propaganda, disguised as institutional university publicity. However, the power of persuasion is very high, and the future students or their parents lack the cognitive tools to detect them ion time and thus avoid falling into the swindle net.

Now the positive factor of the democratization of the internet among the young has led to a negative subfactor such as the lack of concentration in the reading of texts. Since the 90s, with the advance of the interactive design and the adaptation to the hypermedia contexts, a change has taken place in the traditional models of structuring the textual contents of the analogical newspapers in the digital supports. A process in which not only the notion of the inverted pyramid has been respected, but also has reduced the text to a minimum. In this sense, applications such as Twitter have fostered non-reading among the young, and the wiring of a text “kernel” style (only the core of an issue in 140 characters, including the gaps, or 120 if there is a link or an image). This shortness of the message bears a direct relationship with the origins of the Internet, such as was the transmission of messages among different places of the US geography.

Some social researchers claim that among the teenagers the lack of interest towards the reading of complete books (i.e., the great works of universal literature), the growing inability to carry out mentally basic mathematic operations (divide, multiply, subtract and add), the noncommunication with other members of the family nucleus, study colleagues, friends, etc., and at its epicentre the social networks, without considering the other variables which intervene in the education process, such as the quality level of the didactic and educational contents, whether they are interactive or not. As it has been previously mentioned, education is one of the cornerstones of societies that tend to define themselves as developed. The inclusion of professionals non akin to pedagogy inside issues related to social or interactive communication etc., has generated destructive groups, strongly interrelated at an international level and who use the networks to carry out their delinquent activities.

Once their profiles are analyzed in the social networks, and placing the temporal variable alongside posts and happnings, with the passing of the months it is seen that it is they who boost the digital ldivide, the mobbing and university stalking, the destruction of international events (conferences, seminars, workshops, etc.) the prizes in the framework of the ICTs rigged beforehand, the illicit obtainment of financial funds for R&D pseudo projects, and a long etcetera. In short, they are members of the Garduña (Cipolla-Ficarra, 2013). If in the Internet those destructive parochians could be easily excluded, the positive factors of the social networks would prevail over the negative.

Their authors keep on working and studying normally in their respective institutions, since in many European communities there is a legal void in these issues. Besides, there is the possibility of hiring legal and informatics services to erase theany damage caused in the virtual communities. Once again can be seen the malleability of online information. In few words, a digital laundering to eliminate ad

Figure 5. Propaganda of the funds obtained from banking institutions in tenders rigged beforehand (www.upf.edu). In other words, the propaganda of the banks that finance the bogus university research alien to the interests of the community where that structure is inserted.

upf. Universitat Pompeu Fabra Barcelona

Departament de Tecnologies de la Informació i les Comunicacions

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31.03.2014

Cinc projectes de recerca de la UPF han aconseguit ajuts de RecerCaixa

0

L'Obra Social "la Caixa" i **l'ACUP** van lliurar el **28 de març** al **CosmoCaixa** els ajuts als projectes seleccionats a la **quarta convocatòria del programa RecerCaixa**, adreçat a impulsar i estimular la recerca a Catalunya i evitar així la fuga de talents.

S'han atorgat ajuts a **26 projectes** de recerca d'excel·lència amb un **finançament d'1,8 milions d'euros**. La gran qualitat científica dels projectes i la quantitat de propostes presentades han fet que la convocatòria hagi estat altament competitiva.

Projectes seleccionats en la IV convocatòria de RecerCaixa

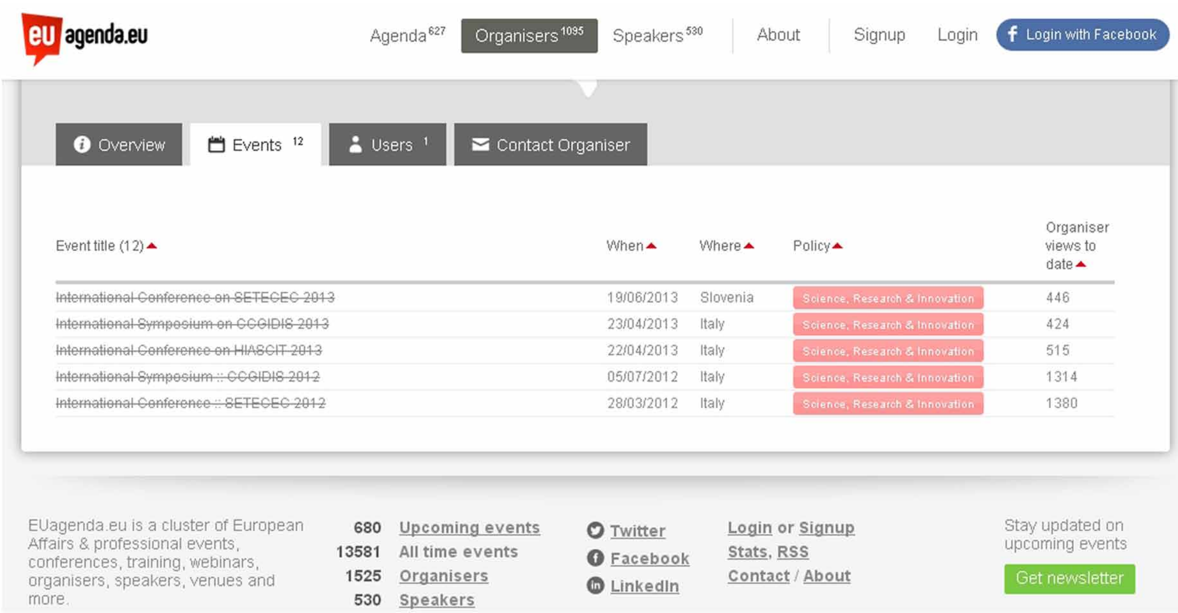
Sergi Jiménez, professor del Departament d'Economia i Empresa per: " **Foment de la integració en el mercat laboral de treballadors amb discapacitat: exercici d'avaluació política a Espanya**". En aquest projecte s'investiguen dues iniciatives polítiques que tenen l'objectiu d'augmentar les perspectives d'ocupació dels treballadors discapacitats: subvencions per a ocupadors que contracten persones amb discapacitat i subsidis per a treballadors amb discapacitat per treballar per compte propi.

Narco Poros , professor del Departament de Tecnologies de la Informació i les Comunicacions (DTIC) per: " **Integració de nens amb autisme a la societat mitjançant les TIC: INAUTISTIC**".

Aquest projecte aprofitarà el nou potencial que aporta la interacció anomenada de cos sencer (embodied interaction) entre persones i ordinadors. Es pretén que els infants amb **Trastorn de**

eternum all the evidence of the crimes committed by the cybercriminals and their colleagues, through the anonymity that allegedly the social networks offer. In the view of such nefarious examples stemming from the social networks for those authors, their accomplices and followers, an old Spanish saying applies: "Tell me who you go with and I will tell you who you are" (Romero, 2000). In the annex #1, listed are examples of destroying messages of the social networks and the democratic advance of the

Figure 6. Statistic example of an access counter to a European portal (www.euagenda.eu) is the destruction of international events through messages in the social networks, such as the interested reader can see in the annex section



formal and factual sciences. Aside from those human and social factors, in these pages we have tried to gather a myriad works from the formal and factual sciences, regarding as their origin and/or design of interactive systems. A design which can be divided into categories for its better understanding, such as: the content, the presentation/layout, the navigation, the structure, the synchronization of the dynamic and static means (panchronism) and connection. In relation to these categories and the intersection of the formal and factual sciences, some of the main topics which are approached in the current book are Internet, computer science, computer graphics, computer animation, interactive design, communicability, videogames, education, security, human and social factors, sociology, social communication, etc. In other words, we intend to have a first 360 degrees vision of the phenomenon of the social networks, considering a wide range of variables, stemming from the formal and factual sciences and tending to increase the quality of the communication.

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Chapter 1
Phaneroscopy for Video Games

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ABSTRACT

The authors present a first study for the classification of the video games from a synchronic and diachronic perspective, in relation to the notion of phaneroscopy. The chapter analyzes categories of interactive design and communicability. In addition, there is a constant interrelation among the components of the multimedia systems aimed at entertainment in the late 20th century with the so-called "Z generation," in the era of the expansion of communicability, and through the latest video game technologies, which allow the functioning of those interactive systems.

INTRODUCTION

One of the functions of the design models of interactive systems is to generate a common language among the designers, programmers, quality evaluators, etc. (Cipolla-Ficarra et al., 2010). The purpose is to avoid ambiguities which can increase the production timing and consequently reduce the costs. Although there are different models aimed at the design of hypertext, multimedia, and hypermedia systems from the 80s to days, (Garg, 1988; Yankelovich et al., 1988; Tompa, 1989; Stotts & Furuta, 1989; Hall & Papadopoulos, 1990; Schnase et al., 1993; Hardman et al., 1994) in terms of the production of interactive systems aimed at education, information, tourism, culture, entertainment, etc. their notions have been used or are used, when it comes to the design of the interactive design, whether it is an online support or off-line. How is it possible that a model born in electronic and computing departments in Milan (Italy) does not agree with the department of computer science and engineering in Zaragoza (Spain), when the mentors and potential users of said model are all university professors of mathematics and computer science? How is it possible that a design model of hypermedia systems generated between a private college in Brazil (Pontifical Catholic University of Rio de Janeiro) and another hybrid in Italy (Polytechnic University of Milan) is not understandable to a Spanish public university (Polytechnic University

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of Catalonia –Barcelona School of Informatics)? (Schwade et al., 1995). The answers to these questions can be found first in semiotics –our research work uses several notions from it (Nöth, 1995). In second place, and in terms of human factors in software engineering (Cipolla-Ficarra et al., 2011) it is possible for disagreements to be present, –there are alwsy diferent viewpointss–, however we won't analyze the same the current study, though, and because we leave this as a line of research for the future.

The use of semiotics in the design of interactive systems has proved to be very efficient when it comes to generating systems that reduced costs and with provide a high quality level, whether it is for e-learning, tourism or cultural heritage, etc.

The strategy followed has been to classify the main elements which make up the design of the system from several categories: presentation or layout, content, navigation, structure, compatibility or conectibility and panchronic (Cipolla-Ficarra et al., 2010). These categories of interactive design have been evolving with time, in order to generate quality attributes, metrics, techniques and evaluation methods, new professional profiles, etc. (Cipolla-Ficarra, 1999; Cipolla-Ficarra et al., 2010). In this sense, Umberto Eco, stresses the importance and the validity of the classifications (Eco, 2009) at the moment of generating and/or interacting with interactive systems of bidirectional interrelations, orthogonal or not orthogonal, unions and intersections, etc. These methods and techniques may be applied amongst the diffferent components which in principle can be presented as lacking those links among themselves. In our case, after experimenting with some design models of hypertext systems, including multimedia and hypermedia forms/types, and with few positive results for the heuristic evaluation of the new systems of multimedia mobile phones, we have resorted to the main notions presented by Theodor Holm Nelson in his book "Literary Machines" (Nelson, 1992), and those deriving from semiotics or semiology. In the current chapter we resort to the notion of phaneroscopy in the discovery of universal categories.

In the current work we will present a first set of categories related to the videogames –or video games, starting from the main concepts of the multimedia systems, a brief evolution of the new generations of users for the videogames, a first diachronic analysis of two design categories, and inlcudeing user capabilities such as the presentation and the navigation of information/data/interactive responses and feedback etc. Finally, we present the learned lessons, and make reccomendations in terms of possible the future lines of research along with an overall summary and thea few specific conclusions.

Texts, Reading and Z Generation

The sending of short texts for safety reasons has been one example of the origin of the Internet in the last century. The service worked among a relatively few, but identified at the time as key, governmental or public bodies in the USA. The democratization of the service came in parallel with a great diffusion of telecommunications, which through landline phones would go quickly through several peripherals: MODEM (modelatur – demodelatur), router, server, etc. until reaching multimedia and wireless phones, currently. That is, the hardware of the public bodies went over to the homes, businesses, etc., of millions of people oin our planet, turning it into a partial installation of the global village as Marshall McLuhan anticipated in the 20th century.

In this process, the text messages would join the static images and later on the dynamic means (animation, music, video, etc.). In other words, the switch from hypertext towards hypermedia. However, in this process the text would lose the interest of the users, in face of the dynamic contents, reaching the second decade of the 21st century by the users of interactive systems practically do not as a class or group read literary works –at least as demonstarted in major behavioural studies (Cipolla-Ficarra et al., 2013).

That is, the ideal structure of the three parts which make up the inverted pyramids (Cipolla-Ficarra, 2010), in the first home pages of the web for the news has disappeared with multimedia mobile phones and the social networks. Only the lid or the first 15-20 words endure. This is due to the new online portals such as Twitter, where the text regains its importance once again, but the service is oddly limited to a minimum number of the characters including the blank spaces. This shortening of messages is itself, superior to the traditional SMS of traditional mobile phones, whose use has tended to disappear among the young er users who have been born in the time of the democratization of the Internet, especially with the Web 2.0 known as Z generation.

We note the Z generation as those infantile and pre-teenager users who since their earliest childhood have been interacting with the Internet and smartphones. By smartphones we understand the term to be defined in the current work whereby the devices combin telephony and computing, and that conceptualized as early as 1973 and offered for sale beginning in 1994 (Barnes & Meyers, 2011). However, the term "smartphone" did not appear until 1997, when the phone manufacturer Ericsson described its GS88 model "Penelope" concept as a "Smart Phone". Another of the denominations we use as synonymous is NRG (Not Reading Generation). Whilst these terms may seem prejudicial to the younger generation, in this chapter we adopt an apporach whereby we note the behaviour of paritioned sets. classes of people as a whole.

Another way to group them is through the notion of pure digital natives, that is, currently we mean all the users from 0 to 12 years of age. Finally, the term Z may related to a computer animation called "Ant Z".

1998, by the American producer DreamWorks SKG (www.dreamworksanimation.com). In some way, it implies revolutionary changes and not through evolution. That is, that the digital divide between users and the use of new technologies, has decreased with the purpose of increasing the consumption of commercial products, not only from the point of view of the software, but rather of the hardware. In this sense there has been a switch from a familiar multifunction product as was the personal computer, to the personal micro-computing of the multimedia mobile phones wired to the Internet, without considering the difference between the positive or negative signs which the terms evolution and revolution may have in the context of the new technologies. For instance, the lack of reading of texts is not an evolution or

Figure 1. Ant Z film –DreamWorks (www.dreamworksanimation.com), 3D computer animation

negative revolution, but rather an involution in the human skills of the future generations (Carr, 2010).

An example of a distinct lowering of intellectual/functional ability –as defined tradionally– is the virtual inability to make mental calculations or even in front of a folio, with division, subtraction, multiplication and addition exercises by those adult users defined as digital immigrants. Those digital immigrants have derived said operations to the calculators since an early age. Later on, the operative systems since their early versions such as Windows would always include that digital accessory. The involutions in the calculations as well as in reading among the new generations render the cognitive computing studies totally obsolete, since the human being, after losing the reading skill for prolonged periods of time and without interruptions, will lose the ability of a fluid and relational expression of the issues he/she approaches in the exposition. However, a common denominator still exists among all these generations, the game or videogame.

VIDEO GAMES: OLDER GENERATION VERSUS NEW GENERATION?

The rhetorical question allows us to introduce some conclusions from experiments carried out with real users from different ages, computer knowledge, experts in traditional games, etc., and with regard to the smartphone videogames, tablet PC, etc., and those who work in the personal computers. First of all it is necessary to make a differentiation between two great groups of videogames development of the 20th century: "classical" and "special" developments. For instance, the entertainment sections in the digital encyclopedias serve to boost the knowledge acquired by the user, as in the case of the crosswords or the trivial or the Movie Guide Corel encyclopedia (Movie Guide Corel, 1995). If the new generations do not read enough, the interest and the ability to make crossword puzzles automatically will also decay until they disappear, for instance. That is, there is an involution of the human skills as has happened with the arithmetic operations, and in terms of the transition period between the old and the new millennium.

- **Classical:** Crosswords, trivial, jigsaw puzzles, etc. The content is directly related to the main system.
- **Special Developments:** Mostly they are graphical adventures, which follow the storytelling stages: exposition, conflict, plot and denouement (Garrand, 1997).

Traditionally, the content must adjust to the different kinds of users. In order to reach this goal in the classical entertainment, several levels are usually inserted which are chosen before starting to interact with the subsystem (at these levels of the entertainments it is possible to determine the "difficulty" to be overcome. For instance, the approximate total number of words to be discovered at the minimal level are 20, in the middle level are 30 and in the high level 50). In the special developments which belong to the "classical" and "graphical adventure videogame", as one advances in the stages of the narrative generally the level and complexity of the content increases. In the figure 3 a screen shown which belongs to a classical subsystem where the user can choose between two types of entertainment, four types of contents, and even the number of players.

If one considers each one of the levels of content of the classical systems, then it can be seen that there are a high number of constituents or components which belong to the four main categories of the interactive design (layout, content, structure and navigation), which are kept in common among these levels, such as can be the location of the navigation keys on the screen, the typography, the background color, the modality of access to the information in the database, etc. This homogeneity can be seen in the crossword subsystem inside the screens belonging to the low

Figure 2. For a correct resolution of the crossword the previous interaction with the system is necessary

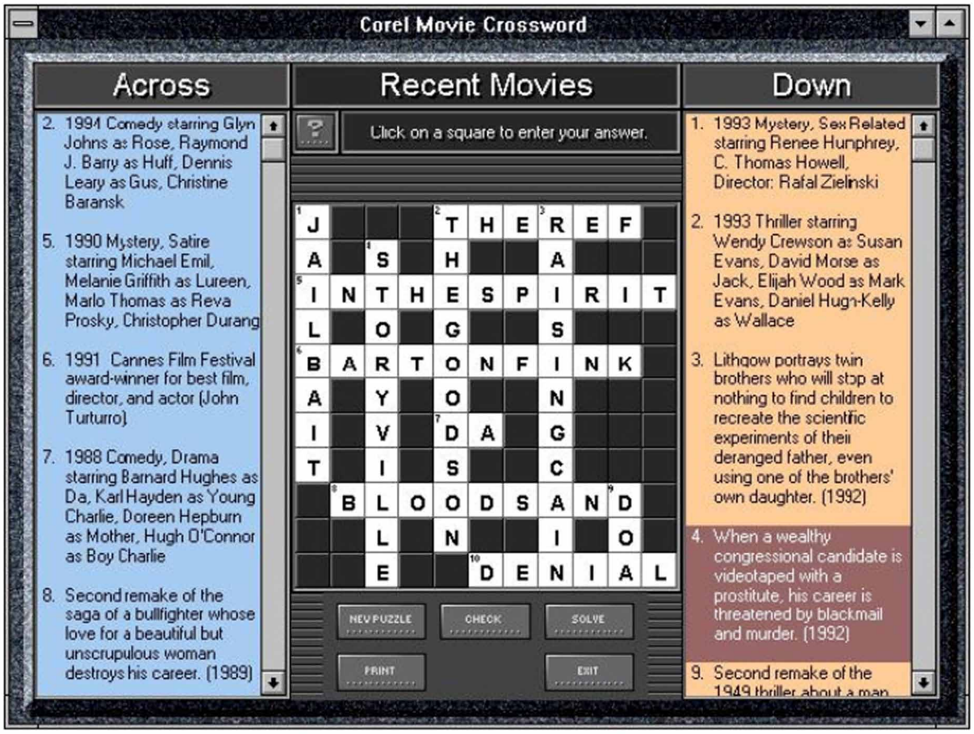
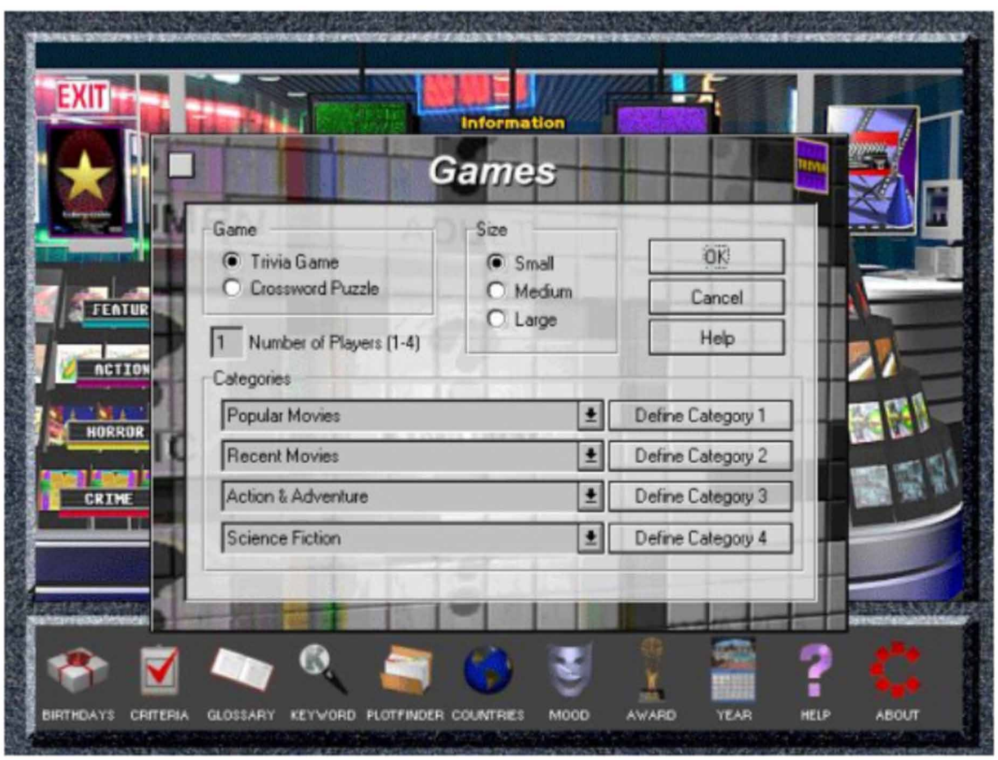


Figure 3. The user can choose three difficulty levels of the interactive system



level (figure 2) as well as the high and mid level of the 4 and 5 figures.

The crosswords in paper medias, especially those published in newspapers or magazines, are regarded as a valid tool to maintain the plentiful functions of the brain in the passing of time. Cross word puzzles and similar games is a pastime which has maintained and increased those roles (i.e., attention, memory, etc.) in the off-line multimedia systems, as it can be seen in the Figures 4 and 5, through the possibility of increasing or decreasing the degree of complexity. The same happens with which we might more or less call its numerical version, such as Sudoko (digit-single or number place). However, the use of crossword puzzles and the like has folllowed a popularity curve which is more limited among the population today and preferably youth related to the formal sciences due perhaps to the affinity of issues towards mathematical functions, as opposed to literary ones; and in terms of the great majority of the members who make up the new generations of interactive systems users, for instance. Some experiments made with adult or senior users of interactive systems have shown that 83% prefer a crossword without difficulty levels; rather than interacting with Sudoko (Edvardsen & Kulle, H., 2010). The same being an interactive system

Figure 4. Middle level of the crossword

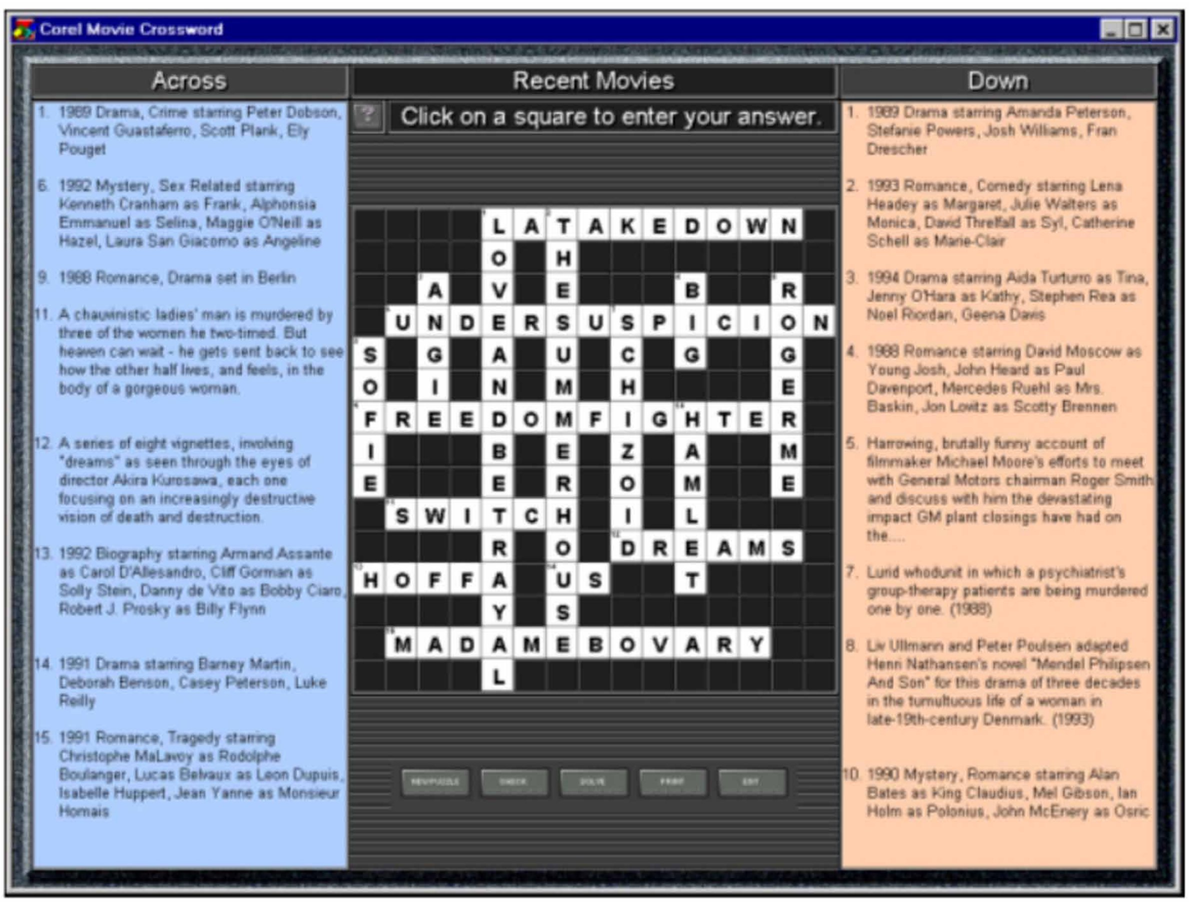
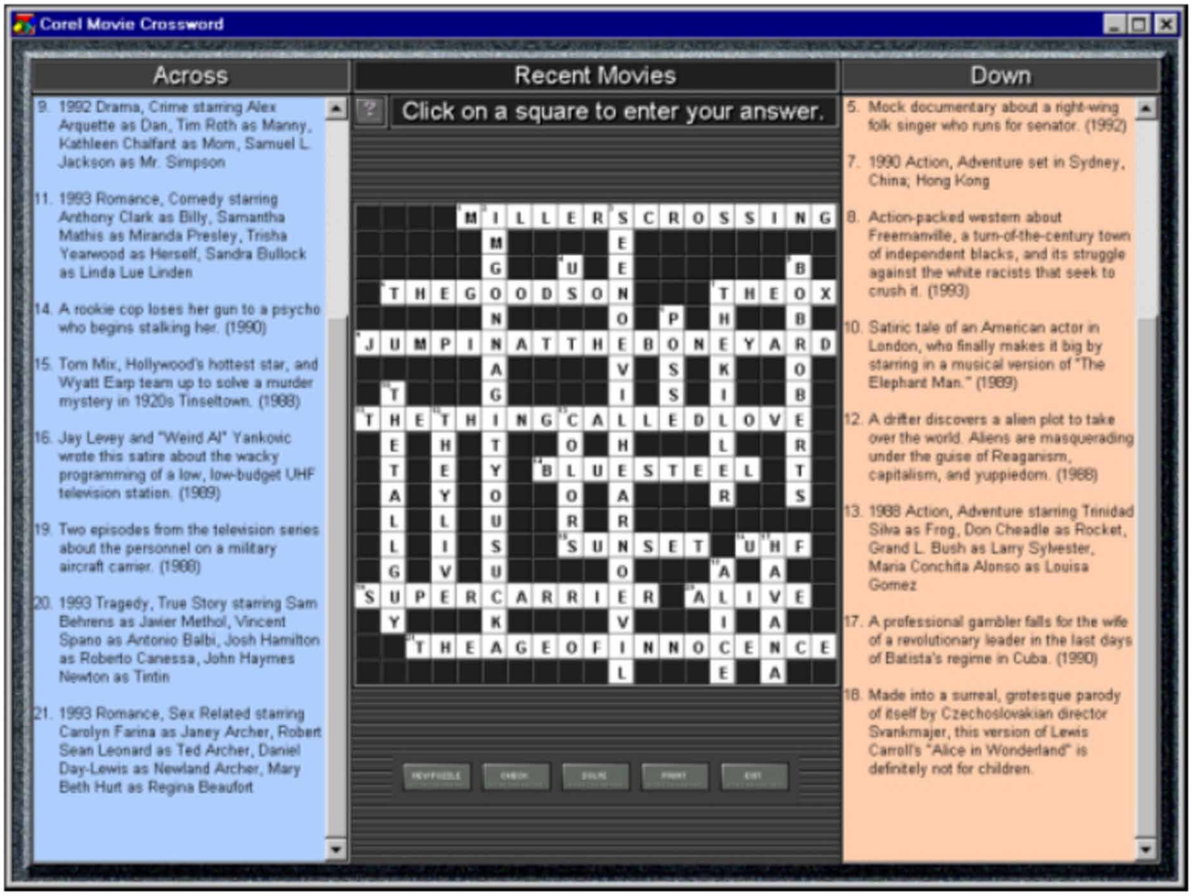


Figure 5. High level of the crossword



which may contain the same options of increasing or decreasing the difficulty levels, for instance.

MULTIMEDIA AND VIDEO GAMES: STRUCTURE

Another category of design examoned is that which we call structure. The structure of many videogames is similar in some cases to off-line hypermedia systems. For instance, if we watch basic types of access structures we have: linear list, two-way linked list, cycle, tree, re-entrant tree, free form network, etc. (Mitchell & McCullough, 1995) These structures at the moment of design are related to several attributes of quality such as can be accessibility, factual function, control of the fruition, etc. (Cipolla-Ficarra, 1997; Cipolla-Ficarra et al., 2010). Whilst analyzing any particular one of them we can grasp to a greater or lesser degree of evolution or revolution patyhways or trends within such new devices for interactive entertainment through the computer. For instance, the control of the fruition is a quality attribute of the interactive system, and which allows the user to manage an interaction process towards those specific areas of the structure of the interactive system that the designer conditioned should be directed towards and what actions can be performed on the system or videogame (the quality attributes of the hypermedia systems are broadly described in the following references (Cipolla-

Ficarra, 1997; Cipolla-Ficarra, 2010). One might think of the same as a process of delineating the choices available to the user – in terms fo actions, pathwatys, interactive possibilities etc. We therefore establish three types of control levels within the fruition of interactive systems: low, high and middle. Next each one of these levels is briefly described with their matching examples:

1. **Low Level:** When the control of fruition is required to be low, the paths to be chosen are restricted and set beforehand, such as in the Computer Aided Education (CAE), the tales or adventures for children, etc. For instance, in the first graphic adventures of the off-line multimedia based literary works for children from the late 20th century, the structure of the interactive videogame admitted a single direction in the navigation, without any possibility to return to the main menu until not finishing with the set of nodes which make up the chosen subject. For instance, in children CD-ROM (Peter and the numbers, 1994) present is a low level in the control of the fruition, since only active option until the nodes sequence isn't finished is "Continue". This videogame for example has both sequential and unidirectional sequences present in early hypertext systems, whereny one starts from an initial node (P_1) and continues until one reaches the last node (P_n). However it is not possible to go back to the first node (P_1). In the following figure 6 an outline is shown to highlight the sequential and unidirectional structure of the system:

2. **High Level:** The control in the fruition is high if the user can head from one part of the structure to the totality; or in other words if more than the half of nodes are accesible in this way and which make up the multimedia system. Examples include cases of searching of information structures such as in the hyperbase (the word stems from the semantic model design of data bases for hypermedia systems called HBMS –Hyperbase Management System (Schnase, 1993), that is, an administration system of data bases) or in the execution of tasks. For instance, in the multimedia system "Magical Theatre" (figure 7) the user can go from any node to the rest of nodes which make up the structure and carry out tasks without any need to go previously through other nodes. One has a real flecxibility of navigation or branching capability. These kinds of tasks generally consist in modifying an image, insert sounds, eliminate part of a content, request help, etc. The access to all the nodes of the system is distributed in the margins of the following screen as follows:

A way to graphically depict a set of nodes corresponding to the previously described system is as follows:

Figure 6. The user must go through all the nodes to go back to the start

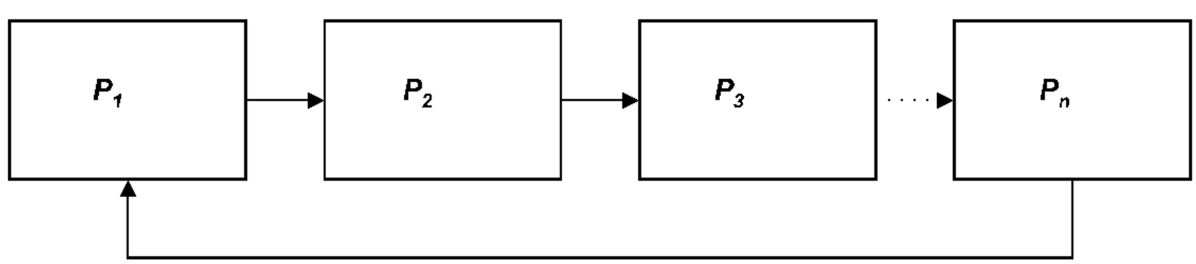


Figure 7. This hypermedia system has a low level in the fruition (Magical Theatre, 1994)

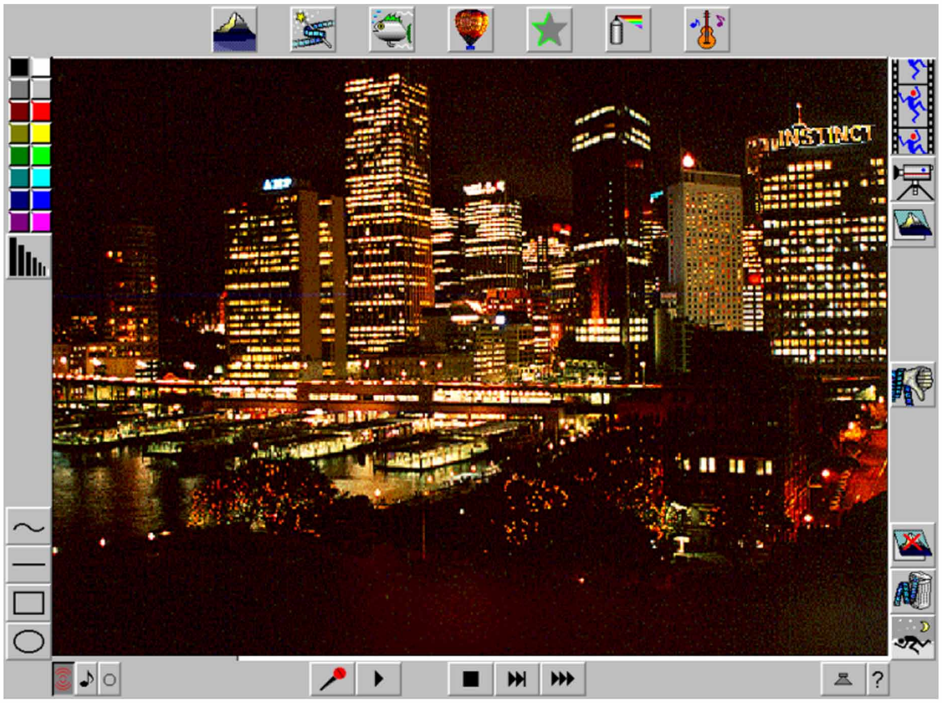
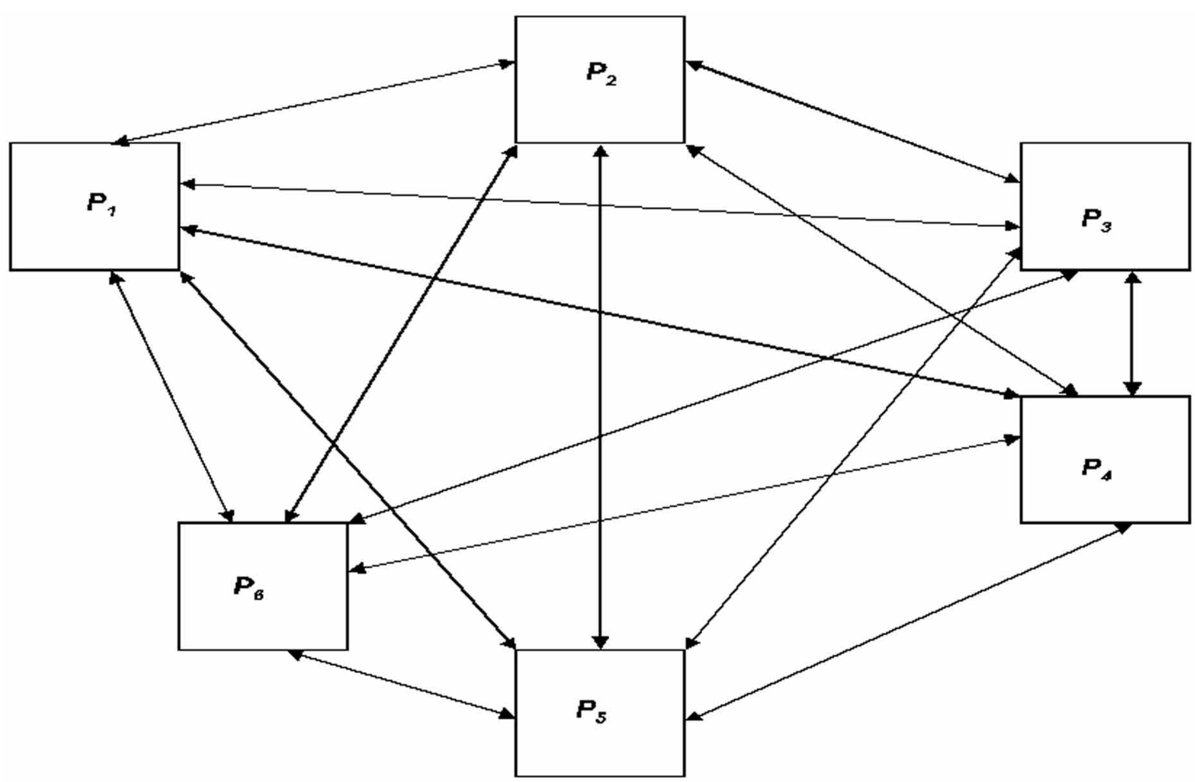


Figure 8. From any node there is access to the remaining nodes in the structure



3. **Middle Level:** There is a middle level in the control of the fruition when in the sequential and bidirectional navigation of a structure represent are one or nodes which are interrelated to a subset of nodes, and which in turn are all interrelated among themselves in a bidirectional way. In the nodes of the subset aside from observing the content it is possible to modify it. In the figure 9 is shown an example of a system where the fifth node has several connections to other nodes which are related among themselves in a bidirectional way.

An example of middle level of control in the fruition is to be found in the system "World's Greatest Classic Books" (figure 10). In this system a capability is preovided whereby while one navigates amonst the data units, and through certain elements of textual content belonging to a literary work such as "The Confessions of Jean-Jacques Rousseau", one can access variouse textual elements and carry out a set of actions on each the visited node: and for example to highlight sentences, mark a page, erase a paragraph, etc. (figure 10).

Excepting for amoment those videogames which allow Wi-Fi interaction, for instance, the Nintendo Wii videoconsole, and the movement of practically the whole body in the interaction such as can be the golf, tennis, rhythmical gymnastics videogames, etc., the rest of the current computer videogames that we explroed can be included, from the point of view of the control of fruition, in one of the mentioned sets. Besides, the control of fruition allows another classification of the content of the multimedia systems or videogames in relation to the quantity of human-computer interaction. This amount of interaction can be split into three levels: lower, middle and superior. At the superior level a greater interaction with the system is required (taks dependent) than in the lower level. In the lower level there are the ebooks, information standpoints, catalogues, etc. whereas in the higher level are located the games. Between both levels there is the middle level with

*Figure 9. P5 is the node which is connected to other nodes which are "different" to P+ and P**

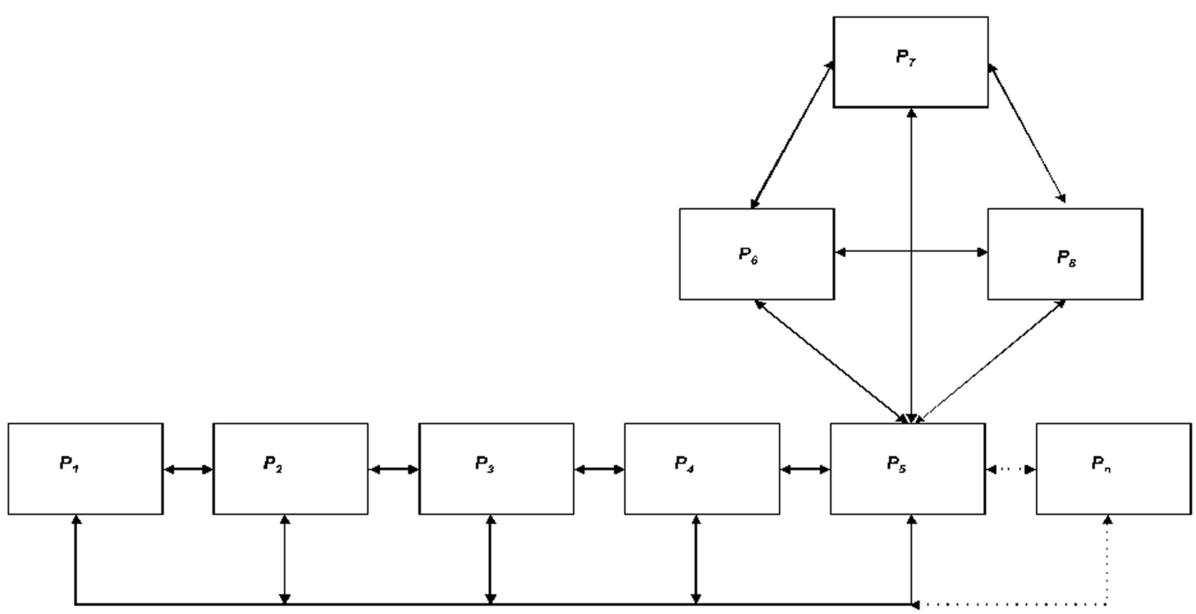
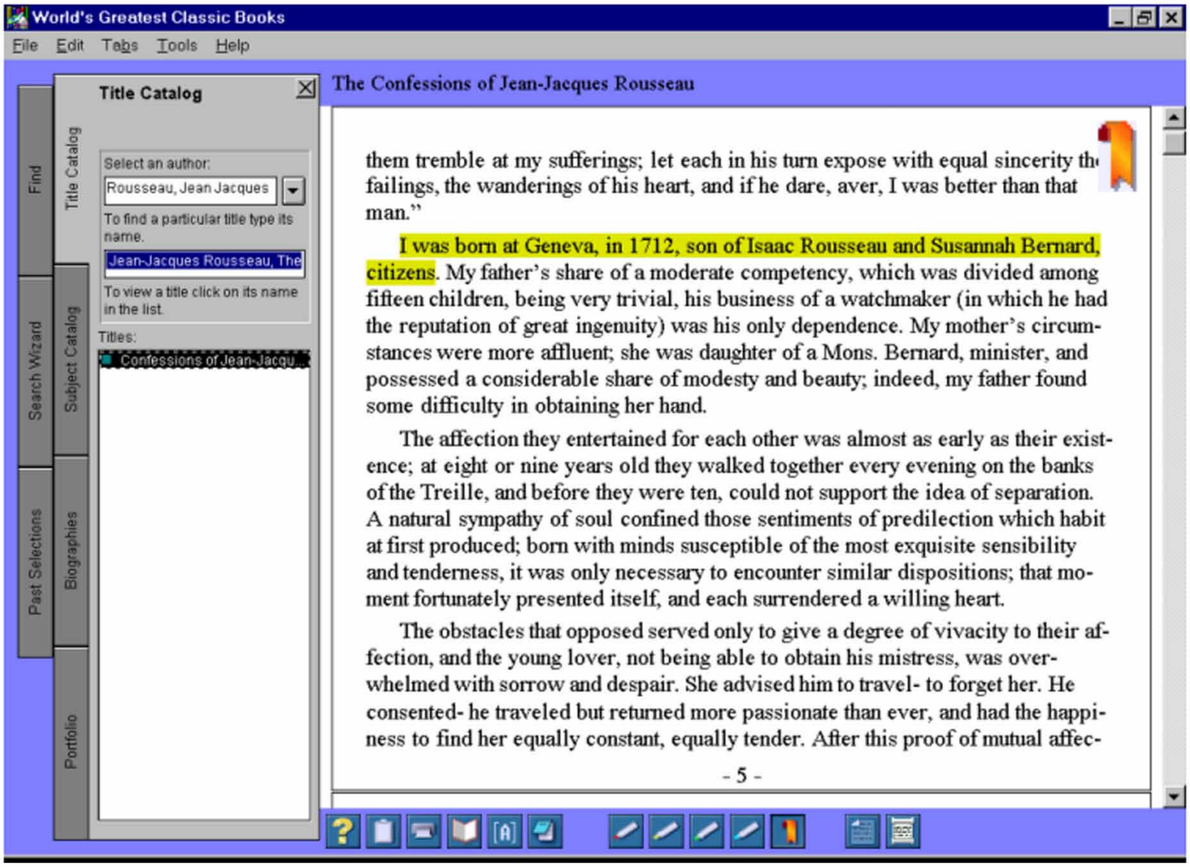


Figure 10. In the structure of the system there are "areas" which allow one to modify data elelments in several ways the content of a textual element (World's Greatest Classic Books, 1995)



computer aided education or the encyclopedias. At the moment of the design of the multimedia system the content and the eventual types of users determine the interaction level (Lundgren, 2008).

TOWARDS TO THE PHANEROSCOPY

Now considering the structure and in relation to the skills deployed by the user at the moment of the interaction, for instance, concentration, reasoning and the movement of the fingers, hands, arms, etc., the interaction with videogames has obviously been evolving in relation to the hardware and the software which is at the disposal of the users (Piaget, 1993). In the period of time which goes from the late 20th century untill the beginning of the 21st century, we have two great sets, where there are intrinsic attributes which interrelate with each other:

1. Body movement or psychomotion,
2. Memory, logic, strategy and psychomotion.

A first set of examples of computer videogames and video consoles (Kent, 2001; Wolf, 2012), bearing in mind the skills that they demanded from the user, and in relation to the software and the hardware, are as follows:

- **Skills:** Psychomotricity related to sports (soccer-FIFA, basketball-NBA, etc.) fights (Doom, Mario, Pacman, etc.).
- **Skills:** Psychomotion and reasoning, logic, strategy and memory. For instance, adventure and role games (Indiana Jones, Monkey Island, Final Fantasy, Tom Raider, Pokemon).
- **Skills:** Reasoning, logic, strategy and memory. Simulators and constructors (Microsoft flight simulator, Sim City, The Incredible Machine); strategy games (Edge of Empires, Civilization, Lemmings); Puzzles and logic games (7th Guest, Tetris) and questions games (Trivial).

Several of these same videogames, even though they belong clearly to one of these sets, also present some characteristics from the other sets. For example, it is frequent that in the adventure type videogames that there are some arcade scenarios. In other words, the modern videogames such as Tomb Raider, Prince of Persia, The Sands of Time, World of Warcraft, etc., can't be classed in a totally pristine way in some of the presented groups. Obviously, this is a factor related to the creative aspect of the videogames design, and gameplay aspects, and especially when said videogame is analyzed from a narrative point of view. The narrative structure transferred to the videogames has boosted this entertainment software industry, whose content has surpassed the educational systems. The construction of narrative experience belongs traditionally to the adventure and role playing genres, and in the last several years the narrative component of the videogame has taken an ever increasing importance in all the genres.

Since the late 90s, games such as Tomb Raider or Final Fantasy brought a new hybrid commercial genre to the fore; the action/adventure genre. This is a very peculiar genre, not only was it originated from the integration of the narrative in the action genre, but it is also based on the enrichment of the traditional mechanics of chase-capture of the action videogames, and with different ones. For instance, in Bioshock, marksmanship is combined with the search/exploration in Prince of Persia; and with The Sands of Time whereby swords fighting is combined (hunting mechanics) with the mechanics of physical/perceptive dexterity inherit and perhaps developed from the platform games. On some occasions different game mechanisms are integrated in such a balanced and varied way that it is very difficult to distinguish a prevailing one from amongst them. For instance, in Grand Theft Auto IV are frequently alternated; scenes based in driving (race); with scenes of armed confrontation against gangsters and thugs (hunting/capture). In the role videogames it is also very usual to see at balanced alternation of several dominants in the game mechanics, for instance among missions based on the search for treasures and/or missions with the goal of facing and destroying classical characters of medieval literature such as are the wizards, sorcerers, dragoons, etc. This great variety of missions is specially apparent in the narrative worlds of those videogames which have an online component and where the users have either in an isolated way, or in groups, have as their goal the victory of good over evil. Skills and/or dexterities that require from the potential users a previous experience such as are the rules for the chess game or a cultural background for the Trivial. However, those games that require knowledge expanasion, little by little, have been removed by those which only entail physical dexterity, such as can be the sports through the Nintendo video consoles (Wii). With regard to those skills and/or dexterities Ball highlighted the following (Ball, 1978):

1. They can be used to stimulate the sense of alertness of the players and improve their thinking skills.
2. The format of the videogames, in many cases, can simulate an experience or real life situation.

3. They can increase the attention gap of those players which present difficulties in the making of an individual task after a specifc period of time has elapsed
4. They can help in the development of skills for the identification and assimilation of numerical concepts, words recognition, identification of objects and colors, increase of the reading rate, improvement of understanding, etc
5. Some activities fostered by the videogames can be specially adequate to those people who must face up to learning problems related to acceleration and retard in terms of perception, reading or writing skillsm or physical/mental skills, etc.
6. The players may perceive their own mistakes and are encouraged to correct them or select other options
7. The players can transfer the patterns of behavior learned through the videogames to real life situations.

Ball, aside from stressing these potentialities of the videogames (Ball, 1978), very usable in the educational environment, for instance (Gervautz & Shmalstieg, 2012; Salas & Peyton, 2009), established four areas for the evaluation of the videogames as didactic means: the instructive development of the videogames, the development of skills by the videogames, the design of the videogames and its ability for adaptability and flexibility. In order for an educational game to fulfil the function of educating by entertaining it must respond to some of the main features which are next listed:

- The structure and the access to the information must stimulate the player, and even better if the goals to be reached are established.
- Keep down the maximum of known elements by the potential users, especially in the construction of the interface metaphor.
- Variety of non-repetitive contents. That is, to foster the quality attribute of usability of information in the interactive systems, by resorting to the notion of perspective, for instance. There is also a reference to the attribute of richness in terms of both the dynamic and static means to foster the learning process in regard to the potential users. For instance, at the moment of looking up or exploring a page on an interactive encyclopaedia a child can appreciate the animation and sound effects, whereas an adult, because of time reasons regards them as a kind of waste of time at the moment of accessing what he is searching.
- Use of world-renowned characters such as those stemming from literature, animation cinema in the computers, comic, etc. In the case of virtual characters created for a given interactive system, all of them should be extremely wellmade, that is, with an elegant style and in agreement with the content.
- Include several games and didactic activities in relation to the potential user's skills, without causing any frustration in the user.

Currently in many education centres in Southern Europe the reigning educational culture regards computer playing as harmful to the young users, especially in the first years in which they attend schools (Salas & Peyton, 2009). Contrary to this, the studies made by Piaget, for instance, have demonstrated that the processes that guide the game and those which foster learning are similar (Piaget, 1993). In the behaviourist conception of people, reality is not a discovery, but rather a continuous construction of people. That is, it is based on the development of an asymmetrical model instead of a single model of a magisterial nature. Under this perspective playing is not a kind of escape from the materiality of the present, but rather a specific dimension (neither spatial nor temporal) of the behaviour that allows humans to rebuild reality. It is a space whereby one may exercise the mind in new ways and/or to new degrees and for the pupils who to live in modern society. That is why it is necessary or desirable that there is an intersection between the real world of the child and his activities outside school.

LESSONS LEARNED AND FUTURE RESEARCH

Aside from a fast classification which can be made of the videogames from a commercial point of view, that is, production date, necessary technological support for its functioning, languages of the content, etc., identified and present are videogames which occupy a central point in the interaction of several sets and modes of working and realiting to reality. In other words, games are not easy to classify in terms of cultural funtions, since they have common denominators with more than are posisble to explore within a narrow set of videogames, when analyzing their structure, the role and purpose of the player and the actions to be developed with the game stemming traditionally from the board games, such as: hunting, war, alignment, recollection and race. This is a consequence of for example commercial factors present in the south of Europe, and which systematically strives to demolish many new scientific environments, stemming from the innovations of software and hardware, through the downplaying of the obtained results, in the first research. That is why in the current work a correct phaneroscopy is that which focuses on the contents of the videogames. Starting from them, it is possible to establish sets and subsets contents and potential users, for instance. It is also feasible to carry out semiotics analysis but regarding these interactive systems as an intersection of dynamic and static means, and not as a union. The union of means is the analysis made by some semiotics professionals when automatically transferring the semiotics tools in the task of classifying them. The environment of the intersections from the point of view of the interactive design categories is another open line for future research.

CONCLUSION

Building models for the design of hypertexts, multimedia and hypermedia is a positive activity, specifically if all the agents who take part in the process from orgin to production during the conception of a system use a common language, for instance. The passing of time in the last two decades has demonstrated that this goal hasn't been fulfilled and rather has been generated a kind of Babel tower amongst all of the agents that must intersect in the elaboration of the videogames as a medium of human activity with possible realities, for instance. Besides, there is no accepted or stanadard terminology or methodology which can be applied to this so essential activity; as in for example the classification of the interactive systems, and whether they are aimed at entertainment or not.

A way to solve this problem is by resorting to the basic notions of the interactive systems (hypertext, multimedia and hypermedia) and semiotics, whereby the ambiguity between the signification and the significant practically doesn't exist –and is recognised as such by the designers of such systems. A way ahead that may solve the aforementied problems can be found. Perhaps by starting with a correct classification of the videogames themselves, with the specific aim content category; and helping the the Z generation to educate themselves, and to orient themselves in terms of the wide universe of games, educational or playful purposes available to them, for instance. This way is very important because the longer-factor book type reading process is disappearing in the Z generation, and we do not wish this fundamental caoability to also has practically disappear in as similar fashion to the ability to make mental calculations as happened with the digital born generation.

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KEY TERMS AND DEFINITIONS

Communicability: A qualitative communication between the user and the interactive system, such as hypermedia, mobile phones, virtual reality, immersion multimedia, among others. The extent to which an interactive system successfully conveys its functionality to the user.

Control of the Fruition: Is the degree of autonomy in navigation that the structure of the multimedia systems given the user. The degree of autonomy in the user's enjoment of system can be high, middle or low when the user decides towards which areas of the structure the system can be directed, and what actions can be carried out from within by the user him/herself.

Design Model: It is the intersection between software engineering, interface design and human-computer interaction/communication into the multimedia/hypermedia area.

Generation Z: Is one expression used for the denotation of people born after the new millennial. There is no agreement on the exact dates of the generation with some sources starting it at the mid or late 1990s democratizationn of Internet) or from the mid 2000s, to the present day.

Interactive system: It is a computer device made up by a CPU and peripherals, whose functioning requires a constant interaction with the user. Currently these systems tend to their miniaturization, the mobility and wireless connectability among them.

Phaneroscopy: A term Charles S. Pierce. Pierce coined this term from the Greek words phaneron and scopy. The principal task of phaneroscopy is the discovery of universal categories. In other words is a doctrine of the categories.

Video Game: Is an electronic game that involves human interaction with one or more user/s interface/s to generate audio-visual feedback, for instance, on a video device.

Chapter 2
Synechism in the Video Games Design

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ABSTRACT

The authors present an analysis of the first set of elements belonging to the interactive design categories: layout (naturalness of metaphor) and content (storytelling), which make up synechism in video game design. In addition, they examine the evolution of the notion of the video game in relation to the advance of the software and hardware. Finally, the authors include in that analysis the changes in storytelling, due to the greater or lesser presence of the dynamic means and the static means of hypermedia communication.

INTRODUCTION

The term synechism is a term that Charles S. Pierce coined to designate continuity (Colapietro, 1993). Although it is a word that stems from the Greek (zyneches "continuous" + ism from "together" + échein "to have", "to hold") and which has diverse applications in the context of the factual sciences. We use it in the current work to investigate some of the elements of the design of interactive systems which have stayed invariable across time. The notion of design in our case is made up by several categories (Cipolla-Ficarra & Villarreal, 2011): presentation or layout, content, navigation, structure, compatibility or connectibility and panchronic.

There are categories which serve to establish parallelisms among the online and off-line multimedia and hypermedia systems, aimed at education, information, etc., and entertainment, especially the video games (or videogames) of the so called digital born or Z generation. In the current work we will focus on the narrative aspect of the interactive systems. A narration which through interactive design is underpinned by components of the computer graphics, data-

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base, social networks, etc. (Mine, 2012; Denault, Kienzle, & Journey, 2011; White, Koch, Gehrke, & Demers, 2009; Badler, Palmer, & Bindiganavale, 2012; Shahabi et al., 2007; Morris, 2012; Churchill, Bowser, & Preece, 2013), and in order to increase communicability among the users and the interactive systems. This underpinning has an essential goal, to make the users surf through the whole content of the system, since starting from the first hypertexts, sequentiality in the reading of a text, for instance, can be interrupted.

The first commercial hypertexts stemming from the software multinationals such as Microsoft or Corel (Cowpland Research Laboratory) included the whole literary work in multimedia off-line support such as CD-ROM, CD-I, DVD, etc. The novelty of the interactive support required special solutions for the graphical interfaces and usability engineering in the early 90s, since the democratization of contents in digital supports was taking place. First the static means prevailed (texts, sketches, graphics, etc.) above the dynamics (video, computer animations, audio, etc.), for reasons of capacity in the storage of the information and speed in the access to said information (Cipolla-Ficarra et al., 2011). As the speed of the personal computer processors and the graphic cards was increasing, there was a tendency for the dynamic means to surpass the static means, especially with the momentum of the multimedia video games in the mid 90s. With the democratization of the Internet in the 90s, again the cycle repeated itself, in terms of the dynamic means surpassing the dynamic means due to the speed of the net, that is, the transmission of bits per seconds.

The use of the optical fibers in telecommunications made that barrier disappear in communications, through the computer for millions of users. Users who could share multimedia contents and interact among themselves. Obviously the possibility of playing online opened new horizons of research and development in the multimedia environment. However, across time, the capacity of drawing the attention to the textual contents decreased, as well as the ability to lend attention to oral communication, especially among the users born in the momentum of the internet. Now, although they have decreased (interconnection(s) between voice/text) it doesn't mean they have disappeared, and it is starting from them that we establish the parallelisms among the video games and the multimedia systems in off-line support, for instance. One of the foundations of narrative is the separation between the narrated world (author, designer) and the existential world (reader/user). The degree of effective achievement of this separation depends the success of the story and the suspension of incredulity in front of what is told, to that which naturally tends to occur or pop-up in the mind of every reader/user.

We have inserted in this relation the roles of the enunciator and the recipient of the interactive contents, in the generation/development of a videogame. Now, in an interactive game the reader makes progress in the story through intersections, in such a way that every interaction entails a connection between both worlds. The link is achieved through immersion (Cipolla-Ficarra, Cipolla-Ficarra & Harder, 2008). That is, what is called immersive multimedia. The greater the immersion of the player, the greater the feeling of said player of being inside the game, and the greater, therefore, his/her credulity. The immersive feeling has a very important implication for fruition: the self-identification of the player. However, the greater the identification, the less interesting become the other characters, the less is the empathy they must inspire and the lesser is, in short, the wealth of the narration (Cipolla-Ficarra, 2005; Cipolla-Ficarra et al. 2011).

Consequently, immersive multimedia in the video games is not akin to narrative. The opposite is true, it runs against it. A way must be found to mollify the identification impulse and thus boost the appeal of the rest of characters (within of interactive fiction), and to change the point of view. In the games in first person, (Myst) the user of the videogame is the protagonist of the story and, therefore, the identification is maximum. In contrast, in the games in third person, the user controls the protagonist (Tomb Raider) or watches the protagonist (Resident Evil) which grants more attention to what happens is the environment. Consequently, an environment related to the main aspects of graphical computing, such as can be emulation or reality simulation, is/are developed, analysed and dicussed.

Now, a videogame can be regarded as a formal structure, lacking in narration (Tetris, checkers, chess, etc.). In contrast, in a narration there are components that are complex to formalize, for instance, the behavior of the characters (Sims).

VIDEO GAMES AND INTERACTION

There are several definitions of video games that correspond to the same notion as hypertext, multimedia and hypermedia; and these alignments have been evolving with the passing of time. At the same time, it is necessary to differentiate the union between the user and the computer or another supportive method in terms of microcomputing or the multimedia and wireless mobile phones; for instance, of the interaction between the videogame and the user. In this latter case, traditionally a game, according to Huizinga, is a free action carried out "as if" and felt as placed out of the common life (Huizinga, 1998), but which, despite everything, may completely absorb the player, without there being any material interest nor obtaining in it any profit, which is carried out within a given time and a given place, which develops in an order submitted to rules, and which gives rise to associations which tend to be surrounded by mystery or to disguise in order to distinguish themselves from the ordinary world. Starting from this definition, other definitions have been developed about the concept of the game and the recreational element of the game, in the context of the social sciences.

The birth of the video games field has led to a cultural change of great relevance in current society, the first generations were spread among

Figure 1. The Sims –Electronic Arts (www.ea.com), characters 3D and the simulation of the life

the population as simple entertainment systems where people could find a recreational pastime, but little by little this relationship grew stronger and started to appeal to more users in the world, so the games evolved as a system of entertainment at a higher level of experience, where the user can find and relate to series of new worlds and experiences. The new kinds of games include a greater interaction with the consumer and necessarily submerge him/her in the role to be played inside the videogame.

Talking of video games today is to talk of communities, society, of lifestyle, and these applications are no longer the key element of entertainment, but they are a sociocultural means rooted in the world of today. In an unconscious way it is a new lifestyle for the Z generation, who see in them the chance to know, interact and coexist in presence or virtually with those who share their same interests. Consequently, it can be said that the video games linked to the Z generation are already creating a society of the consumption of goods and services of cultural products (cinema, books, etc.), specifically and only for the short term future.

Now, regardless of the group to which the user belongs, in relation to age, previous knowledge in the use of computers or other devices with interactive systems, any game gives to the user (potentially) a set of experiences with a full sense; and because of its development has been linked to a set of goals (determined by the programmer of the videogame or autonomously chosen by the user), the same goals by/through which are limited and simultaneously generated by a system of rules. In relation to the rules and the determining degree of interaction of the user in the development of the game, this usually possesses a high rate of variability among the different sessions, that is, complemented with certain invariable actions and events such as can be the options that make up victory.

The videogame distinguishes itself from the traditional game through its communicability attributes, together with the interface device and other peripherals which allow the human-computer interaction in this kind of interactive systems. It appears obvious that the videogame distinguishes itself from other kinds of audiovisual experiences of a cultural or entertainment nature such as the viewing of an animation film on the computer, and due to the determining influence of the participation of the user in the development of the experience. In regard to the difference between the videogame and the traditional hypertexts, an essential distinction is that which takes place between an "explorative" interaction of the user and a "configurative" interaction (Cipolla-Ficarra et al., 2011; Ryan, 2001).

METAPHOR: EXPLORATIONS GUIDED AND NON-GUIDED

In the case of the interaction and the types of interfaces it is important to see how the interactive design models switch quickly from the entertainment industry to the artistic sector (Cipolla-Ficarra & Cipolla Ficarra, 2009), for instance, where the timing of interaction sessions and/or attentions-spands tends to increase. In these systems the user seeks entertainment, and besides, the attention and the motivation is constant in several systems of musical multimedia in off-line support of the 90s. All of this is achieved thanks to the used metaphors. It is then when interaction or exploratory navigation is considered. Exploratory interaction is that in which the interface of the computer does not show any kind of options and the user must find out with the mouse, with the keyboard or with some other input peripheral, how to get the access to the information of the system. In regard to the kind of used metaphor, two kinds of exploratory interaction can be established:

1. Exploration guided by the kind of metaphor.
2. Exploration non-guided by the kind of metaphor.

A exploration guided by the kind of metaphor is that interaction in which the metaphors allows users to anticipate the likely content. On screen one of the figure 2 of the system *Il Ballerino*, it can be seen how the metaphor of the interface depicts a gallery where it can be inferred that in the frames of the pictures there are hidden paintings (Il Ballerino CD-ROM, 1994). On screen two, upon selecting with the cursor on the image of the Guernica there appears a video of the musician. On screen three, the musician comments on the chosen painting. Besides, at the lower left margin of the three screens of the example and in the shape of a sphere, are the navigation keys which allow the user's attention to drift to other parts of the structure of the system. These keys favor the exploration of the system.

The non-guided class of interface, influenced by the kind of metaphor exploration used, is that interaction in which the metaphor does not allow one to determine the possible content. In the interface depicted in the figure 3 of screen 1 of the system *Eve*, are hidden a number of shellfish (screen 2) which are musical pieces and which the user must discover with the movement of the mouse and open them to listen to the audio (screen 3). In this system and in contrast to the preceding one, the keys for the navigation of the system are also hidden. *Eve* is a system with the maximum exploration level for navigation inside the set of music CD-ROMs of the 90s (Eve CD-ROM,

Figure 2. A exploration guided by the kind of metaphor

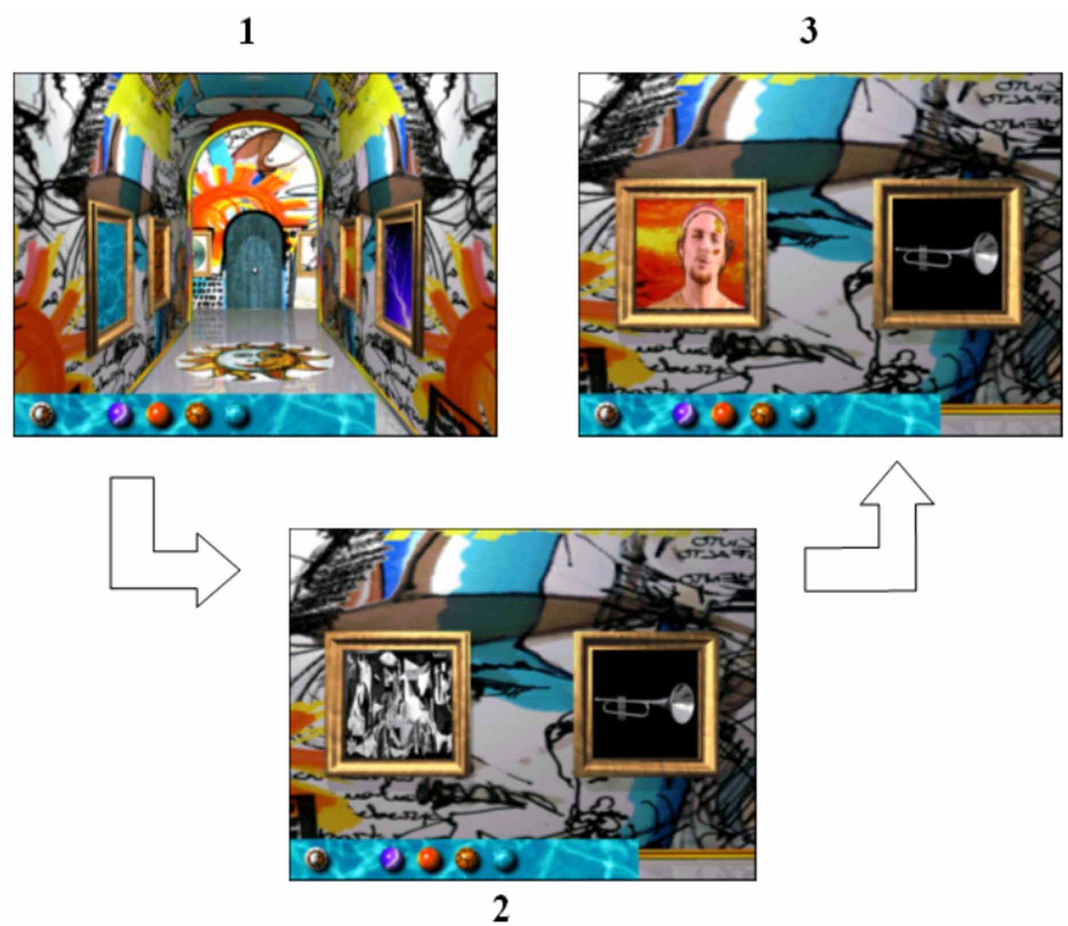
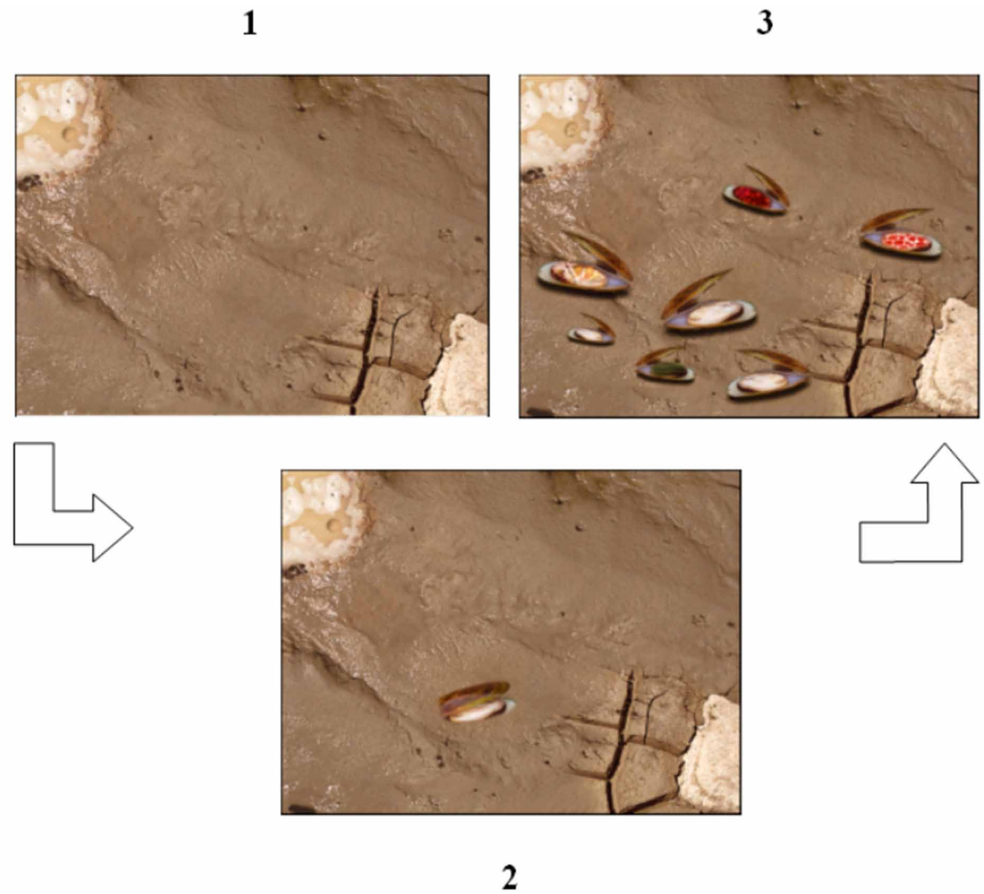


Figure 3. The non-guided by the kind of metaphor exploration. On screen 1 there is a maximum level of abstraction of the metaphor.



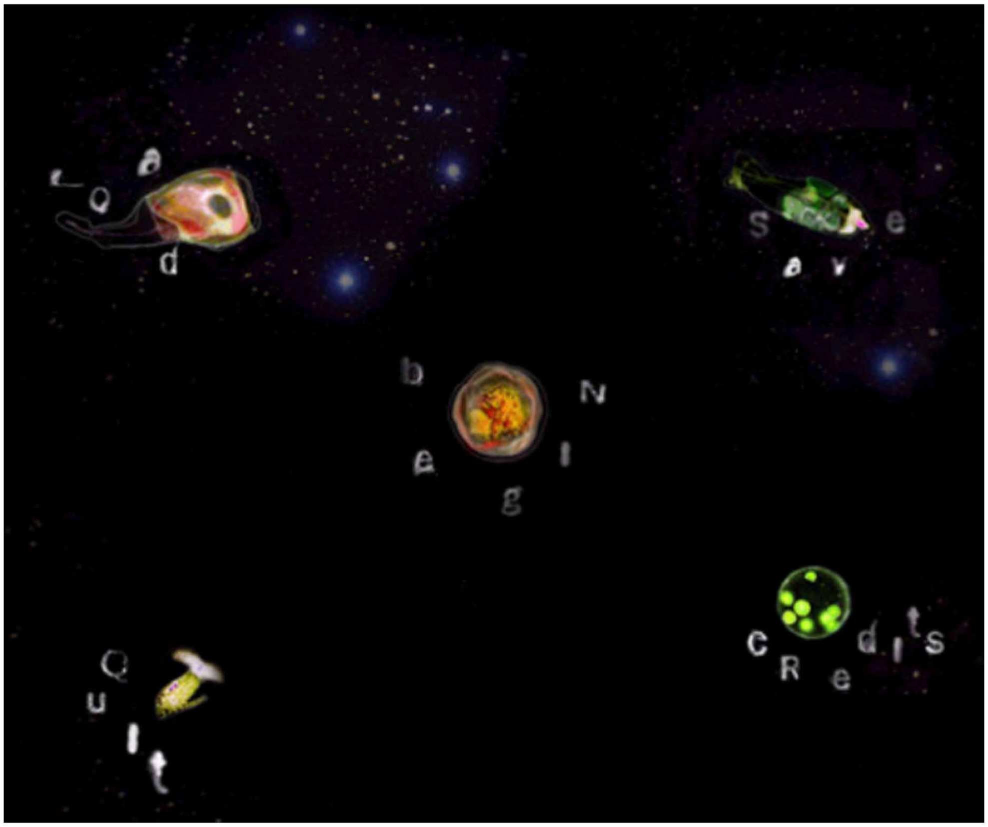
1994). Obviously, here we are speaking of music oriented multimedia systems. However, the young users needed an interaction which combined in many cases both kinds of exploration.

In the combination of interaction among young users and video games a first categorization of the video games in the 80s can be established. Many of the video games of those years were based on cinema, history, literature, paintings, etc. Others, in contrast, have been developed to take the utmost profit of the computer system. These interplays/feature were useful/helpful, since the 90s, the tridimensional graphic medium of computer science has played an essential role in the industry of multimedia video games. Later on, the experiments of combining 2D with 3D were started, and with excellent results from the point of view of the users' motivation. Many of these games competed with some films. It was also the epoch by the first computer animations appeared on the big screen in the cinema, and for instance, Toy Story, and in video games.

NARRATION AND PLAYABILITY

The narrative function in the multimedia systems of the 90s was essential for the learning of languages by playing, for instance, and also to overcome the usability stage of many users, who

Figure 4. The high degree of abstraction of the metaphor of the EVE multimedia system can also be observed in the titles of the menus. The titles do not fulfill the anchoring notion between text and image since the letters are disorderly arrayed by the side of 100% abstract icons.



because of their biological age should (by all accounts) belong to the Z generation, but for reasons of use of mobile interactive multimedia systems are today mistakenly included in the set of digital immigrants. Another mistake as to consider the games like SimCity as a kind of narration because the temporal variable is progressive, although the game contains exceptional events to stop this continuous advance such as can be tornados, floods, earthquakes, etc. In contrast, the Sims (ultimately) is a simulation of a family, whose members have different actions because they fulfill different roles in relation to the generation of contents. That is, it is a first example of a dramatic simulation and of an interactive experience which is closest to fiction in a traditional sense. The term “interactive fiction” appeared for the first time in the promotion of the Zork game in 1982. Another example is Myst. In spite of the narrative poverty of Zork, the adventures genre to which it belongs constitutes one of the (first) reference models, a model according to which the interaction reveals, progressively, the story. Another playful model to be taken into account are the MUDs (Multi User Dungeons) where the experiences evolve in keeping with the interactions, as in SimCity, but besides are developed in the heart of a community of players, and so that the player doesn’t only play against the computer, but against other players, turning the interaction with this game into a social environment. That is, an anticipation of the current social networks.

Figure 5. In this image can be seen the excellent graphical quality of the interface of SimCity. That quality can also be found in the special effects that are produced with the passing of time: tornados, fires, earthquakes, etc.

Social networks where the common denominator is the entertainment among its participants going beyond the simple informative function of Facebook or Twitter. Although games like MUDs, Myst, etc., belong to the class of the interactive narrative, from an audio point of view it is necessary to differentiate the narrators from the speakers, for instance. In some multimedia systems a way to focus the attention of the user is the incorporation of several speakers or narrators. When there is more than a narrator or speaker, a change of voice takes place. With the change of voice the attention about that that is being told or narrated at a given time increases. This synchronism in the narration or locution is called focus point of the locution. In the 90s, with the momentum of usability engineering, there was a tendency to regard the multimedia systems as a narration (Mallon & Webb, 1997). The origin of this tendency is to be found in the use of a given commercial software for the elaboration of multimedia applications, for instance the Macro Media Director (MMDirector) which allowed the programming of the first off-line multimedia applications. However, it was a mistaken tendency from the point of view of interactive design and communicability for two reasons:

- Not all the multimedia systems have their content organized in the shape of a narration.
- One of the main characteristics since the origins of the hypertext is to break the sequence of the content at the moment in which the user is interacting with the multimedia/hypermedia system.

However, the borders between narrative and playability aren't well defined yet. On a theoretical basis, the differences may be remarkable. For instance, the differences in the treatment of time. Within the narrative that is told, is present usually, a past time, whereas the game takes place in the present. The narrative resorts to jumps in time and besides, it usually compresses it, in contrast, and with the game the experience follows a strict real time. There are also differences in the way of treating the space that surrounds the action, the spatial environment is an essential part of the game and of the narration, especially from a visual point of view for the smallest users. Obviously there are games which escape these rules, such as Tetris which doesn't have a narrative content, which doesn't prevent it from working or the user from interacting with the imaginary "world".

Now what really exists from the point of view of interaction among the categories of content and dynamism is a focal point of the textual narration, but if this interaction is regarded synchronically, that is, as the focus of the attention of the user in front of the system at a given moment (Cipolla-Ficarra et al., 2011; Cipolla-Ficarra, 2005; Cipolla-Ficarra & Cipolla-Ficarra, 2009). Besides, depending on the addressee of the system there can be a speaker or a narrator. In multimedia works such as the tales, legends, etc., there can be a narrator which in some applications is an animated character, as in the case of Kiyeko (Kiyeko CD-ROM, 1996). The speaker is for the adult audience. Between the speaker and the narrator there are several differences. The function of the narrator is to tell events from the past (or future where a sub-story is told). This action of telling is generally in an automatic way, that is, not the result of a request from the user to the system (query). In contrast the speaker is omnipresent (voiceover) and his function is the reading of the content of a textual element at the request of the user. A multimedia system with an omnipresent speaker is the Museum of Orsay (Musée d'Orsay CD-ROM, 1996). In this application, when the option "guided tour" is activated, there appears the silhouette of a guide, who comments in the foreground, and in relation to the different links to collections within the system and later the silhouette disappears upon reading the content of each one of these collections. The silhouette stands in the centre of a guided link. Next two examples:

In the figure 6 there is a narrator and in the figure 7 there is a speaker. This differentiation has influenced in the interaction "culture" of millions of people whether they belong, or do not belong, to the summit of the digital divide, for instance. Now to realize the maintenance of the quality of the told content, whether it is in narration or in locution, it is necessary to consider the following aspects in the multimedia/hypermedia systems (Cipolla-Ficarra et al.. 2011; Cipolla-Ficarra, 2005; Cipolla-Ficarra & Cipolla-Ficarra, 2009) aimed at entertainment or not:

1. The relationship established between:
    a. Text and audio.
    b. User and main character of a narration/locution.
2. These relationships generate three alternatives:
    a. The narrator/speaker increases with the locution what the user/character knows.
    b. The narrator/speaker says the same as the user/speaker knows or sees.
    c. The narrator/speaker comments less than what the user/character knows.

The first alternative is the best in the communication process, since it increases the extension of the message by incorporating new information. The second situation is justified if they one is resorting to other static or dynamic means to boost the content of the message, especially in the case of CAE (computer aided education) in languages. The third option affects detrimentally the usability of the system by not inserting new contents. In this latter case the activation of the content doesn't have as its purpose to enrich the presented content. The use of more than a speaker or narrator is another prospective mechanism of communication. The purpose is to motivate the user to keep on with the fruition of the system; and by breaking the uniformity or monotony that the audio may reach. In several off-line and

Figure 6. Kiyeko (Narration)

Figure 7. Musée d'Orsay (locution)

commercial multimedia systems which have teaching as their goal a way to buttress this focal point of attention is through mechanisms which allow to detect on the text what the user listens. Besides, if in the grasping of the messages the user reaches a 80% between what he sees and listens, the synchronism between the audio and the advance of the text is essential for a successful communication. It is necessary to consider how the advance of the text takes place at the moment of the locution or narration.

The locution or narration of the textual content must be associated with the automatic advance of the written text which is being visualized on the screens of the multimedia systems. For an audenience children, simultaneously with the locution or narration the color of those words they are reading is usually changed, which is useful for the learning of languages. An example is the Kiyeko (Kiyeko CD-ROM, 1996), where the yellow color words in figure 8 are those that the speaker is narrating. Another example of karaoke is in The Interactive Alphabet (Interactive Alphabet CD-ROM, 1996), multimedia system off-line (figure 9).

In Anatomy 3D (figure 10), there also takes place the automatic and vertical advance of the text as the locution progresses (Anatomy 3D CD-ROM, 1996). But in said multimedia system off-line the words aren't stressed and generally the last paragraph can't be seen, and so that the user has to shift it by hand with the keys. Whereas in the Zoo multimedia system (figure 11), the locution of the text is only a sentence which is not in the text (Zoo CD-ROM, 1994). Here the locution doesn't cause an increase in the written information, but rather generates a "noise" in the communication process between the user and

Figure 8. Karaoke technique in Kiyeko

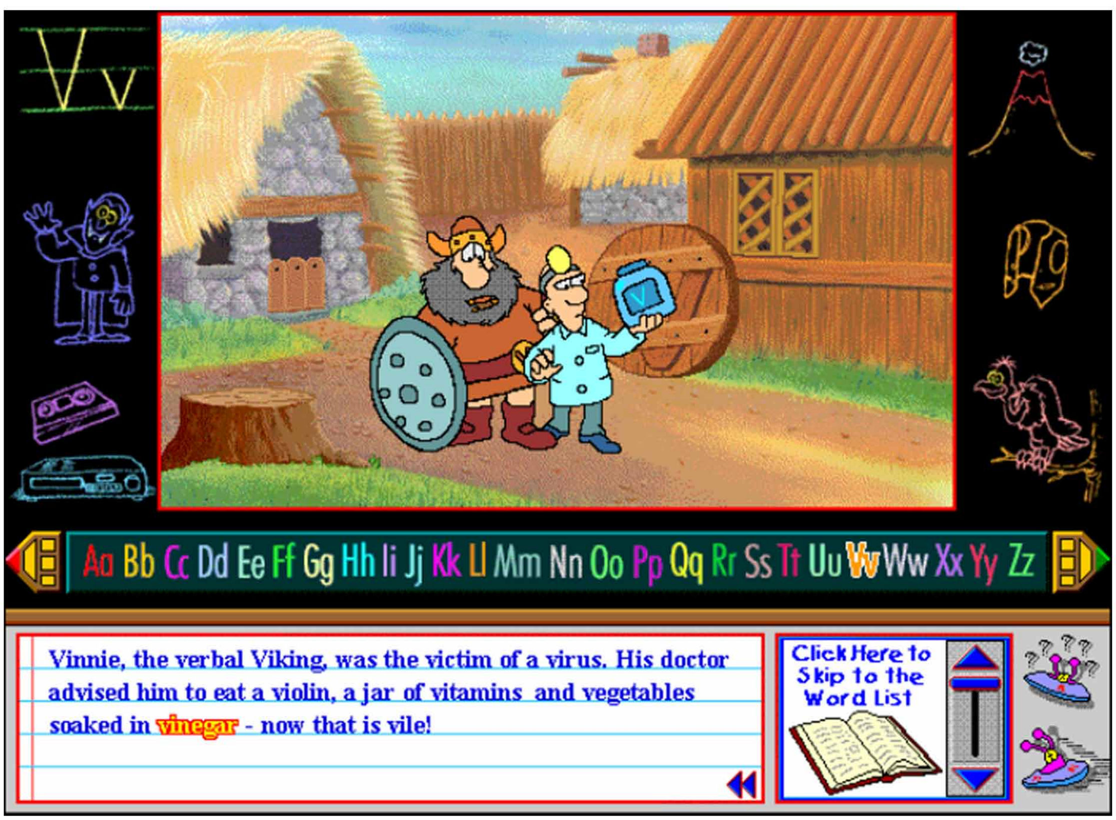
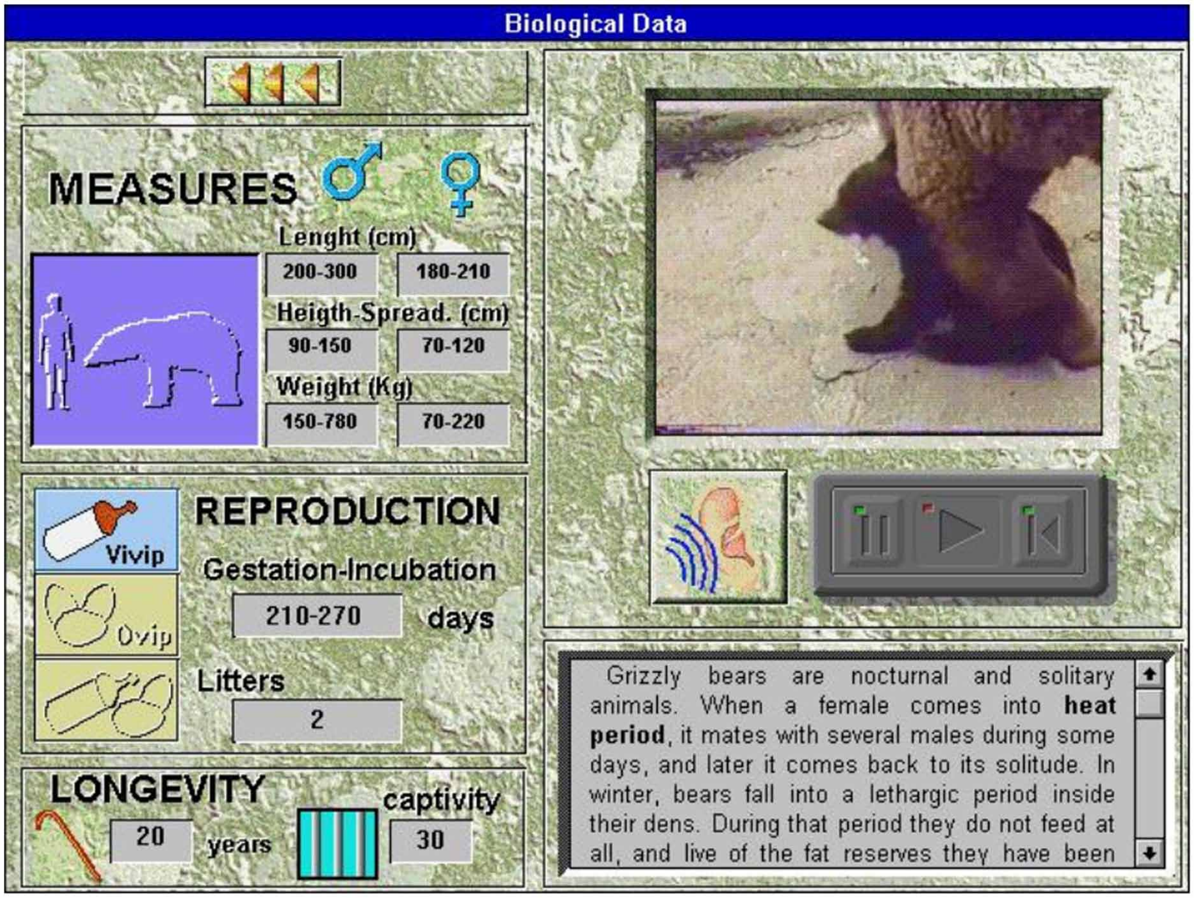


Figure 9. Karaoke technique

Figure 10. Anatomy 3-D

Figure 11. Zoo



the system (Edvardsen & Kulle, 2010). That is, hearing a text which doesn't match what is being seen, linked to the manual shifting to try to locate that which is being listened to doesn't motivate or foster the continuity of the use of the system.

The advance of the text with the locution is important in the learning process of languages and particularly if the "karaoke" technique is used, since it allows the user to focus his/her attention on what the he/she actually listens to and sees. The attention in the learning of languages can be focused on each one of the words of a language. Now interactive narrative is regarded as an innovation of structures, much more than of procedure, on which the multiineal discourse is grounded instead of the sequential one, and stories do not necessarily have a beginning and an end, what entails narrating environments rather than stories and patterns of behavior rather than specific behavior. It may be that interactive fiction is something very different from traditional fiction and that, in short, it is about replacing the pleasure of storytelling by the pleasure of interaction. Examples include; where an interaction where the general aspect is as present as it can be; and whereby the classification of a hypertext/multimedia/hypermedia system is visible, and/or the belonging to a certain genre because of its content is made explicit, as if it was a literary work.

Consequently, it is not mistaken to claim that in video games there is an interest in the study of the meaning of the videogame as a discourse, since it defines a general framework of meaning of the game (as a medium of expression/communication in general). Along with the history of computer entertainment, there are different possibilities of drawing up classifications of the video games as it has happened with the classical games. In both cases, in order to obtain interesting results it is necessary that the 'belonging' of the video games to the different sets/classifications employed; are derived from a specific featured classification scheme, and have some common elements in the determination of well defined criteria and that the different sets obtained do not have a high number of interactions among each other. Finally, those classification criteria must be constantly adapted to the evolutional situations of the videogame in the course of time, and from the point of view of the software, the hardware, the interactive design and communicability.

LESSONS LEARNED AND FUTURE RESEARCH

Narration in the multimedia systems and video games of the 90s required an excellent graphical quality to motivate the potential users from an early age. In the early multimedia systems excellent interactive products were created, from each one of the design categories and especially for the children audience such as can be Kiyeko. Word and image had a balanced role in interactive communication. In contrast, in the video games systems the image edged out the text (perhaps in a similar way, andf for similar reaosns, as with the mediums of movies and sutuatilnak plays etc). An image of a media is develeoped that (once had) in the computer screen of the computers illustrated scarce quality due to the interaction speed that the interactive system required, through the keyboard or the joystick, for instance. However, from the point of view of the structural design category, those components as can be guided links, the links index, etc. of the early interactive systems are still very positive in the new millennium, when one strives to reach the highest communicability with the least possible cost. In future works we will focus on the immersion of the user in the video games scenarios and in the narration ability of the characters with the user's real-time approval/attention/inclusion, whether it is in the first or the third person.

CONCLUSION

The possibility of establishing links with those elements of interactive design which do not change with the passing of time is positive for communicability. These links and/or relationships are both unidirectional or bidirectional among the elements; and hence make easier the designer's task at the moment of making decisions in the production process of the videogames, for instance. In other words, by knowing beforehand what elements play a fundamental role in the interface or the storytelling, he/she may then decide to widen or reduce certain dynamic or static means which make up the interactive design. Although not all of the current videogames tell a story, the Z generation is (presumably) more than OK with this situation, since they may not be prone to and/or predisposed to communicate in a face to face fashion, and/or physically in front of another person. This isolation is usually compensated through the videogames where the immersion is practically 100% and he/she acts in the first or the third person. The fast learning process in issues of functioning of commands of the diverse interactive systems through direct practice and not neccesarily in relation to the previous theory, makes reading (ostensibly) disappear even for the programming of the systems. Here is one of the explanatory frameowork containing reasons that bring together causitive factors in some European educational institutions of the first cycle, that is, the mandatory basic schooling, children already learn to program as if they were playing, applications which are useful for multimedia mobile telephony. That is, just the same as McLuhan's global village, it has been concretized in-between the 20th and the 21st century. The principles of Seymour Papert and his group of researchers preestablished the Logo and the programming as a game, which is also concretizing quickly in the new millennium. However, with very low programming levels which tend to meet the requirements of the fashions of the commercial market of the multimedia software, which in many cases are aimed at the videogames as a simple pastime.

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KEY TERMS AND DEFINITIONS

Communicability: A qualitative communication between the user and the interactive system, such as hypermedia, mobile phones, virtual reality, immersion multimedia, among others. The extent to which an interactive system successfully conveys its functionality to the user.

Interactive System: It is a computer device made up by a CPU and peripherals, whose functioning requires a constant interaction with the user. Currently these systems tend to their miniaturization, the mobility and wireless connectability among them.

Naturaless of the Metaphor: The user's ability to understand the set of images that make up the structure of the interface. An image is natural when by itself it tends to suggest a single meaning. The naturalness of the image is in direct relation to the representation by simulation of the real world.

Playability: Is defined as a set of properties that describe the user/player experience using a specific game system/video game whose main objective is to provide enjoyment, entertainment and learning strategies, for instance.

Synechism: Is a term that Charles S. Pierce coined to designate continuity. Although it is a word that stems from the Greek (zyneches "continuous" + ism from "together" + échein "to have", "to hold") and which has diverse applications in the context of the factual sciences,

Video Game: Is an electronic game that involves human interaction with one or more user/s interface/s to generate audio-visual feedback, for instance, on a video device.

Chapter 3
Lookable User Interfaces and 3D

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ABSTRACT

A new philosophy of user interface design is described. Named the "Lookable User Interface," or LUI, the approach is based on the concept of a Personal Reality (PR) system. Here the computer adapts to the user's worldview in a personalized way, and according to the specific requirements, behaviors, and perceptive skills of the individual. Typically, a PR system creates and adjusts (in real-time) 3D perspective view(s) of a data-set, including (potentially) the field of view of a scene and the apparent distance and scale of objects, whilst also creating an aesthetic "eye-friendly" context for computing operations. A Lookable User Interface (LUI) affords the maximum degree of visual accessibility to digital content. The authors examine the results of testing a Lookable User Interface. Spectasia is one example of a Personal Virtual Reality (PVR) that can be used to visualize links between universals and particulars within digital worlds.

INTRODUCTION

We apply the concept of the Lookable User Interface to computer system design; and in particular with respect to the efficient navigation of information structures / hierarchies. A personalized approach to user interface design is developed, and in-part through analogy to the natural three-dimensional "curvilinear" shape of the human visual field.

The concept of Personal Virtual Reality (PVR) is compared and contrasted with Virtual Reality. PVR systems are put forward as a (partial) solution to the problem of providing sufficient "context" within information views. Addressed is the difficulty in providing rapid overviews and/or fostering explorative freedom within complex information structures.

Today the scope, scale and richness of information systems causes data "bottle-necks" to gather wherever people interface with computers. Especially problematic is knowing anything of what you do not know, and in terms of information hidden in vast data-mountains. Unfortunately, tools like Google search require users to ask the right questions and/or to use valid keywords in order to

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locate specific items. And much remains unseen. Must we rely on luck to locate interesting content? On the contrary, we recommend the attributes of the Lookable User Interface as a (partial) solution, allowing the user to (visually) boost his/her knowledge of available content.

THE USER INTERFACE: HOW SHALL WE DEFINE THE "USER INTERFACE" (UI)?

In the 1991 book "Computers as Theatre", Brenda Laurel states that we should think of - and design - a computer interface in terms of a theatrical metaphor (Laurel, 1991). Her idea is that like effective drama, good interface design must engage the user in both thought and emotion. Laurel also says that the user interface (UI) in a way obstructs access, and that it stands in the way between us and what we are trying to do. This is a useful perspective. But it is by no means the only one.

Others have spoken in terms of overcoming the communication barriers that exist between one world and another. For example, sending messages between the hidden digital "world" of the computer, and the human "world" of language and vision. In this view, actions in one world must be "interfaced" using a language of commands that both "sides" know how to interpret. Thus the happenings in one world must be communicated (and translated) into an entirely different realm. The UI's "job" is to hide unnecessary complexity and to expose public events/actions/information in each world, and so to mediate between the different regions of being. From this perspective, there are many different types of UIs; including operating systems, TV remotes, and washing machine controls etc. Even language itself, which communicates the thoughts of one individual to another, may be seen as special kind of UI.

Ideally, a UI provides useful views into an information space; according to the actions, behaviors, choices, and needs of the user. And this would perhaps be a relatively straightforward task, if it were not for the great diversity of different types of computer system, varying purposes, and the vast complexity of information types dealt with. To say nothing of the great range - and constantly changing - user interests. A large variety of different types of UI designs (and interaction techniques) are needed to cope with such diversity of purpose.

Over the last 50 years there have been many innovations in UI design. For example, in the 1960s, Sketchpad introduced interactive graphics (Sutherland, 1963). Soon after the mouse - and other key elements in the field of human-computer interaction - were invented by Douglas Englebart (Tuck, 2013). Later the Xerox Star system (Johnson et al., 1989) was introduced and the PARC user interface (Hiltzik, 1999) arrived which pioneered graphical elements such as windows, menus, radio buttons, check boxes and icons. More recently also, the touch-screen approach has been used on mobile computers and even full-sized displays. And the success of all of these techniques (generally) has led to an explosion in number and types of user interface designs. Progress has been so rapid, that in today's world, it would be difficult to get through even a single day without using multiple UIs.

Sometimes it is difficult for the UI designer to decide what type (or set) of interaction tools is best for a particular application. One approach is to split larger interaction methods into smaller components, in an attempt to form a "language" of human-computer interactions, and to then reassemble the standard techniques according to need. Obviously in so doing, it is vital to match appropriate techniques to the nature of the task at hand. However such an approach assumes that all of the useful interaction techniques are already known. In this chapter we adopt a different mindset.

We begin with an examination of visual perception, specifically in the hope that new 3D interaction techniques may be identified and categorized.

Our analysis starts in the following section with a study of the nature of 3D, in the belief that a key problem with respect to current UI designs is the inability to provide (visually) rapid and efficient overviews of information structures.

3D USER INTERFACES

Three-dimensional (or 3D) computer interfaces have become a useful human-computer interaction method, as seen in Computer Aided Design (CAD) systems, Virtual Reality (VR) worlds and also in a variety of computer games. The topic of 3D user interfaces is also a popular one in science fiction movies, for example as depicted in Jurassic Park, Star Trek, Minority Report, and Star Wars. Here spatial interfaces have been used to enhance the feeling of being in a high-technology society, or else to depict advanced and more intuitive, informative, and/or easy-to-use computers.

Despite these advances and predications, the fact remains that for many tasks, 2D user interfaces are quite sufficient. 3D UIs are quite rare as a result. For example, we see no popular 3D file managers, and there are no examples of standard 3D data explorers, 3D operating system elements and/or general-purpose 3D interaction techniques. The question remains of why this should be so, because many researchers, universities and companies have attempted to create new and improved 3D user interfaces (Bowman, 2004).

I think part of the reason for the lack of 3D UIs, is that many people actually like 2D interaction techniques. At the same time people often dislike looking at depictions of 3D on 2D screens, at least in situations where the simpler, more familiar, and perhaps as a result faster, 2D techniques are available. Here we refer to 3D user interfaces as viewed on 2D computer displays, and we shall ignore (in general) more complex holographic or stereoscopic type displays (which have yet to become commonplace - at least in terms of even attempting stereoscopic UIs).

And we refer here to the state-of-affairs as it exists outside of the computer-aided design and animation fields, where 3D user interfaces are a de-facto standard.

I am not going to suggest that we can overturn (or even begin to overturn) the lack of popularity of the 3D user Interface (for the general public), and especially by means of a short chapter like the present one. Rather a key aim has been to explore the suitability of a range of 3D interaction techniques, and in relation to the provision of useful methods for application to general-purpose UI studies that may be performed elsewhere.

Perhaps a summary of motivations is useful at this point. Put simply, we are attempting to discover the first few building blocks of a new "language" of human-computer interaction in the third dimension. This is a difficult and ambitious task. For example, it is a fact that a far wider range of interaction forms are possible in 3D (as opposed to 2D). Many of these potential 3D techniques will not be useful and/or be inefficient and/or be unnatural; and thus have poor usability as a result. Perhaps the most useful solutions will be well-hidden. Therefore due to the size of the 3D design space, and the difficulty of discovering new and *efficient* 3D interaction techniques, we shall test only a rather small number of (discovered) useful techniques. Potentially existent within the (much larger) "universe" of spatial human-computer interaction techniques may be other (even more useful) methods and information display forms that are yet to be discovered.

In brief, in this chapter we present the results of testing new kinds of 3D user interface prototypes. Before presenting our findings, first (in the next section) we take a step backwards and explore the nature of human perception of the third dimension.

ON WIDE-FIELD PERSPECTIVE

We are concerned here with the nature, viewing and representation of the third dimension or 3D, and in particular with those issues which are relevant to the representation of wide-field perspective scenes on two dimensional (2D) computer screens. The graphical representation of 3D has a long history going back many thousands of years to the ancient Greek, Egyptian and even Chinese civilizations (Panofsky, 1997; Veltman, 1995a; Veltman, 1995b). During the intervening centuries, a number of different systems have been used to aid in the realistic representation of 3D, but here we shall focus mainly on the underlying mechanisms used by humans to actually perceive 3D.

HUMAN VISION AND THE DEPTH CUES

People often say to me that 3D on a computer screen is not "true 3D". But they are then unable to explain this statement any further, and sometimes they also add that flat screen images cannot be true 3D because they do not show stereoscopic views. Along the way people occasionally mention that stereoscopic glasses are needed for 3D, one being red and the other blue for the left and right eyes. In one sense what these people are saying is correct, in that a flat screen does not show stereoscopic images. However they are entirely incorrect when they assume that only stereoscopic images are "true" 3D.

Vision experts have long known about the different aspects of depth perception, and that these can be grouped into two categories: monocular cues (cues available from the input of one eye) and binocular cues (cues available from both eyes). Each of these different "cues" is used by our brains, either independently, or else together, in order for us to perceive the third dimension.

It is important to note that not all of the cues are required to be present simultaneously in order to give us an accurate or realistic impression of 3D. It has been demonstrated, for example, that we can get a realistic impression of 3D when just 1 or 2 cues are present, as in a perspective drawing for example. Whilst I don't want to turn this article into a scientific monologue on the topic of 3D, I think it it is worth reminding ourselves of the cues in a list at this point. Monocular cues include Motion Parallax, Color Vision, Perspective, Distance Fog, Focus, Occlusion, and Peripheral Vision. Binocular cues include stereopsis - (or binocular disparity sometimes also called binocular parallax) which is the difference in shapes and positions of images due to the different vantage points from which the two eyes see the world. The other binocular cue is convergence, or range-finding stereopsis which is the human ability to judge the distances to objects due to the angle of convergence between the eyes.

Note that some vision experts (Gibson, 1986) would argue for the inclusion of other yet more subtle (monocular) optical cues, including occluding edges, horizons and other affects due to the "direct perception of surface layout", but for the purposes of simplifying an obviously complex topic we shall ignore these additional factors here.

The greater number of items on the monocular list, gives a first clue that perhaps stereoscopic vision effects are not the primary way in which we as humans perceive depth or the third dimension. You can easily test this yourself by closing one eye, and immediately you notice that the world still appears to be spread out before you in all of its three dimensional glory! With one eye closed you may have difficulty with the finer points of depth perception such as picking up a pin off the floor. However largely for ordinary tasks if you lost one eye, then you would still be able to rely on the other eye for 3D vision, in fact exclusively by relying on the monocular visual cues.

On passing I would like to note here that those who suggest that stereoscopic 3D (aka red-blue parallax films) is the only true 3D, and further that its mechanisms are well known, are in fact claiming that they have more than a head start on some of the greatest experts in human vision who ever lived. World renowned scientists agree that science has yet to even begin to understand the mechanism by which human beings combine or overlay two different parallax views in real time into a single correlated image sensation (Panofsky, 1997; Gombrich, 1960)

Some even proclaim this image combination feat to be a miracle of the human perceptive system - and so it may be - because the source images are thoroughly misshapen and also distorted one relative to the other.

PERSPECTIVE DEFINED

Let us pause at this point and take a stock of where we are. I hope I have been able to convince you of the fact that stereoscopics are not required to give an impression of 3D. If they were we would not be able to make much sense at all of television, films, photographs or even the vast majority of drawings and paintings (Gombrich, 1960). These methods, one and all, solely rely on the monocular cues for depth depiction, yet we have no difficulty understanding the 3D worlds depicted in which objects lie at different apparent distances from the viewer.

One of the most important of the monocular cues for depth perception is perspective. Let us now agree on a very simple definition of perspective. Perspective (from Latin perspicere, to see clearly), is an approximate projected representation of a scene as seen from a particular viewing location. Kim Veltman has made an exhaustive study of the history and nature of perspective (Veltman, 1986; Veltman, 1995a; Veltman, 1995b). The two most characteristic features of perspective are that objects are represented with a smaller scale as their distance from the observer increases, and also that the scene experiences so called spatial foreshortening, which is the distortion of items when viewed at an angle. A rudimentary knowledge of the different types of perspective is essential if we wish to understand how are able to see in 3D.

THE DIFFERENT TYPES OF PERSPECTIVE

At this point I would like to make a distinction between two different types of perspective. Firstly, there is the type that arises from the perception of depth in human vision (sometimes called Visual or True Perspective) and secondly there is the type that is created to facilitate the perception of depth in graphical images. (Sometimes called graphical perspective). Regardless of the features of the specific definition adopted, experts are in agreement that perspective is a very powerful depth cue in both the graphical and vision forms. It stands to reason therefore that in order to maximize the effectiveness of this cue in any representative method, it is important to mimic the overall optical affects of visual perspective as closely as possible. Here once again there are complications and disagreements over which is the most natural and realistic form of graphical perspective.

It turns out that there are many different forms of graphical perspective, including linear, curvilinear, spherical, and axial etc. Arguments continue to rage over which is the more natural. Linear perspective (see Figure 1), which was first developed during the period of the Italian Renaissance, is perhaps the most familiar form of perspective to the Western eye. Nevertheless, vision and optical experts have noted that linear perspective is not a good approximation to so-called natural or real visual perspective (Panofsky, 1997; Gombrich, 1960).

In particular, at the outer extremes of the human visual field, parallel lines become curved, as in a photo taken through a fish-eye lens. It may surprise you to learn that the human visual field has a natural curvilinear shape! However painters, building designers and scientists have been aware of this fact for hundreds and possibly even thousands of years.

It has been claimed for example that the Ancient Greeks made the Parthenon columns bow outwards to account for - and correct - the curvilinear shape of the human visual field. Also painters like Leonardo Da Vinci and Turner added curvilinear effects into their depictions to more closely mimic reality as seen by the human eye.

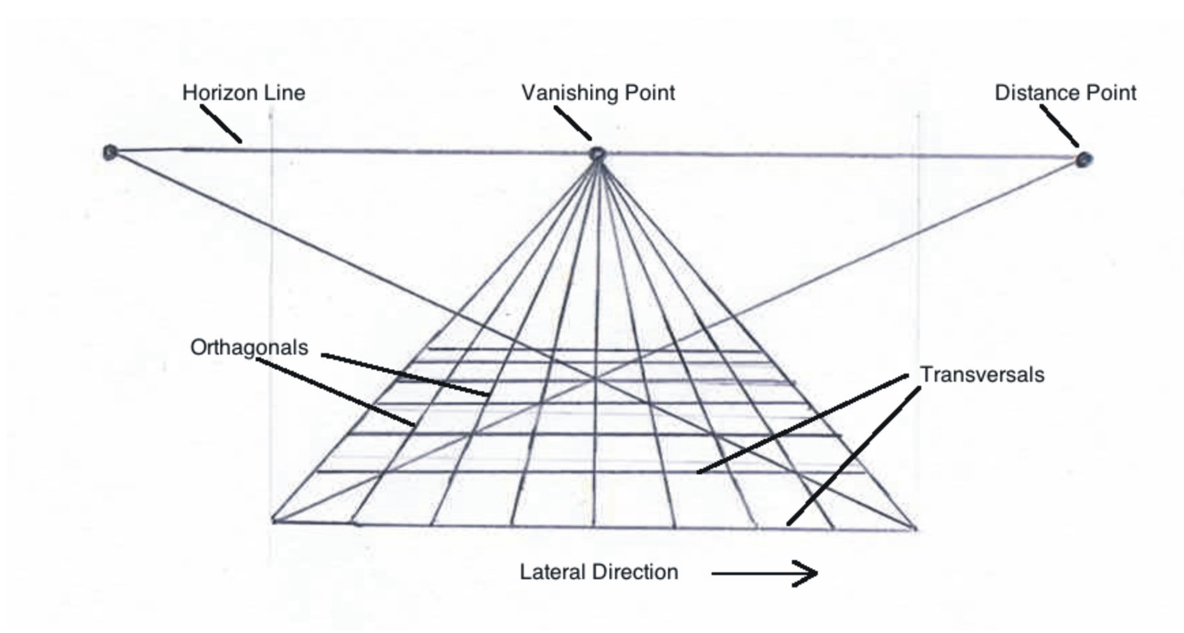
It has also long been known that it is possible to graphically re-create scenes in which the geometry conforms to an overall curvilinear shape similar in form to the views projected by a fish-eye lens. This form of perspective has sometimes been called curvilinear perspective, and it is a form of perspective which has an undeniable origin in the natural optics of scenes. Curvilinear perspective was ably explored in "Curvilinear Perspective, From Visual Space to the Constructed Image" by Albert Flocon and Andre Barre in their 1986 book (Flocon & Barre, 1992). Artist Dick Termes has also produced many works based on curvilinear and 6-point perspective (Termes, 2013).

Curvilinear perspective has a geometry which is closely related to the human visual field. In particular the rules of optics cause objects located at large distances from the central visual plane to be contracted in size, a true to life effect that is not depicted by linear perspective. Also others have noted that the human eye projects images onto a spherical retina, causing images to curve outwards in the same way as images in a wide field lens.

In Flocon and Barre's detailed mathematical study of curvilinear perspective (Flocon & Barre, 1992), we see drawings which ably represent the basic features of the natural curvilinear shape of human visual field. Especially noteworthy here is the curvilinear shape of wide-angle scenes, and the "realistic" (if exaggerated) foreshortening of scale in the lateral dimension.

Overall many experts are in agreement that the human visual field is in fact curvilinear in shape.

Figure 1. Linear Perspective Construction



It is important to note here that curvilinear perspective is related to one of the monocular depth cues experienced when viewing real scenes, that of peripheral distortion experienced when viewing wide-angled scenes.

CAN 3D EVER BE "TRULY" REPRESENTED

The most realistic 3D would be one which employed all of the depth cues, however no method to date has been devised which has been able to employ them all. In fact it may not even be an achievable goal to construct a system so realistic that it employs all of these cues. Such a system would be indistinguishable from reality, and may in fact be an impossibility because it is known that human vision uses other yet more subtle scene based optical cues to form an impression of 3D.

The fact that no single method employs all of the different depth cues (perhaps) leads to the conclusion that no one method of depth representation can be claimed to be more "real" than any another. What about holograms you may ask - don't they employ all of the cues, both mono and stereo? I am afraid not. It is true that holograms do employ both monocular and binocular cues, but they do not usually employ moving images and so miss out on the moving cues. Other cues are often missed here including changes such as color, shadow, occlusion and also peripheral vision due to the relatively narrow field of view of most holograms. Overall I would conclude that no representative method currently employs all of the depth cues, and so none is true 3D in the strictest sense of the word.

As an aside the author has invented a new type of mirror, named the "Hologram Mirror" [Figures 2 & 3], which produces an image of the self which "floats" in space in-front of the mirror's surface (Radley, 2009). Here, unlike with holograms, image occlusion affects are created, and the viewer obtains a strong and realistic

Figure 2. Optical concept for the hologram mirror

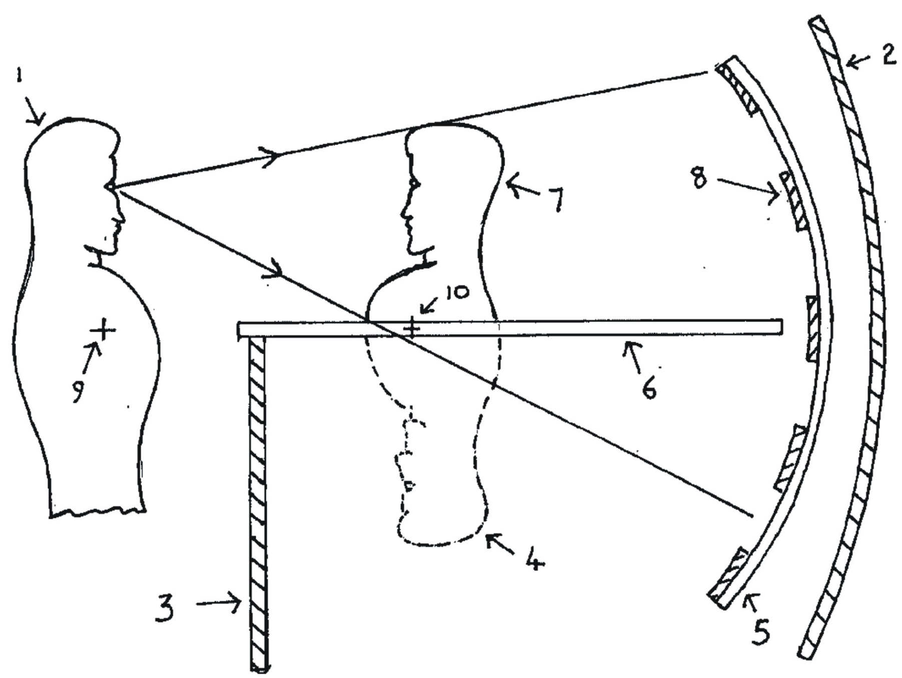
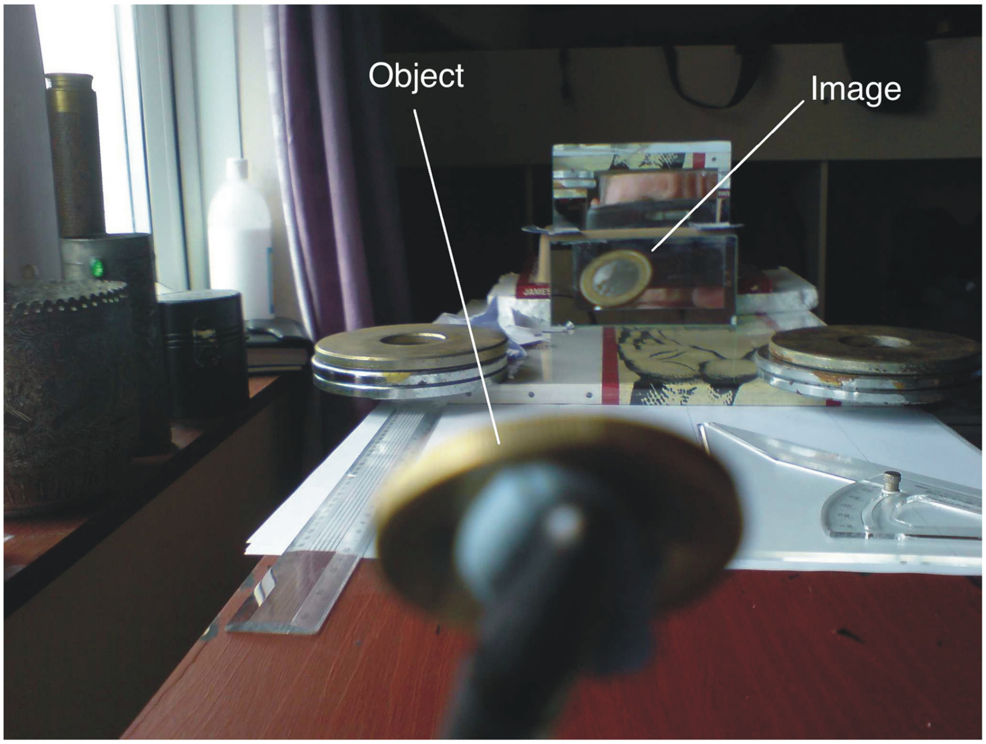


Figure 3.



impression of 3D. Similar optical devices may be used for producing improved types of 3D displays, specifically for interfacing (naturally) with future computing systems. A short explanation of the "Hologram Mirror" principle is salient. In Figure 2 we can see that the mirrors labelled 2 and 3 form an upside-down image of a subject (1) at 4, whereupon a (partially transparent) mirror labelled as 5 re-images this intermediate image into an upright, life-sized reflection of a person (7) that is observable "floating" in space at a short distance in-front of the same person (1).

CURVILINEAR REALITIES

The facts of human vision presented here will come as a complete surprise to many. The question arises as to why it is that the facts of human vision should surprise us? Perhaps we are all too close to our own sense of vision to notice the natural curvilinear shape of every wide-field scene we ever look at, and likewise we do not generally take any notice of the miracle of 3D perception because it is ever present. Or perhaps we are all to-familiar with concepts such as Linear Perspective and/or the narrow field-of-view of photographs. In fact narrow-field photographic images do work rather well - in terms of 3D impression.

Next time you are looking at 2D television or at a photograph notice how strong the affect of depth or the third dimension really is. You have no trouble here forming a good conception of the different depths of the objects that are depicted, and can form an accurate overall impression of scene geometries. No 3D glasses glasses are used here, and in each case we use "monocular" cues to form an accurate internal mental "model" of these scenes, which aids and supports our comprehension of 3D.

At this point you may be asking yourself why it is that photographic, film and also television images do not exhibit scene curvatures. The answer is that they would if they covered a wide enough field of view - say around 180 degrees, and in any case optical designers have worked hard to ensure that the camera lenses involved eliminate such "distortions". Note here that the so-called "Fish-Eye" wide-field lenses do show extreme curvilinear distortions similar to those depicted in the Spectasia interface. (see below)

Also when you have a moment, get a 30 cm ruler (longer is better), and whilst looking forward bring it close to the bottom of your nose, and notice how its shape at the outer edges curves upwards and forwards. It may take you a few minutes to be able to see this effect, because you are so accustomed to **not** noticing it ! But once you do you will be amazed to see your curved field of view as it really is for the first time.

It is an established fact that wide-field optical perspective views are naturally curvilinear in form. Fish-eye lens views are not curved because of any effect introduced by the lens itself, but rather because that is how reality looks when you decide to project a specific scene over a very wide field of view! Eagles and birds see the world like this, that is in the ultra-wide field aspect. This fact leads me to conclude that curvilinear perspective has a strong foundation in reality.

I am not claiming here that curvilinear perspective is necessarily a more real depiction technique than the linear ones that we are used to seeing, but only that all things considered it is an equally valid form of representation! Perhaps the main reason why curvilinear perspective seems so strange to us is that we have become so used to seeing everything in terms of straight lines and right angles. We may be missing out as a result on some quite spectacular images as a result.

Therefore, although curvilinear scenes may at first seem like a distortion of reality, our discussion has shown that this shape is in fact rooted in the natural optics of scenes and also at the same time in the human visual field which is inherently curved in shape.

ESCHER'S UNUSUAL 3D PERSPECTIVES AND OPTICAL DISTORTIONS

Dutch artist M.C. Escher made extensive studies of the nature of 3D perception as depicted on 2D surfaces, and he produced a number of interesting prints that explored the nature of new forms of perspective - including also curvilinear perspective (Ernst, 2007). Escher's work is important for anyone seeking to find new ways of presenting 3D views on 2D displays. In particular Escher studied the nature of distorted optical views, being ones containing multiple - but connected - vanishing points. Often in his lithographs, "curvilinear" grids form harmonious and multiple-perspective views that contain distant and close-up views simultaneously and/or combine up/down views into the same picture.

In his 1956 "Print Gallery", Escher manages to show internal and external views to a gallery viewer at the same time. Escher's work on perspective highlights the peculiar nature of our perception of the third dimension, and possibly hints at the unreality of linear perspective (in human terms). In the present chapter, what we "borrow" from Escher's perspective views, is the possibility - or even desirability - of combining multiple perspectives into the same graphic, and/or the possibility of doing so within a single (integrated) graphical display. Noteworthy here, is that when it comes to human perception of 3D, one does not always have to stick to "reality" - and especially in terms of traditional optical theory.

The usefulness of Escher's work (for the graphical user interface designer) does not end with perspective. He also developed a strong interest in spacial structure, and in the regular division of the plane. Especially interesting are his explorations of the relationships between space and the flat surface, and in regard to pictorial representation. In Escher's 1956 print "Fish and Scales", he manages to combine (what would have been) the regular division of a plane with an optical distortion that has conjoined black and white fish swimming in opposite directions - and at increasing scales! The end result is a type of multiple-scale or multi-magnification graphic that combines focus plus context views for a large number of fish images. More on the potential application(s) of such techniques later.

In conclusion, I hope that I have been able to convince you of the fact that you don't need stereoscopic 3D glasses to see things in "true" 3D, and also not to dismiss out of hand the "reality" of curvilinear perspective scenes and/or multiple and distorted perspective views.

PERSONAL VIRTUAL REALITY

Richard Bolt first talked about Lookable Graphics in the classic study by Stewart Brand (Brand, 1989). Dr Bolt predicated that "A whole graphic art will arise concerning "Lookable Graphics" – graphics which are concocted and generated with an awareness that they will be looked at". This insight seems to have been ignored by many subsequent researchers in the 1990's, who sought to create virtual worlds and 3D Interfaces which re-created all the complexity of the real world, including the supposed geometry and optics of reality, inside the computer but without taking into account fully the physiology and psychology of the human visual perceptual system.

It seemed that many of the VR computer scientists and engineers had forgotten to talk to the vision experts and also perception scientists in the early years of the development of Virtual reality (VR.) Immersive interaction was the great premise of the Virtual Reality movement in the early 1990's. Within a short time VR UI's would be everywhere, many proclaimed. As it turned out VR systems today remain largely stuck on entertainment consoles and in research labs. We are still waiting to see the widespread application of VR systems in day-to-day life. Perhaps one of the primary reasons for the failure of VR is that until recently efforts have focused on the creation of fully immersive interactive worlds which attempt to mimic the full complexity of reality complete with all its visual messiness and confusion.

The problem here is that even when you do succeed in producing convincing artificial realities, people find it extremely difficult to navigate inside these VR worlds using ordinary displays and interaction techniques. In fact these methods often prove to be less efficient for everyday tasks such as retrieval, than the alternatives such as ordinary 2D menus. I am convinced that many in the VR community took a wrong turn in terms of designing broadly applicable UIs. By fully immersing people into the computers world they placed people about as close as it is possible to get to the digital content. This in fact closed off the view of content, creating a narrow view at the expense of an overall view. As a result the user ends up constantly moving his viewpoint and/or location about (inside the VR world) in an attempt to find items of interest, and navigation becomes the key task.

The VR system designers forgot that it is distance itself which constitutes a scene and which provides room for the user to contemplate the whole. It is critically important to be able to achieve a reasonable amount of distance from which to survey a scene efficiently in an overall sense, and this is a context related rule of human perception. Thus if we are to be able to build an efficient 3D user interface, which facilitates information retrieval tasks such as browsing, we need to ensure sufficient distance is achievable from the viewer to represented objects in the simulated world.

I would like to go one step further here and put forward the suggestion that the VR pioneers made another mistake in terms of building efficient user interfaces. They chose to give the user complete freedom to adopt any optical or physical vantage point within these simulated worlds. This invited loss of context and thus made building interfaces which efficiently performed tasks such as information retrieval very difficult if not almost impossible to achieve.

Another approach to the design of Artificial Reality (AR) systems is in one sense the very opposite of Virtual Reality (VR) systems where the user is immersed in a virtual world which he then adapts himself to. This new approach is the Personal Reality (PR) system which we are introducing here for the first time. With PR systems the world view adapts to the person in a highly specific way, and this class of artificial reality system may be properly called a *Personal Reality* (PR) system. The nature of the personalization of the system is not defined and may differ from one design to the next. Typically the PR system might adapt optical parameters such as perspective projection, the field of view of specific aspects of a scene, the distance and scale of objects, and also as well creating background contexts for aspects of the display where appropriate.

We now go on to examine the features of one particular class of PR system, the Lookable User Interface.

LOOKABLE USER INTERFACES

A Lookable User Interface (LUI) is a user interface which has been designed to afford the maximum degree of visual accessibility of digital content to an individual human user. A LUI displays to a particular user, at any instant, a highly personalized display (usually in 3D) in which all of the constituent components are projected and arranged so as to afford optimal viewing from a fixed station or observation point. Lookable user interfaces "know" they are being looked in the sense that they automatically adjust all of the visual aspects of the scene so as to project content in a personally optimized way towards a notionally fixed viewing location. Here optimized is understood to refer (for example) to efficiency parameters such as the overall amount of information or content presented or retrieved by the user, per unit time, on the specific tasks that the LUI has been designed to facilitate.

Note here that LUIs are classified as PR systems where the station point and viewing angle relative to the optical scene remains fixed. It is important to note that a LUI is envisaged to be a highly integrated and also immersive environment and one which provides a rich background context for computing operations. We do anticipate therefore that most LUI's will inevitably be 3D representations in one form or another. Note however that some LUI structures may be semi-3D, or else purely 2D, and perhaps also adopt warped forms of representation (to produce "optical" type distortions) - and thus be similar to the "Fishes and Scales" distortion techniques seen above.

A LUI is designed in such a way that the whole optical environment accommodates itself around the users viewpoint. Within this framework items automatically adopt locations, scales, and local reference angles such that they afford maximum visibility from the users vantage point at any moment in time. Here the user does not have to move items directly or worry about his/her viewpoint, rather the LUI manages the view of the scene to afford the maximum visibility of all components. Users are then free to observe the content without worrying about the details of how to maneuver in order to look at the scene from an ideal location or direction.

Vision is inherently selective and also relational in nature, and thus maintenance of the correct context is essential. LUIs are also designed to operate as context interfaces, and inherently provide distinct and fixed visual reference locations for interface components. Thus LUIs tend to solidify the impression of context in the users mind. A key distinction between LUIs and other GUIs is that

LUIs are designed in an overall sense with visual accessibility as the primary factor. Objects automatically maintain optimal distances and viewing angles in order to preserve context and so to foster the visual articulation of the field of view.

In addition to the 3D arrangement of the interface components, LUI interfaces will often employ 3D objects (and/or 3D optical illusions) to foster the rapid perception of the different items present in the display space. Note here that the LUI will automatically control the visible 3D form, scale, geometrical position, and also the local angle of such 3D objects. The user may influence these parameters according to specific interactive selections, but the LUI always maintains overall control of these factors so as to be able to optimize the optical parameters of the scene as a whole.

How to Recognize a LUI

It is useful at this point to briefly summarize the differences between LUIs and other types of human computer interfaces such as GUI's, ZUIs (Zoomable User Interfaces) and also VR type systems. Firstly we note that LUIs are generally 3D user interfaces, but this is not thought to be one of the primary distinguishing factors because it is just possible that the principles of LUI design may be applied to a 2D user interface.

A LUI is different from other GUIs in the following 3 key respects. Firstly with a LUI the overall scene is automatically arranged in real time so as to afford the maximum degree of visual accessibility of digital content from a fixed point of view. Here all components automatically adopt positions, distances, optical scales, and alignments as necessary and in order to accommodate the users personal view angle and field of view. Note that in a LUI items may sometimes adopt unrealistic optical scales (and also un-characteristic positions and alignments), one relative to another, for the purposes of optimal visual display.

Secondly an overall visual context is created which allows objects to adopt fixed visual reference locations relative to one another, and which fosters the visual articulation and mapping of the visual field. In particular the use of a patterned background context to aid the display of content is normal in a LUI. Generally some kind of hierarchical arrangement of content is also preferred with individual display units or cells being visually distinguishable. These cells are necessary in order to provide a filing and linking structure which maps content into easily definable visual compartments.

Finally LUIs often employ unrealistic and apparently distorted optical perspective views. The key aim here is to provide focus plus context views in order to expand the optical display space whilst simultaneously accommodating detailed views. Here multiple vanishing points are sometimes used both to frame individual visual fields and also to provide local visual structure.

It is important to note here that with LUIs multiple display spaces may be present in the same scene, and that each view may be entirely unconnected to the others in optical projective terms. (apart from the fact that the different scenes fall within the same display window and/or perspective window, and in a similar way to the multiple perspectives of "cubist" art). A departure from optical reality is a strong feature of LUIs which in all cases favor clarity of visual structure over the ordinary rules of optical projection. Once again we reference the artist M.C. Escher's work here, and especially in terms of the creation of seemingly unrealistic views of reality, being views that nevertheless retain sufficient structure to be readily scanned, memorized and internalized into a *consistent picture* within the viewers mind.

The goal of the LUI was succinctly put by a VR pioneer whose name escapes me: "And then the user interface itself disappears altogether and you have the illusion that you are interacting with the content itself. "

"LOOKABILITY" EXPERIMENTS

Following our (necessarily brief) discussion on the nature of perspective and on the topics of 3D depiction and the human perception of 3D, we now present the results of experimentation with the concept of the Lookable User Interface. Remember that we stated that it would not be possible to explore the design space of 3D user-interfaces comprehensively, due in part to the shear number of different kinds of 3D user interfaces that are possible. That is in fact the reason why we decided to use the theory of human perception as a starting point, in order to reduce the size of the design-space probed, whilst also giving us (hopefully) a head-start on where to look in the solution space itself.

Our experiments began with a visible "pole" of data, in the form of a 3D UI that we call the "Data Stick". Here rings of data (actually 2D/3D icons which represent documents or items of data) were stacked, one on top of another, all being at first invisible. Next when the user moved his mouse over a region of the stick, the closest "ring" becomes visible - including any and all contained data icons. Items on the visible "ring" could then be selected/rotated, whereupon the referenced data items were displayed; and exactly as happens when you click on a Finder item. The Data Stick mouse controlled "hide-show" visualization technique, proved to be a quick way to locate items from a data-set of around 50-500 items.

Next we experimented with a number of different curvilinear-shaped UI geometries. Most had vanishing points left and right as well as up and down and forward and backwards. Thus the design(s) conformed to a form of "curvilinear" perspective. Contained objects scaled themselves according to the momentary distance from each vanishing point, and objects either faced the station-point or else aligned themselves with the nadir of the rear vanishing point. Various animations and selections were possible with these UIs. We also tested the effects of different perspectives, horizons, station and vanishing points, background textures, colors, scales, icon-types etc, on scene "Lookability" (See below). In particular, we noted that the curvilinear geometries do (appear to) magnify the user's perception (and memory) of on-screen item locations.

Previously we mentioned artist M.C. Escher's fascination with the regular division of the plane and in particular we noted that his print "Fishes and Scales" could be a design pattern worth studying for UI designers. We speculate that this lithograph points the way to provision of useful trompe-l'oeil affects that could be created, whereby the user is able to see some data items in close-up view whilst maintaining an overview of a large number of other items.

SPECTASIA

Spectasia is a design for a new class of 3-D User Interface which aims to enhance the information visualization and retrieval capabilities of computer users in a wide range of circumstances. For example, we believe it can amplify the visual search, navigation and also selection capabilities of users when interacting with digital content. Spectasia employs a form of curvilinear perspective which is similar to an extremely wide-field view of a scene as projected by a fish-eye camera lens. We chose to use this particular form of perspective in order to provide an exaggerated impression of depth to the user, and also to provide an expanded representational "space". It is important to note that Spectasia's curvilinear scenes foster rapid visual articulation of a very wide "field" of view. Here a large number of objects can be rapidly scanned, and the impression of item location, and 3D or depth, is a very strong one.

Spectasia's curvilinear scenes create an effective visual background context for objects to reside in. Spectasia employs curvilinear perspective to boost the visual accessibility of content. Here three vanishing points produce a smooth optical magnification continuum which creates an expanded representational space in which objects can reside. A smooth blending of focus plus context is produced, and optical zooming and panning operations are easy to achieve. A key advantage is that users can focus their attention on the precise (relative) screen location of desired items with greater accuracy, immediacy, and also within a predictable time-scale. (user-testing is required to validate this claim)

Spectasia is applicable in those situations in which a smooth blending of focus (i.e. projected visual detail) plus context (positional, ordinal and structural relations) is to be maintained during simulated optical zooming and panning operations. The network of visual objects can be animated under user control to either bring new regions of the hierarchy into view and/or to bring "distant" objects closer to the viewpoint. Spectasia also employs other presentation mechanisms (ranking along an axis, ranking along a radius, and drilling through icon classes) to allow other attributes of the data mountain to be examined. Where an array of displayed objects extends beyond the bounds of the display aperture, the projection may be visually animated or scrolled (laterally or in the orthogonal direction) to simulate optical panning/zooming. Simple to use on-screen navigation cursors, scroll position indicator displays and level indicators allow the user rapidly to navigate, and to efficiently browse, all types of content. Spectasia also includes a click-stream memory, 3D pin-markers, and an instant search utility plus a spotlight highlighting device.

Spectasia is ideally suited to the analysis of the ontological features and/or the subsumptive relational aspects of content. Significant technical challenges have been overcome during development of Spectasia, including memory management for 3D object databases and 3D scene paging, curvilinear perspective rendering, as well as interaction complexity. Spectasia is applicable in a wide variety of information display scenarios, including hand-held devices, PCs, information kiosks and shopping terminals. The entire display area can be finely scaled to achieve an efficient utilization of the span of display elements (or pixels) within the available display area or to affect rapid field-of-view customization. In principle these procedures do not result in a reduction of the represented information vista, thus the method is applicable on a variety of different physical display area sizes. Spectasia is serviceable wherever digital content is to be presented as an array of item choices and/or where product/item categories are to be browsed and/or navigated. It is applicable on different kinds of display systems, including those of either the 2-D or 3-D stereographic class. (3D icons are supported).

CONCLUSION

In this article we have explored a new theme in graphical user interface (GUI) design, named the Lookable User Interface (LUI). The success of the Spectasia user interface, in terms of providing wide-field overviews of, and rapid access to, digital content, points to the existence of a rich vein of design space for system designers who adopt the LUI approach. LUIs appear to solidify the impression, and memory of, on-screen item locations (one relative to another), and therefore they operate as context interfaces. Benefits to users may include faster retrieval plus improved knowledge and memory of digital content.

Whilst LUIs are designed to visually adapt themselves to a single viewpoint, Personal Reality (PR) systems would address the broader aspects of how to create artificial realities which adapt to the users specific needs from *multiple points of view.* Note that a key goal of PR systems is the instantaneous optimization of the "Lookablity" of the scene, only now from multiple viewing angles and various projection locations and over a period of time. A key premise here is PR systems are similar to VR systems in one respect, in that PR systems are explorable. These systems may include full-blown artificial worlds, and possibly also reality augmented systems. PR systems would probably contain multiple LUI devices to facilitate human-computer interaction. In this respect LUI systems would be sub-components or building blocks of larger and more complex PR systems.

We have built and tested a Lookable User Interface named Spectasia which provides accelerated access to digital information. Spectasia offers improved wide-field views of complex information structures; and especially ones containing universals and particulars. Spectasia facilitates efficient navigation and effective "way-finding"; and it is particularly useful for the rapid location of items from within data-mountains that contain 1000s of items. The provision of comprehensive overviews and/or improved explorative freedom are anticipated from such Personal Virtual Reality systems.

ACKNOWLEDGMENT

Thanks to Dr Kim Veltman, and Philip and Ellen Radley for advice and for making this chapter possible.

Figure 4. Data Stick Prototype

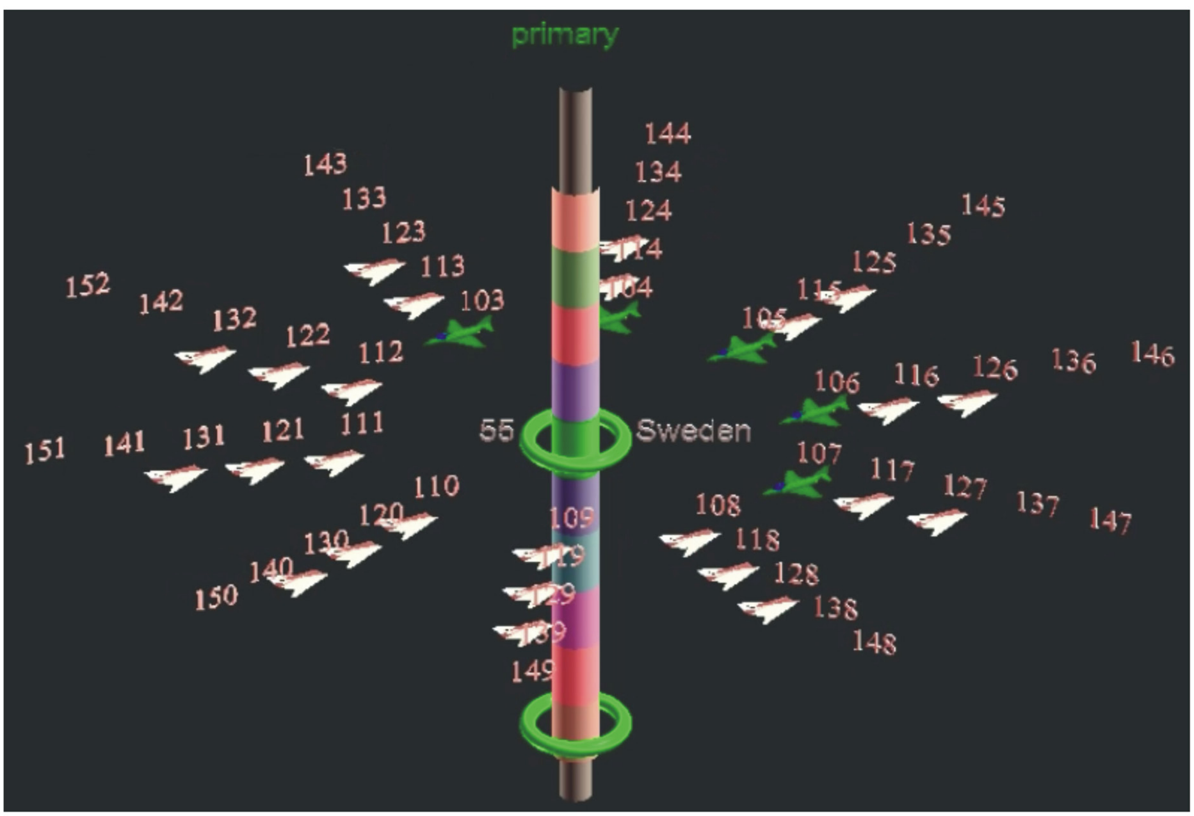


Figure 5. 3D User Interface Prototypes

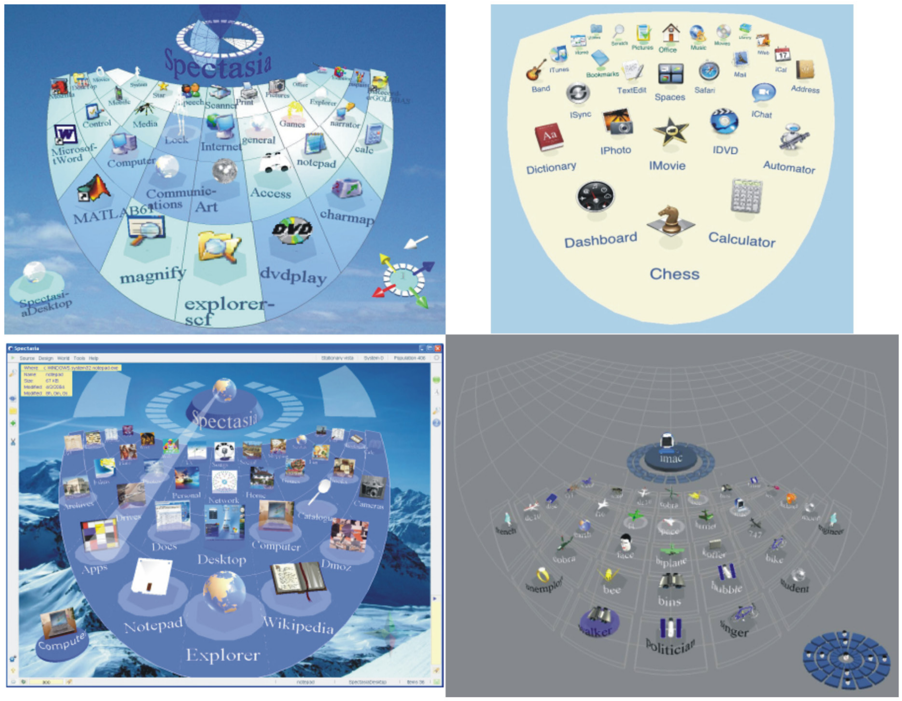


Figure 6. User Interfaces with different perspectives, geometries, scales, views, vanishing points etc

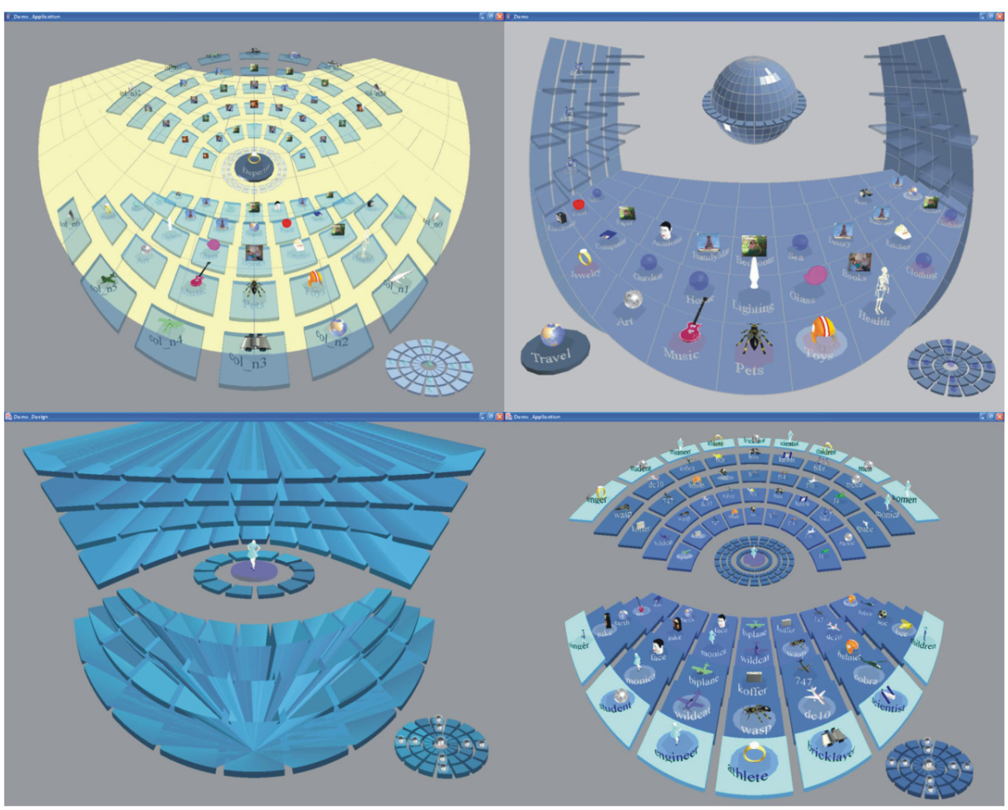
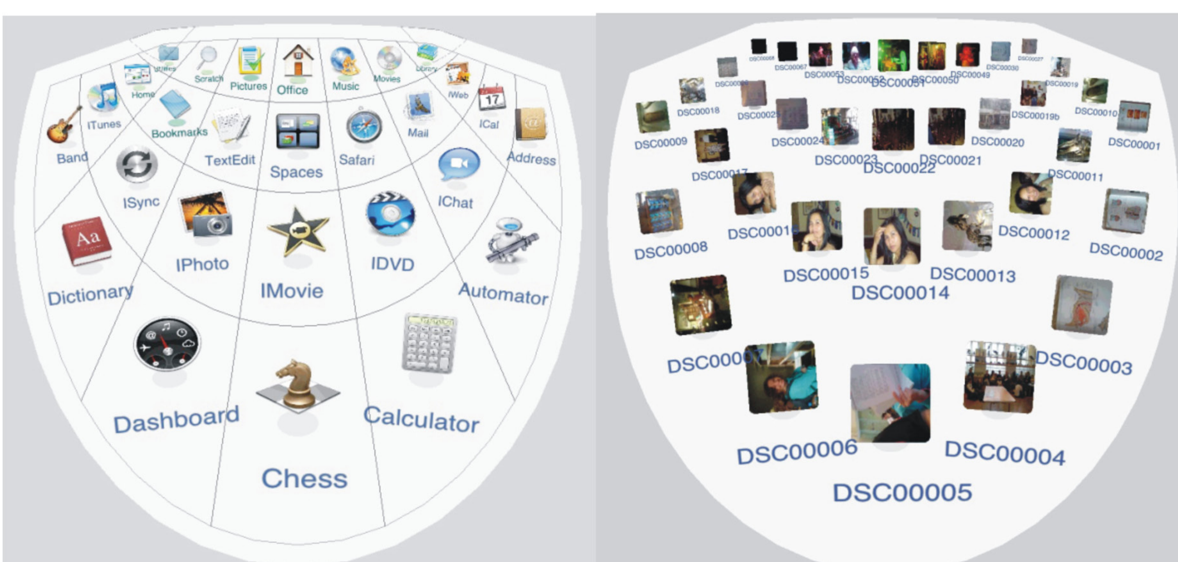


Figure 7. Spectasia on Windows 8

Figure 8. Spectasia on Apple OSX



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KEY TERMS AND DEFINITIONS

Curvilinear Perspective: Is a graphical projection used to draw 3D objects on 2D surfaces.

Graphical User Interface: Is a visual way of interacting with a computer using items such as windows, icons, and menus, used by most modern operating systems.

Hologram Mirror: Is a mirror system which produces a one-to-one scale stereoscopic "reflection" image which faces the object, and which floats in space in-front of the mirror surface. Also, when used by a person to look at his/her own reflection, a "Hologram Mirror" produces a three-dimensional image of the person's face, but without the clutter of background images that are normally seen.

Hologram: Is a technique which enables three-dimensional images to be made. It involves the use of a laser, interference, diffraction of light intensity recording and suitable illumination of the recording.

Human Computer Interaction (HCI): Is the study and planned design of human and computer activities.

Lookable User Interface: Is a user interface which provides a high degree of visual accessibility for digital content. Typically a LUI enables the user to explore a 3D representation of a large collection of data items or object models.

Personal Reality (PR): Is another approach to the design of Artificial Reality (AR) systems, and is in one sense the very opposite of Virtual Reality (VR) systems where the user is immersed in a virtual world which he then adapts himself to. Here the world view adapts to the person in a highly specific way, and this class of artificial reality system may be properly called a "Personal Reality" (PR) system. The nature of the personalization of the system is not defined and may differ from one design to the next. Typically the PR system might adapt optical parameters such as perspective projection, the field of view of specific aspects of a scene, the distance and scale of objects, and also as well creating background contexts for aspects of the display where appropriate

Stereoscopic: Relates to or denotes a process by which two photographs of the same object taken at slightly different angles are viewed together, creating an impression of depth and solidity.

Virtual Reality: Is a computer-simulated environment that can simulate physical presence in places in the real world or imagined world

Chapter 4
Time-Windows:
Reconnecting the Window-Metaphor of the GUI to Real Space

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ABSTRACT

A large percentage of computing tasks in our contemporary environment are spatial problems carried out on mobile or spatially distributed computing devices. In this chapter, the authors evaluate if and how the commonly established metaphor of a windowed user interface may be adapted in order to suit contemporary usability needs. The study observes user behavior and interactions with a set of large-format touch screens in order to assess user's ability to integrate their interpretation and operation with the displayed information across multiple, spatially distributed screens.

1. INTRODUCTION: SEEING THROUGH THE WINDOW

Since almost three decades the Graphical User Interface is the standard for the human-machine interface and whenever we interact with computers we are inclined to expect this interaction to employ Windows, Icons, Menus and a Pointing device. Despite significant technological changes over the course of this timeframe the concepts of how users interact with computers has remained mostly the same. For a core technological function of computers this is a surprisingly long time of constancy and already in the 1990 (Hinckley, 1996) this was regarded as stagnation and an imminent change predicted according to the changes in computing machinery. Myers et al. write that "Virtually all applications today are built using window managers, toolkits, and interface builders that have their roots in the research of the 70's, 80's, and 90's." (Myers et al., 2000). Again the authors predict that the conventional GUI is ill suited for many contemporary computing applications and thus will be changing soon. Nevertheless, the WIMP concept is still the standard on most of our computers today. While the mouse as a pointing device has in many cases been replaced by trackpad or touch screen based interactions, the window as a conceptual tool to facilitate the user in the negotiation of multiple coexisting contexts and tasks. The window metaphor is established as an easy way to delimit the different contexts

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of sets of information, applications, files and the various objects we encounter in our work with computers and thus to allow the users to orient themselves and organize their workflow.

The window as a frame to distinguish information contexts goes hand in hand with the development of personal computing. The window was implemented in form of a display screen in Douglas Engelbart's oNLineSystem (NLS). It was part of a visual interaction system comprising a television monitor together with the mouse, "a hand-held X-Y transducer" constituting a system to "augment the human intellect" (Engelbart, 1968). The original implementation of the NLS used the physical frame of the display screen as a delimitation for the representation of information contexts shown on the screen and required the user to navigate through a hierarchical structure of different 'screens' of information representations. In subsequent implementations, though, the idea of framed visual representation and the window as a metaphor of the possibility to look into a different, coexisting world informed equally the software design. Alan Kay adopted the notion of "a general window that viewed a larger virtual world" (Kay, 1993) first in the development of the FLEX machine and later of the Smalltalk language, which was to become at the same time the user interface and the development environment of the Xerox Alto computer. The window metaphor was extended not only to use the display screen as a frame into an information world but it was subdivided and converted into a space in which multiple 'virtual' windows could be stacked and overlapped to represent multiple different information contexts. Kay was deeply influenced by the notions of visuality and visual cognition formulated by Seymour Papert and Marvin Minsky (Buchanan, 1974), who stressed the importance of the visual in their research on artificial intelligence (Kay, 1969). In his Ph.D. thesis "The Reactive Engine" Kay imagined large format virtual screens controlled by a windowing system that manages screen subsets and overlaps: "The portion of the display inside the windowed area is only what is transmitted to the CRT. A clipper is used to find the intersection of lines with the window boundaries. Any number of v. screens, windows and viewports may be superimposed." (Kay, 1969)

1.1 Augmenting the Human Intellect

From these beginnings of the graphical user interface we have kept until today the concept of the windowing system that allows us to structure our workflow through a combination of physical (screen hardware) and virtual (software) windows. The persistence of this concept, even though often criticized, is without doubt owed to the cognitive advantage it brings to our work with the computer. The stress on the visual and its particular formulation in the window metaphor was successful at realizing at least partially the early goal Engelbart pointed out in his concept of "Augmenting human intellect". With this notion he means "increasing the capability of a man to approach a complex problem situation, to gain comprehension to suit his particular needs, and to derive solutions to problems" (Engelbart, 1962). Engelbart conceives the computer as an intellectual tool intended to address problems in various domains such as engineering, mathematics, social life, and physical sciences. As an illustration of his concepts he uses an example situated in a particularly visual and spatial domain: the work of an architect, which is augmented through computational tools specifically arranged around the visual display window as the center piece: "He sits at a working station that has a visual display screen some three feet on a side; this is his working surface, and is controlled by a computer (his "clerk") with which he can communicate by means of a small keyboard and various other devices." (Barnes 1997) This "clerk" is apt to offer views into a virtual space with spatial representations of the planned building.

Engelbart's concept of the computer as an augmentation to the human intellect is in this sense very close to the idea of the Memex, which was conceived earlier by Vannevar Bush. Reportedly the MEMEX was an early inspiration for Engelbart's efforts (Barnes, 1997). Also Bush's thoughts were revolving around a screen, indeed a pair of screens, as the center piece of the device with a predominantly visually oriented form of interaction. The Memex was essentially thought of as an opto-electric device that organized information in optical frames of microfilm, which could be viewed, generated and edited by means of the screens of the machine (Bush, 1991).

1.2 Challenging the Window

As we pointed out earlier manifold criticism has been brought to the conventional WIMP interface concept. With computing becoming indeed ubiquitous and permeating many aspects of our daily lives many of the standards of the personal computer and the screen as its center piece need to be critically reflected. When in 2000 ubiquitous computing was starting to become a reality, already in 2009 mobile devices such as the cellphone are the most ubiquitous computers Markoff 2009). As computing enters many aspects of our daily life it necessarily gets distributed and moves away from the central desktop computer. A large component of human computer interaction takes place on mobile devices and it accesses other kinds of information than in the earlier kind of personal computing. A high percentage of the tasks solved with mobile computers are relating to spatial questions, problems and tasks. Starting with navigation and way finding all the way to social media applications that establish space-referenced contacts such as *Foursquare* and *Facebook Check-ins*. The kinds of questions we address with computing devices have significantly changed and while the information worlds represented in the windows of the graphical user interface of the traditional desktop computer were abstract meta-level spaces of information we see now a re-connection of computing tasks to real space. A large quantity of the contemporary computing applications are mobile, distributed across many screens, or they involve space-specific computing (Messeter, 2009). The challenges to the traditional window-based GUI are multiple: small mobile devices do not have the screen space to handle multiple overlapping windows – do we have to go back to the hierarchical screen structures as they were implemented in the original NLS (as we currently do with most mobile applications on smartphones); the energy consumption to render a rich graphical representation of the user interface is taxing for the limited resources of mobile devices (Zhong & Jha, 2003); screens exist in multiple locations in real space – how do we map and register real space and the virtual representations?

1.3 Evolving the Window

This set of challenges could be described as a spatial turn in computing – and this rediscovery of space and place, as well as the temporal component linked to space, has been a development that has taken place over the last thirty years, having its beginning in approximately the same timeframe as the graphical user interface of personal computing (Ayers, 2010). Our question in this study is whether we will need entirely new interfaces or is the window metaphor still apt to augment human intellectual effectiveness in spatial understanding and navigation? Devices like *Google Glass*, which, despite its visual component of information overlaid on top of our perception of the surrounding space, implements an inherently voice controlled interface without the window framing as a conceptual delimiter, seem to be indicating that we might need a completely new set of interfaces to appropriately respond to the challenges of shifts in computing. On the other hand the metaphor of the window is so deeply rooted in the understanding and conceptualizing of space that it seems it should offer good opportunities support our spatial tasks and interactions – and solutions like augmented reality applications, where the virtual window of the interface becomes a precisely registered window into the real space, hint at this potential.

In our current study we are investigating the affordances of multiple screen-windows distributed in space and the ability of users to integrate and operate across those screens. Our concerns are on one hand the cognitive integration across those screens and on the other hand an investigation of the cultural context and preexisting knowledge that shapes user's interpretation of the screen contexts. As users tend to refer to familiar cognitive structures when trying to understand or learn new concepts, it will be important for our purpose to examine the cultural context and potential concepts that users are likely to resort to when using the window metaphor as a cognitive tool (Carroll, 1982).

2. METAPHORS OF SPATIAL ABSTRACTION

Even though the pioneers of the GUI did not mention explicitly that they were choosing the window metaphor for its connotation of spatial abstraction, the intuitive understanding of the window as a conceptual device to organize space and the coexistence of different spaces seems obvious. Not only are windows as architectural elements part of our daily experience, we also have a longstanding tradition of the window as an element of visual culture. Be it in the form of photographs, paintings or all kinds of other visual representations we are used to looking at a framed excerpt of a spatial continuum that we mentally extend beyond the borders of the visible frame. The frame as a delimiter that circumscribes one spatial continuum and separates it from the other, the surrounding space in which the first one is perceived, is deeply engrained in our culture and has become second nature to us. Our understanding of the frame is so unproblematic for us that we do not even perceive the act of abstraction that it embodies. This self-evidence of the interpretation of the window frame is what enabled the effortless understanding of the window metaphor in the context of the GUI.

Looking a little closer, though, we realize that there were competing concepts and the trust into which concept will be the one easily shared by most users grew only over time. Several implementations, such as the first version of *Microsoft Windows*, used a tiled window layout, which did not allow for overlapping windows for fear of being too confusing for the users. This approach borrows its conceptual underpinnings from the window as an architectural element. Physical windows in the architectural space cannot overlap, they can only be side by side, cut into a wall. Other implementations, such as *Apple's Lisa* or subsequent implementation of *Microsoft Windows*, use overlapping windows, an approach borrowing from the notion of the picture or document frame, which, as a flat self-contained object, can be overlapping and thus is logically consistent with the desktop metaphor of the GUI. Historically, for the context of personal computing, the desktop metaphor prevailed and the notion of the picture or document frame has supplanted to tiled window approach. In our attempt to reassess the window metaphor for the context of spatial computing it is helpful to pursue the architectural – and inherently spatially rooted – metaphor of the window.

2.1 Construction of the Abstract Window

Compared to the picture or document frame we have surely a much longer history of looking through windows, but the level of abstraction that the user has to muster in order to decipher the conceptual link between a display screen rendition and the architectural window is comparatively high. The abstract representation of the window as a virtual opening into a different, coherent, spatial continuum goes back to the construction of linear perspective, and it is part of our cultural history since the Renaissance. Originally discovered by Filippo Brunelleschi, it was Leon Battista Alberti who delivered the first conclusive account of the construction of linear perspective in his 1435 book *De Pictura*. Alberti introduces the notion of an open window through which the subject to be represented is seen (Alberti, 2004). This window corresponds to an image plane on which a representation of the space behind the 'open window' is constructed with means of mathematical precision. Alberti explains the geometric methods how to establish the illusion of a coherent space and a rendering of the correctly scaled relations between all depicted elements. The method is familiar to us as the construction of linear perspective, which has become until now the dominant method of rendering and conceiving of space. Going back to Alberti's account, though, reveals that already in his understanding we have the notion of a conceptual device that is targeted to – to put it into Engelbart's words – augment human intellect and at extending our cognitive access and ability. Not only is the construction of linear perspective a 'personal' device that exactly calculates the representation for the viewpoint of one precise viewer, the notion Alberti pursues is to "make the absent present" and to represent "the dead to the living many centuries later." (Damisch, 1995) In this sense the perspective window becomes a device to navigate across space as well as across time. With Brunelleschi and Alberti "the modern, systematic conception of space" is introduced in the realm of the arts (Damisch, 1995).

The mathematical scientific version of a coherent space construction is later formulated by René Descartes in his treatise on geometry as part of his *Discours de la méthode* in 1637 (Descartes, 1925). With the introduction of his coordinate system he delivers a method to represent a spatial continuum and algebraically express the relationships of all objects in this continuum. Again his goal is a cognitive augmentation, his geometric elaborations are part of an effort "to intuit the whole thing at once. In this way our memory is relieved, the sluggishness of our intelligence redressed, and its capacity in some way enlarged." (Descartes, 1984-91)

2.2 Integration across Windows

The cartesian coordinate system as well as the perspective construction are methods of integrating disjointed objects into one coherent representation. Before the invention of linear perspective painters were displaying objects as discreet objects that "were not merged in painterly fashion into spatial unity, but rather were affixed to each other in a kind of tectonic or plastic cluster (Panofsky, 2005). This kind of coherent integration across multiple objects is what the window metaphor aims to do in the GUI and in the management of multiple coexisting tasks. We can argue that this integration works only within one window or one frame of reference and breaks down when there are several window coexisting at the same time, thus establishing multiple disjointed frames of reference. If we are looking at this problem within the context of one central screen that displays all the disjointed windows – as is the case with the conventional personal computer – the problem is alleviated because the virtual windows coexist within the frame of reference of the physical window of the screen. We see something akin to a hierarchical stacking of frames of reference. Moreover, in the context of the desktop metaphor connoting the picture or document frame the conceptual possibility inherent to the metaphor that many documents can be stacked on a desk resolves the problem. For the metaphor of the window as an architectural element we would ask, though, if the user would expect all windows that are side by side open into the same space, as neighboring windows in a wall would? And we would ask further what does this mean for a context with multiple physical windows, each on a separate screen? The question how user interface systems should adapt to environments with multiple spatially distributed screens is pressing as we have more and more spaces where multiple screens coexist and where these screens do not always follow a coherent screen architecture as we know it from multiple screen desktop set-ups. Studies have been conducted in terms of the cognitive aspects of large format displays (Andrews et al., 2010) as well as in terms of distribution algorithms across spatially distributed screens (Waldner et al., 2011), but many questions are open regarding the user interface structure.

In order to gain empirical insight into these questions we conceived a set-up consisting of multiple large format screens, each of them acting as a discreet window. The windows show different information that extends along a spatial axis and along a temporal axis. The screens can be synchronized, showing the same temporal or spatial context, or they can a-synchronously showing disjointed representations. Users navigate the screens through touch interaction and by walking from screen to screen. This first iteration of our study focuses on the observation of users and their interaction patterns. Occasional interviews have been conducted. The purpose of this iteration is to get a first overview over the intuitive behavior of users in the test setting.

3 TIME-WINDOWS

The test set-up for our study consists of six large format touch screens of ca. 90” by 50” (each of these screens is a triplet of touch screens). They are mounted on two opposing walls such that they are evenly distributed across a large room (see fig. 1). The room is large enough so that depending on their position in the room users can see several of the screen at once. If standing on the head ends of the room it is possible to see all

Figure 1. View of one wall with three screens. The opposite wall with the second set of three screens is in the back of the photographer.

six screens, standing in the middle the users can see either the three screens on either side of the room or three to four screens on opposing walls of the room. When a user moves to one screen such that he can interact with the screen through touch interaction the screen fills his entire field of view. This set-up means that users can either see several screens when they are not interacting, i.e. when they are in an observer position or they see one screen taking over their view when they are actively interacting. By choosing their position in the room users can comparatively view the screens.

The content shown on the screens was chosen such that it can be either synchronized or a-synchronous along a time and along a space axis. All screens show a series of panoramic images of the room in which the screens are mounted. The portions of the panoramic images are displayed in the corresponding location of the room. Users can navigate the panoramas by panning and tilting them by means of the touch screens; a two finger gesture allows them to zoom in and out of the images.

3.1 Space Images

We decided to increase the field of view to show a larger portion of the panorama than would normally be visible if we showed the exact portion of the wall corresponding to the portion the screen covers. In preliminary tests the larger field of view has proven to be more enticing for users to approach the screens and engage into interaction. Showing just the portion of the wall that exactly corresponds to what is covered by the screen has a somewhat abstract quality and – as in the majority of the panoramas this would be only a flat portion of the wall – does not convey a clear sense of space to the users.

At the beginning, when users enter the room all screens show the same panorama, which is registered according to the space it shows and shows the current state of the room. As users start to interact with the screens and move the panoramas, different parts of the room become visible while at the same time leaving the exact spatial registration with the physical room. As

Figure 2. Excerpt from a panorama documenting the construction process of the building. On the right side is a scroll wheel to navigate different time phases of the construction.

more users interact, the each of the screens will show a different part of the room. If no interaction occurs for a while, all screens get reset to their original position again. Behavioral aspects of the users we are observing are whether they step back to assess the sum image of the screens and how they relate it back to their interaction with a single screen.

3.2 Time Images

The panoramas have been shot over the course of one year and a half, documenting the entire construction process of the building and thus providing a time-lapse representation of the building being-made. The time axis can be navigated by means of a scroll wheel which allows users to choose a particular moment in time during the construction. As multiple users interact with the screens, different phases of the building construction will be shown on the various screens. As with the spatial registration, temporal coherence will be re-established after interaction when no interaction occurs for a certain amount of time.

4. CONCLUSION AND FURTHER RESEARCH

In this first iteration of the Time-Windows set-up we focused on the observation of users and the behavioral patterns they displayed in the interaction with the screens. We conducted a few occasional interviews where we asked users free-from questions about their experience. Our aim was to gather a first set of responses to the following questions:

- How do users interact in general, do they perceive spatial and temporal relationships between the screens and between the screens and the room they are in?
- Further we were interested in seeing whether users tend to see the individual screens as self-contained units not expecting them to have relationships to the neighboring screens (picture or document frame metaphor); or do they expect the screens to represent a continuous space (architectural metaphor)?
- Does the trajectory users are forced to go through in approaching the screens (entering the room users will inevitable see several screens) have an impact on how they integrate their interpretation of the information across the different screens?
- Does the progression from seeing several screens, to few screens to the entire field of view taken over by one screen have an impact on how they interpret and interact with the screens?

In our first study we found that users operate according to the picture or document frame metaphor. They tend to see the screens as individual self-contained units and do not expect relationships between them. The most common movement and interaction pattern of the users was upon entering the room to approach the first screen most prominent in their field of view when they enter (the room has four entrances and users chose either the closest or the most prominent screen) and then to go from one screen to the next. They interacted with each screen individually, abandoning interaction after three screens in order to sample a more distance screen. Only few users moved to the position in the middle of the room in order to observe several screens at the same time. No user was seeking the head positions from where all screen can be seen at once. In this sense it seems that the spatial trajectory users had to go through did not have an impact on the users and did not provide extra information about the information on the screens.

In a second iteration we will conduct more thorough observations and regular interviews and questionnaires with the users. As another iteration we are also planning to install a real-time panorama as the first stage representing the exact moment

Figure 3. Three panoramas showing different phases of the construction of the building

when users are entering the room and interacting with the screens. Another set of questions will be whether a specific shaping of the entrance trajectory can be used in order to communicate first clues about the information on the screens.

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KEY TERMS AND DEFINITIONS

Augmented Reality: Is a technique of displaying a representation of a real-world environment with additional information layered on top of it. This technique of stacked information layers aims to augment the view into the real world environment with additional information. The display system of augmented reality is mostly a real-time camera generated image stream with an additional computer generated information layer on top of the camera image.

Graphical User Interface: Screen based human computer interface using visual representations to establish the communication between the computer and the user. GUIs normally use visual objects such as icons, buttons and other so called widgets to construct a visual language.

Human Computer Interaction: Is the study and the design of communicational exchanges between humans and computers. Human computer interactions are generally channeled through an interface layer that allows humans to utter commands to the machine and in exchange the machine is generally equipped with affordances to represent it internal states to the human user.

Multi-touch: Interaction with a touch sensitive surface that is able to recognize multiple points of contact. Multi-touch technique is mostly used in conjunction with touch screens and allows either input through multiple fingers from one person or multiple people. The touch input can control a cursor in a way similar to the mouse or multi-touch gestures can be interpreted to trigger specific events in a computing program.

Perspective: A technique of representing a three dimensional space on a two-dimensional surface such as the screen or a canvas. Perspective construction assumes a specific point of view for which all the lines characterizing the space are rendered in close approximation to the way the eye would see them in reality. Perspective construction is the underlying notion of computer generated 3D rendering.

Ubiquitous Computing: Refers to the concept of making computing resources available anywhere. While computers used to be large and heavy machines, ubiquitous computing relies on the miniaturization of electronics and therefore the possibility of integrating computing technology into small mobile devices and many kinds of other ubiquitously appearing contexts.

Window: An opening in a wall through which the viewer can see a context (such as a landscape or a room) extending behind the wall. Traditionally an element of architecture, the window is often used as a metaphor in human computer interaction to refer to separate contexts displayed on a screen and separated from each other through a window-frame.

Chapter 5
Practical Metrics for Error Assessment with Interactive Museum Installations

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ABSTRACT

Many modern museum exhibits employ interactive digital installations that can display content on large public surfaces, such as tabletops, walls, floors, etc. Recently, such displays have begun to include special devices that are able to track the user position and thus offer a personalized rendering with respect to the user point of view. While many qualitative evaluations of such systems exist, little effort has been done to define a quantitative testing framework. This is mainly due to the subjective nature of this kind of experience, which makes it difficult to produce objective data with standardized and repeatable procedures. With this chapter, the authors introduce a metric and a practical setup that can be adopted to evaluate a wide range of viewer-dependent displays.

INTRODUCTION

Most stereoscopic displays, regardless of their physical implementation, work by showing to each eye of the user a different image. Specifically, these should be exactly the images that would have impressed his retinas if he really was before the depicted scene.

In many common 3D applications, such as movies or games, the stereo pair is obtained by using two separate physical cameras or by producing two independent scene renderings as viewed by two slightly different points of view. It is clear that the 3D illusion holds if and only if the optical system of the user exactly replicates the one that produced the images. This ultimately

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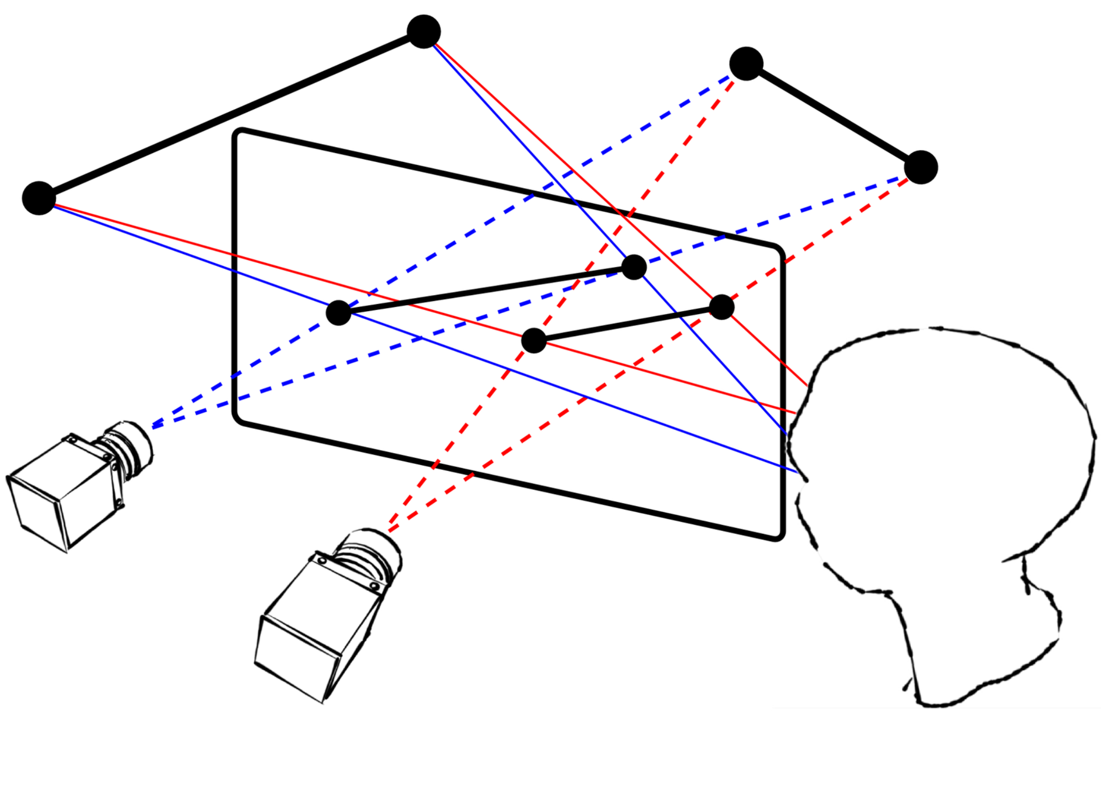
means that both optical centers of the user eyes must overlap exactly with the optical centers of the original cameras.

Differently, the perceived scene will be distorted as the 3D objects reconstructed (by the brain) will diverge from the original in size, position and proportions (see Fig. 1). Additionally, from a perception point of view, the effect can be further aggravated by the fact that points that would originally project into incident lines of sight, would probably result skewed when observed from the wrong point of view. This, in turn, would supply to the brain data that cannot be correctly interpreted in any way, resulting in an unpleasant sensation for most people. These shortcomings (not really advertised by the entertainment industry) are in fact responsible for the fluctuating quality of the user experience in 3D theaters.

The only viable solution to this limitation is to provide a rendering dependent on the user position and on his interocular distance. Of course, such approach would hinder the ability to offer a shared fruition to several users without adopting personal displays.

Nevertheless, viewer-dependent displays have been extensively proposed in recent scientific literature, since they offer many other advantages. For starters, they are able to guarantee that the viewed objects exhibit a correct size within the Euclidean space where the user resides, thus allowing to interact with them naturally and to make meaningful comparisons between virtual and physical prototypes. Moreover, viewer-dependent rendering lets the user walk around the scene, viewing it from different angles and enabling the same inspection dynamic that would be possible with a real object. Such ideas are not new at all and have

Figure 1. The stereo inconsistency problem addressed by this work. Any stereo pair, when observed from a location different from the position of the capturing cameras, will result in impaired perception. Under these condition any observer will see an unpredictably distorted 3D object.



been widely developed in literature since their early implementations with the first immersive virtual reality and CAVE environments (Deering, 1992; Cruz-Neira, Sandin, & DeFanti, 1993).

More recently, Harish and Narayanan (2009) combined several independent monitors arranged in a polyhedra to create a multiple-angle display and a fiducial marker system to track the user pose. In their system the object is visualized as if it was inside the solid space defined by the monitors. Garstka and Peters (2011) used a single planar surface to display non-stereoscopic content according to the pose of the user head obtained with a Kinect sensor.

A combination of Kinect devices and traditional range scanners have been adopted in a very similar approach by Pierard, Pierlot, Lejeune and Van Droogenbroeck (2012). It should be noted that, albeit implementing view-dependent solutions, the aforementioned approaches do not exploit stereoscopy. In fact, their primary goal was to enable the user to walk around the object rather than to offer a realistic depth perception.

Stereo vision is exploited, for instance, by Hoang, Hoang and Kim (2013), that used standard head tracking techniques to allow slight head movements when looking at a 3D scene on a monitor. The concept is very similar to the non-stereoscopic technique proposed a few years earlier by Buchanan and Green (2008). In those cases, while the correct projection is always offered to the user, he is not allowed to inspect the object by moving around it.

Bimber, Wetzstein, Emmerling and Nitschke (2005) ignore the user tracking problem and focused on the design of a combined projection system that is able to account for non-planar surfaces, while still offering the correct perspective. This approach allows to materialize virtual objects in non-specialized environments, such as archaeological sites. It should be noted, finally, that adding stereo vision to any view-dependent approach is usually not a big hurdle, since it just requires to account for each eye separately and to produce two separate renderings.

With this work we are introducing an approach that differs from the literature since it adopts a novel and robust head tracking system that is based on a simple modification of standard LCD shutter glasses. In addition we propose an evaluation method that can be used to assess the accuracy of similar view-dependent systems. According to our knowledge, this kind of quantitative evaluation has not been done before for any alternative approach found in literature.

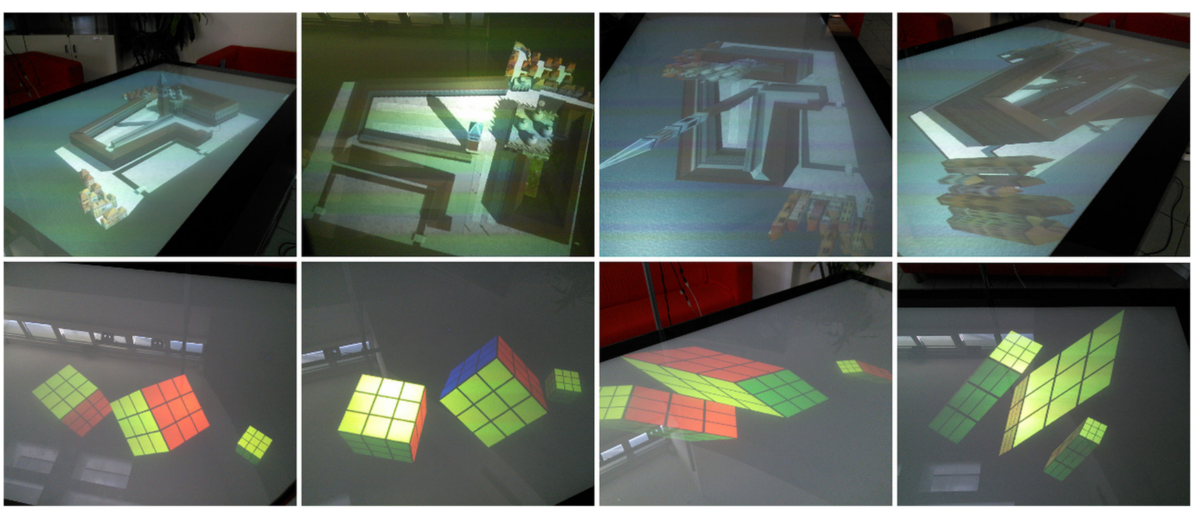
A VIEWER-DEPENDENT DISPLAY SYSTEM

The setup we are introducing is made up of three main components (see Fig. 2). The first one is a planar display. In our case it has been implemented with a short-throw digital projector placed under a translucent scattering surface. The second component is a pair of modified shutter glasses. They have been augmented with two pulsating IR leds that can be easily detected with a low false positive rate. The last component is a pair of IR enabled cameras, that will be used to track the two leds, and thus the user pose.

The main purpose of this setup is to give a correct and timely estimation of the user point of view and thus allowing to render the scene on the surface in a manner that offers the correct projection with respect to the user. In order to give an idea of the resulting effect we reported some qualitative results in Fig. 3. The first two columns show the scene as viewed by the user (putting the camera behind the glasses), while the remaining shots show how the displayed images appear from different points of view.

Figure 2. The view-dependent display and tracking system setup described in this work

Figure 3. An object shown on our viewer-dependent display as seen from different angles. The images in the first two columns have been obtained by putting a camera behind a shutter glass lens.



TRACKING OF THE USER POSE

While many other systems use some kind fiducial markers to estimate the user pose, we chose to avoid any kind of recognition technique in the spatial domain and to perform the identification within the time domain.

To this end we modified a pair of shutter glasses by adding two infrared leds that pulse at a constant frequency (see Fig. 4). By using different frequencies we are able to locate each pair of leds and to assign an unique label to them. Since we set a $\pi/2$ radians phase difference between the left and the right led, it is also easy to discriminate between each eye and thus to give a better estimation of their position.

The led frequency is selectable by means of a set of four switches that are accessible on the controller board, allowing several concurrent users. Of course, in order to support more than a single user the shutter glasses and the projector must be configured to show different images for different users. This is supported by many recent mainstream display systems, however it is not the case for the system tested within this study.

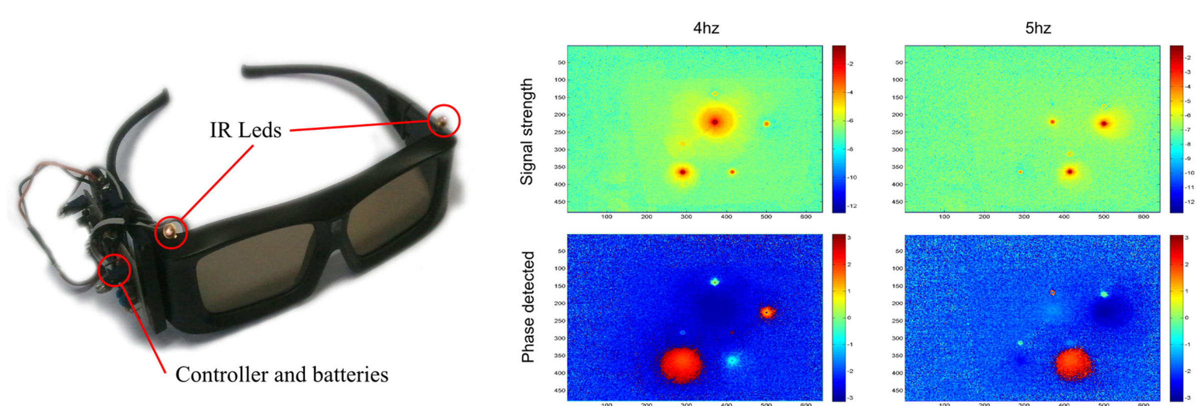
Differently from methods that perform identification by processing object appearance in the image domain (i.e. fiducial markers), our approach allows to use very small features (indeed point light sources) that are detected equally well both near or far from the camera. Of course the identification requires several frames, however, once a pair of glasses has been recognized, its leds can be tracked on a frame-by-frame basis without needing a new recognition as long as the tracker does not miss.

Additionally, the small size of the light sources grants a good precision with their localization and the use of infrared light makes it possible to filter out most of the scene clutter.

In fact, when a camera equipped with the proper infrared band-pass filter is used, only the signal generated by the pointing devices should be detected with an intensity that is non-negligible. Such signal will produce mostly unimodal intensity blobs whose size depend on the distance from the camera, and whose local maximum is located at the center of the led.

In our setup we used some PS3 Eye cameras equipped with a custom filter, modified for infrared, running at 75 frames per second. Each frame acquired is then thresholded with an adaptive method (Otsu, 1979). The resulting blobs are detected and fitted with parametric ellipses using the OpenCV library (Bradski, 2008). Such

Figure 4. Filtering of the signal emitted by two shutter glasses at different operating frequencies. Note that the response strength is highly sensitive to the filtering frequency. Furthermore, phase detection produces garbage data when not applied to a signal with corresponding frequency.



ellipses are thus refined on the original image with subpixel accuracy (Ouellet, 2009).

Each of their respective central points *p* is tracked between subsequent frames and labelled with the timestamp of the frame itself and the intensity of the associated signal. Such intensity has been computed as the average graylevel detected within a radius of three pixels from the tracked point. We refer to the timestamp (in seconds) of point *p* in frame *i* as *t(p,i)* and to its intensity as *I(p,i)*.

Since the signal emitted by each led is characterized by a specific frequency, we are now able to probe the identity of each point *p* by correlation with a sinus wave of the expected frequency *f*, resulting in the vector *Cp(f)*.

The length of *Cp(f)* is proportional to the correlation between the signal associated to *p* and the reference frequency *f*. Further, the angle between *Cp(f)* and the horizontal axis can be regarded as the phase of the signal emitted by *p*. This two facts offer a practical tool for rejecting false positive points that are not generated by pulsating leds, and also for discriminating each user from the others in multiuser scenarios.

The number of frames, n, required to compute *Cp(f)*, depends on the trade-off between accuracy recognition speed. While 3 frames are the theoretical minimum, in our test we found that 9 frames are a good choice to cope with the unavoidable noise coming from the imaging process.

In Fig. 4 we show the effectiveness of the frequency probing. We observed two glasses standing on a horizontal surface emmitting signal respectively at 4hz and 5hz. The first row in Fig. 4 shows the signal strength computed (logarithmic scale). The second row shows the detected phase, which is stable and correct only when the leds are filtered through the correct frequency slot.

Finally, the 3D positions of the detected leds are obtained by triangulation, using the method proposed by Hartley and Sturm (1997) and the positional noise if filtered slightly by using a linear Kalman filter (Kalman, 1960).

VIEWER-DEPENDENT RENDERING

After the triangulation of the IR leds, the position of each user eye can be determined along the line connecting them. This is a reasonable approximation since the leds are placed by construction on the side of the eyes. The exact distance between the leds and the estimated projection center of the eyes depends on the interocular distance of the user, which can be kept as a parameter.

For each eye the actual projection can be computed easily if we know its position in the world reference frame which we conveniently place on the display surface and aligned with its two main axis (see Fig. 5).

In this case, being *n* and *f* respectively the *z* coordinates of the horizontal near and far planes, and *(ex,ey,ez)* the position of the observer, the projection matrix for a general 3D point can be easily computed.

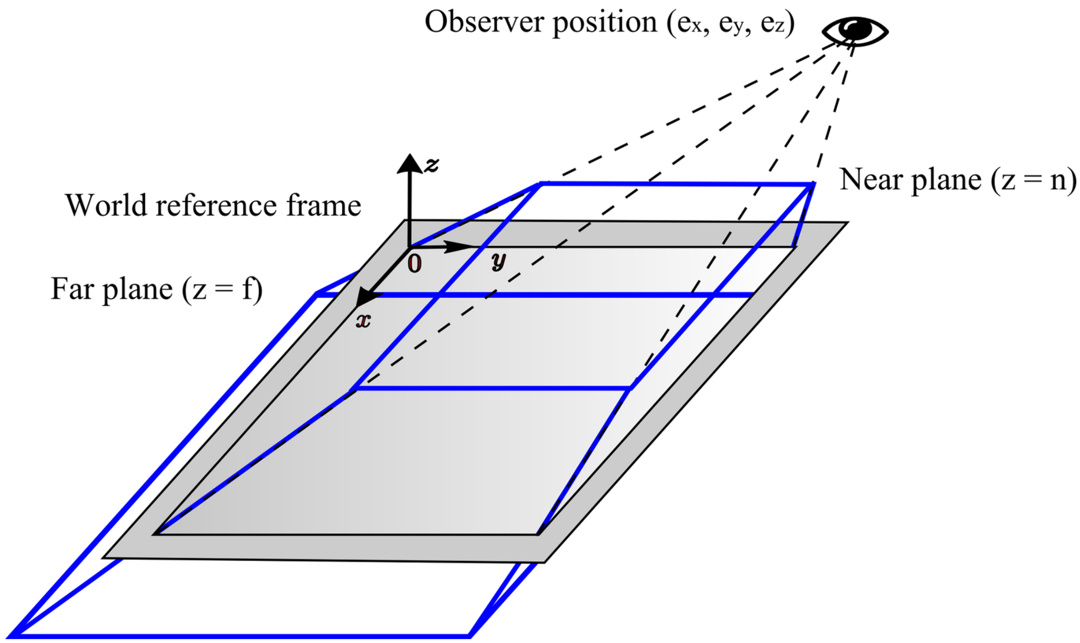
The rightmost matrix projects the perspective frustum into normalized device coordinates, considering a display plane that lies on *z=0* and spans from -1 to 1 on both *x* and *y* direction.

The leftmost matrix scales and translates the obtained *x* and *y* according to the size of the display surface.

The matrix *Pm* can be applied directly with any display framework that supports projection matrices, such as OpenGL or Unity.

Finally, in order to compute the position of the observer with respect to this new world reference frame, we need to know the relative motion between such frame and the cameras used for triangulation. We compute this rigid transformation using the coordinates of the four display corners in the cameras reference frames.

Figure 5. The relation between geometric entities within the setup



These coordinates are obtained by triangulation of a single led placed alternately on the four corners.

EVALUATING A VIEWER-DEPENDENT DISPLAY

Given the subjective nature of this type of displays, it is very difficult to supply some quantitative assessment about their accuracy (or even to define what really does "accuracy" mean).

In fact, most of the literature limits the evaluation section to qualitative shots of the views or to subjective reporting of the quality perceived by the user.

While this is perfectly fine for many application scenarios, in this work we would like to propose a suitable method to measure the performance of a viewer-dependent rendering setup.

To this end, we will account for the three main features that characterize this kind of systems: the accuracy of the user pose estimation, the compliance between the scene that the user is expected to observe and what he really sees, and finally the effect of the lag introduced by the whole pose estimation/display loop.

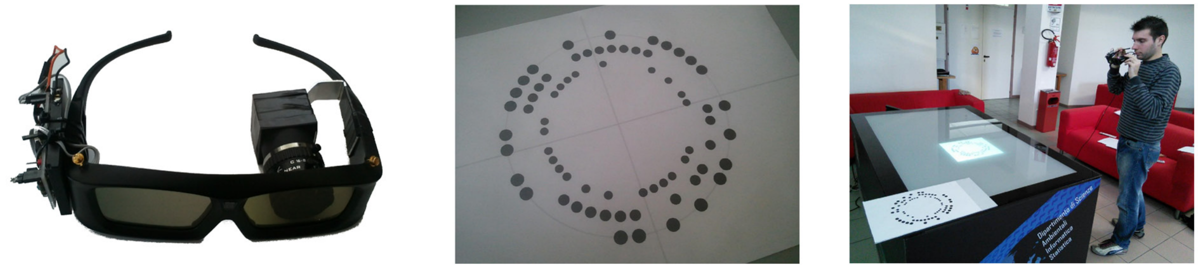
We propose to perform the evaluation by means of a specially crafted setup (see Fig. 6).

This includes a further modified pair of shutter glasses, which we augmented with a camera mounted behind a lens, and a set of Rune-Tag fiducial markers (Bergamasco, Albarelli, Rodola, & Torsello, 2011).

The measuring experiment is carried on by placing a physical tag on the origin of the world coordinate system (i.e. the upper-left corner of the table) and by displaying a rendered tag inside the virtual scene. That can be in any position and with any angle. The typical experimental run involves the recording of a video while the camera is moving along some pattern. Within such video the camera should be able to capture both the reference physical marker on the table and the virtual marker displayed by the system.

For each frame it is possible to compute:

Figure 6. The modified glasses and the fiducial marker used for testing purposes



- The pose of the camera center as resulting from the led tracking and triangulation *Tpose*;
- The pose of the camera center obtained using the physical marker *Mpose*;
- The centers of the ellipses on the image plane of the virtual marker as seen by the camera *Ccenters*;
- The centers of the ellipses on the image plane of the virtual marker as reprojected by considering the camera pose, its intrinsic parameters and the position of the virtual marker in the world coordinate system *Rcenters*. To this end, we use the location of the camera obtained with *Tpose* and the orientation obtained with *Mpose*. This way we guarantee the most faithful orientation of the image plane while still adopting the estimated point of view.

Note that *Mpose* is expected to be significantly more accurate than *Tpose*, since the Rune-Tag used, in opposite to the two leds used for *Tpose*, offers more than a hundred of ellipses that can be used to assess the camera pose.

Moreover, errors in *Mpose* only depends on the intrinsic parameters of the camera (which is a high-end computer vision camera with low distortion), while *Tpose* if affected by the intrinsic calibration of each IR camera, by the calibration of their relative motion and also by the estimated location of the world reference frame.

For this reasons we can consider *Mpose* as a reasonable ground-truth.

POSE ACCURACY

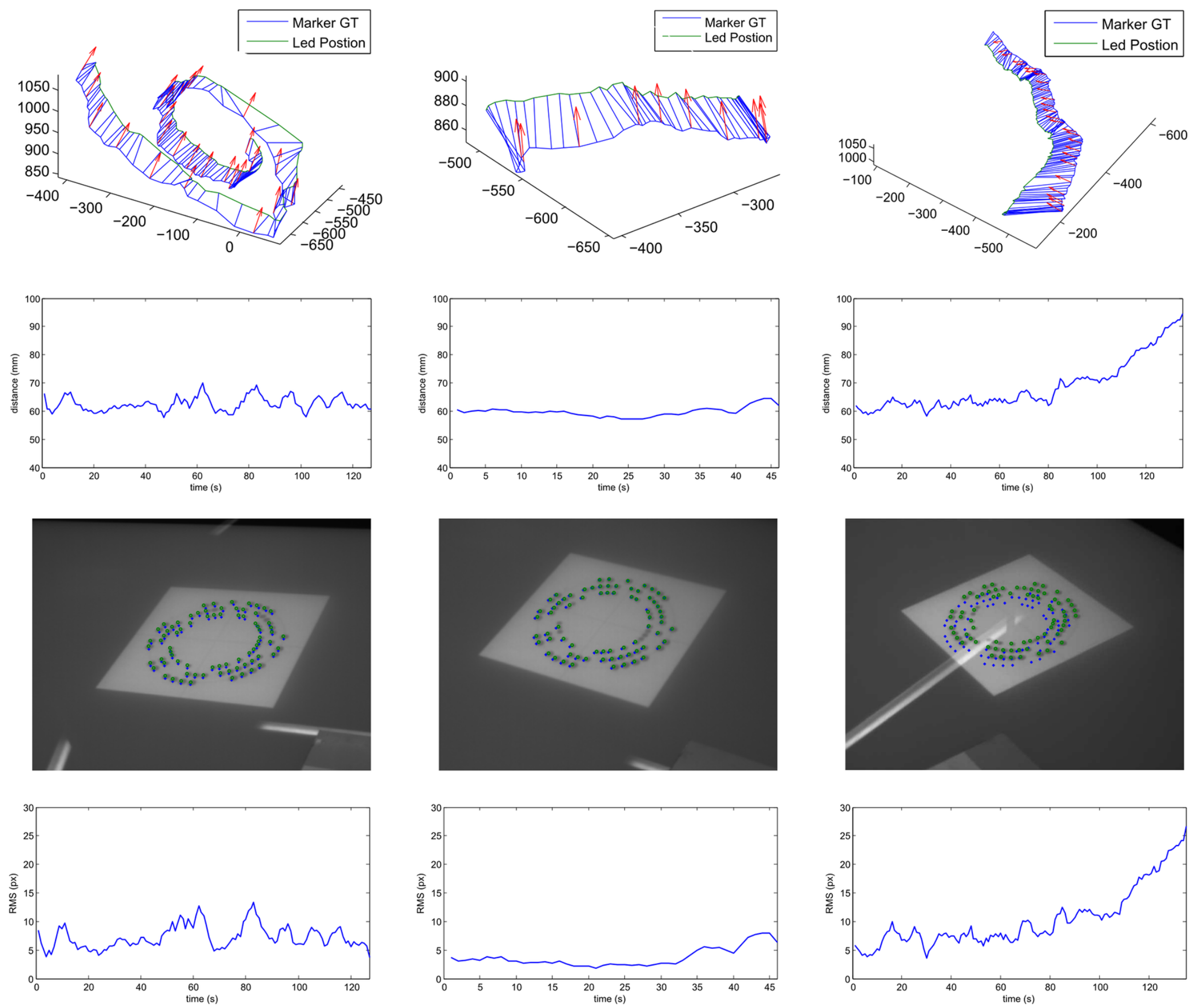
We propose to assess the accuracy of the pose estimation as the absolute distance between the camera center computed by *Mpose* and *Tpose*. Note that there is no point in considering the orientation of the camera, since it has no influence in the image formation process on the display.

Note also that we expect *Mpose* and *Tpose* to be separated by a constant offset, since we cannot guarantee that the center of projection of the camera lies exactly on the line that goes through the two leds.

This is also true for the user eyes and is a known approximation accepted by the approach (the effects of such approximation will be evaluated in the following section).

In the upper half of Fig. 7 we show this distance measured along three different types of motions: respectively a smooth movement along a curve, a slow movement along a straight line and an acceleration with a rotation around the same axis. The standard deviation of the distance under each condition is a good indicator of the ability of the tracking to be resilient to random error source (albeit still biased). We call this measure *pose accuracy*. In the three videos tested we obtained a pose accuracy respectively of 2.63, 1.72 and 8.67 mm.

Figure 7. Evaluation of the accuracy in the pose estimation and positional error commited on the image plane



REPROJECTION ACCURACY

The evaluation of the pose estimation accuracy, while assessing the stability of the tracker, gives little insight about the effects of various error sources on the perceived scene. To better study this aspect, which is the primary goal of a viewer-dependent display system, we propose to compute the RMS error between the points observed by the camera (*Ccenters*) and the coordinates on the image plane obtained by reprojecting the centers of the ellipses belonging to the virtual marker (*Rcenters*).

In practice, this value gives a measure of the compliance between the scene that is actually observed and the scene that the system expects the user to observe. Ultimately, the reprojection accuracy accounts for all the error sources (including the pose estimation bias) and supplies a value that is meaningful also from a perception perspective.

In the lower half of Fig. 7 we show this measure, that we call *reprojection accuracy*, computed over time within the same videos that were used for measuring the pose accuracy. In the three video tested we obtained an average reprojection accuracy respectively of 7.06, 3.35 and 9.97 pixels (over a 1280x1024 pixels image).

OTHER EVALUATIONS

We propose two additional tests that can be used to evaluate the performance of a viewer-dependent display system.

The first one is the study of the observed led distance and of the reprojection RMS with respect to the angle between the line between the two camera centers and the one connecting the two leds (projected on the epipolar plane). In Fig. 8, we show that at grazing angles both measures become less stable.

The second test is designed to measure the isotropy of the perception throughout different zones of the (virtual) scene volume.

To perform this evaluation, the virtual target has been randomly placed at various heights and the reprojection accuracy has been measured.

In Fig. 9, we show a scatter plot of the reprojection accuracy with respect to the target height.

It can be observed that there is no apparent relation between the distance of the target from the display and the perception error.

FUTURE WORK

With this study we concentrated on metrics which are related to a few objective parameters of the systems. However, since viewer-dependent display are usually adopted to build interactive setups, it would be also interesting to study the qualitative aspects of the user interaction.

To study the ability of the system to support interaction, we need to introduce humans into the evaluation.

Specifically, we propose to consider the accuracy and repeatability of direct measures of virtual objects performed by an user using a physical ruler.

To translate the obtained measures into metrics that can be useful for evaluation purposes, three steps should be performed:

Figure 8. Evaluation of the effects of the angle between the projection on the two leds

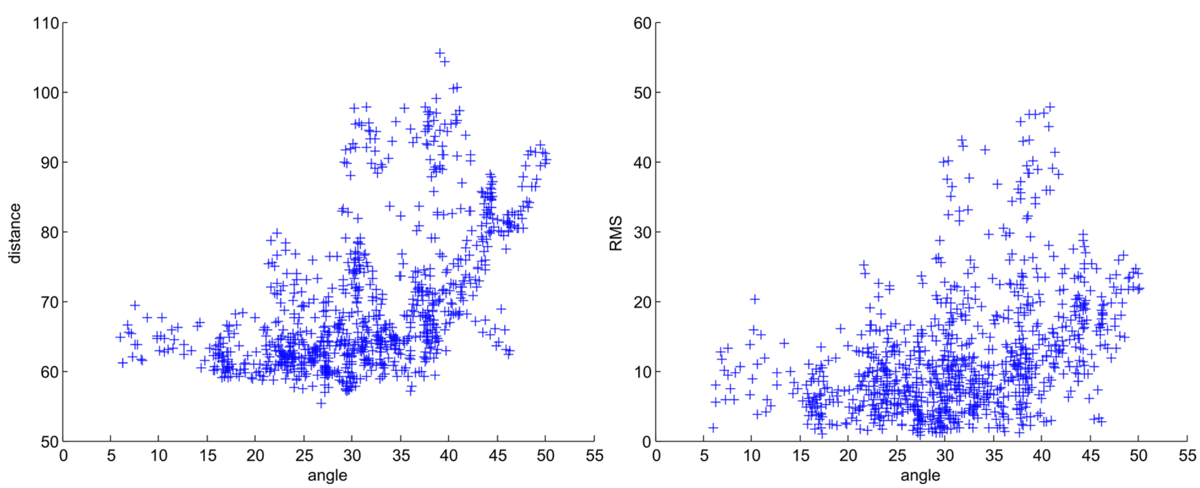
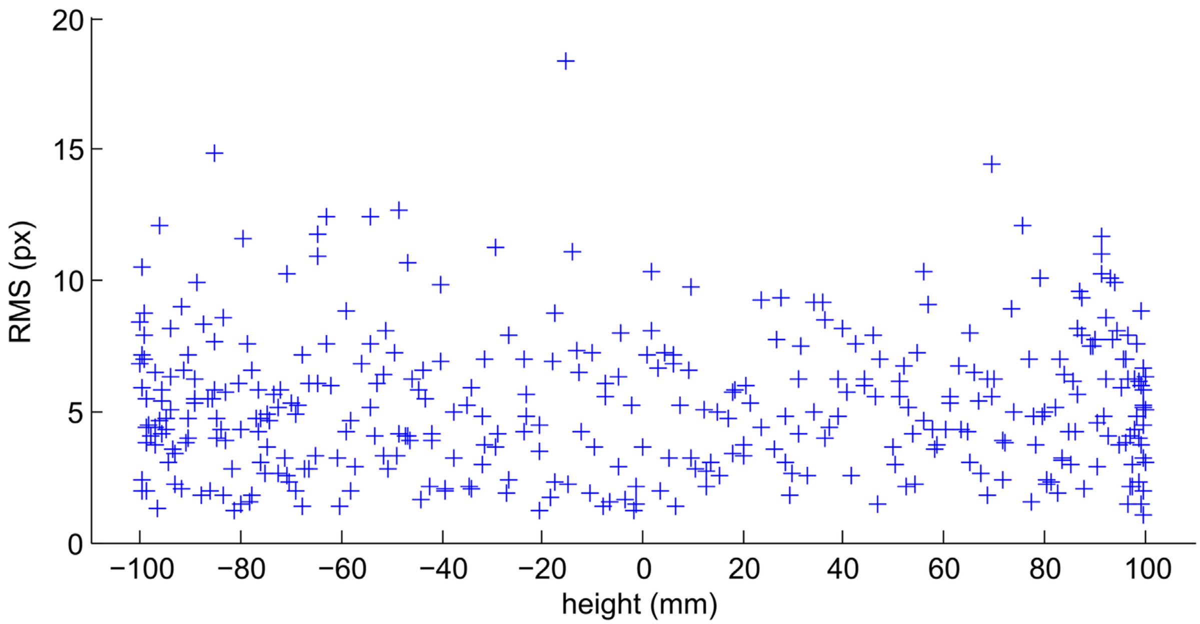


Figure 9. Evaluation of the effects on the reprojection error of different heights of the virtual marker



- All the data obtained are converted into relative errors with respect to the correct measure of the virtual object. The term ”correct” is of course referred to the measure that the object should exhibit in the ideal working conditions of the system;
- A cumulative distribution of the error is computed. This can be obtained by a direct sorting of the obtained values and by computing for each sample the ratio between the number of samples that exhibit an error values smaller than it and the total number of samples gathered;
- Finally, an error probability density function (error Probability Density Function) can be computed over the cumulative distribution as estimated with a non-parametric Kernel Density Estimator (KDE) based on the Parzen-Rosenblatt window method.

This is a rather standard statistical estimator that helps us in getting a more accurate idea about the overall error distribution that underlies the measure processes.

To avoid any bias, all the measures should be performed from a statistically meaningful sample of users (at least with respect to the intended application). Differently the type of users involved should be specified in order to make the results comparable.

Furthermore, in a similar manner to system-related metrics, also interaction-related metrics are influenced by the scene that are used for the tests, thus the characteristics of the scene should be reported to complement each study that adopt this kind of metric.

One the error PDF has been obtained, we can compute the measurement bias as the average of such function. This metric expresses the ability of the system to offer unbiased visual representations to the user.

That is, measurement bias is proportional to the total amount of systematic error introduced by the different sources, including sensor calibration, assignment of a common reference frame, and, where applicable, lags and stereoscopic errors.

It should be noted that this metric should be reasonably free from error sources coming from the user himself since, if the scenes have been designed correctly and the user shows no visual impairments, there are no reasons to think that the measures he takes with a real ruler should be biased.

The measurement repeatability can be computed as the standard deviation of the error Probability Density Function.

Obviously it measures the error dispersion around the average, that is the ability of the system to allow the user to take accurate and repeatable measures.

Differently from the measurement bias, with the measurement repeatability the user directly contributes to the metric. In fact, even if the system was working under ideal conditions (and even using physical objects instead of virtual objects), the measurement performed would still suffer from uncertainty introduced by the resolution of ruler and the skill of the operator.

There is no way to avoid this contamination, however it is reasonable to think that, if the participants to the tests are chosen properly, the effect of the newly introduced error will be similar between different experiments, thus the obtained measurement repeatability would remain comparable.

CONCLUSION

In this work we described a simple yet effective approach to build a view-dependent stereoscopic display and to evaluate its performance.

Specifically we proposed to study separately the repeatability of the pose estimation (with the pose accuracy) and the compliance of the observed scene with the virtual one (with the reprojection accuracy).

This latter measure is able to capture in a quantitative manner the difference between the scene that the system expects the user to view and what he actually perceives.

We addressed the quantitative evaluation of viewer-dependent display systems. The main goal was to define an evaluation method that does not depend on a specific implementation and that can be used to compare different systems.

We introduced two metrics, complemented by two associated experimental procedures. One metric is designed to measure the performance of the system without including a human in the loop.

The other one requires a user to perform some direct measurements. While some external error sources would be introduced, we think that a metric that includes user interaction is needed for a meaningful system evaluation.

In the experimental section we tested the newly introduced metrics with a quite neutral viewer-dependent display system.

The goal of such evaluation was not to assess the performance of the described system, but rather to study if the proposed methodology was practical to apply and would produce a satisfactory level of insight.

With respect to this, we were able to obtain a complete analysis of the many aspects of the system, under different operating and rendering conditions.

The limited availability of public implementations for similar display systems has hindered us from performing a full comparison with other methods, which could however be contemplated in future work.

Specifically, we could implement some of the most successful viewer-depend display solutions and adopt them as a reference to evaluate both our system and the proposed metrics. In order to do this we will need to modify at least the tracking system and, in most case, to place cameras in the expected position of the user head. Of course, this would change slightly the behavior of the systems, but we think that this should not impact the overall performance evaluation.

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KEY TERMS AND DEFINITIONS

Contextual Information: Additional information provided to the user regarding the context in which the user is or is observing.

Interactive Multimedia: An interaction paradigm which displays multimedia content, based on some user input.

Interactive Tables: A table or surface which is able to display some content and allows for user input by means of some interaction paradigm.

Machine Learning: A branch of artificial intelligence, concerns the construction and study of systems that can learn from some acquired data.

Mobile Devices: A small, handheld computing device, typically having a display screen with touch input and/or a miniature keyboard (i.e. smartphone, tablet).

Multimedia Technology: Relates to the reproduction of multimedia content like images, videos, audio files, etc.

Tracking System: A system composed by hardware and software capable of tracking an object in the 2D/3D space.

Chapter 6
Improved Interaction for Mid-Air Projection Screen Technology

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ABSTRACT

Mid-air, walk-through fogscreens are frequently used in trade shows, theme parks, museums, concerts, etc. They enhance many kinds of entertainment experiences and are captivating for the audience. Currently, they are usually employed only as non-responsive, passive screens for "immaterial" walk-through special effects. Suitable sensors can turn fogscreens into interactive touch screens or walk-through virtual reality screens. Several interactive systems have been implemented. However, the cost and other features of 2D and 3D tracking sensors have been prohibitive for wider commercial adoption. This chapter presents a Microsoft Kinect-based 2D and 3D tracking for mid-air projection screens. Kinect cannot track through the fogscreen due to disturbances caused by fog. In addition to robust tracking and lower cost, the custom Kinect tracking also brings along other advantages such as possibilities for projector's hotspot removal, ballistic tracking, multi-user, multi-touch, and virtual reality setups, and novel user interfaces.

INTRODUCTION

A "holographic" display in thin air has been the Holy Grail of display technology (Shedroff & Noessel, 2012). Many techniques can create an impression of a 3D image floating in mid-air (Benzie et al., 2007). Most such 3D displays are not truly mid-air or penetrable, but only provide a limited visual illusion. For example Musion Eyeliner projection system (http://www.eyeliner3d.com/) can create stunning illusions of objects in mid-air, but the image is actually on a transparent, solid sheet. Walk-through is not possible. Volumetric displays emit light from the actual 3D positions, but the images are usually in a confined display volume and interaction with them is limited.

There are many water, smoke and fog screens and related patents since the end of the 19th cen-

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tury, as the Ornamental Fountain (Just, 1899). Even before that the Phantasmagoria stunned people in the 18th and 19th centuries (Blundell, 2011). More recent examples are impressive water screen shows outdoors (e.g., Aquatique, 2014) and a 360-degree multi-projector fog display (Yagi et al., 2011). The image quality of these particle screens is usually low, or the overflowing wetness makes many of them impassable.

Fog is a good candidate for the material of a particle screen. It can be created from pure water, being thus very low-cost and available everywhere, and if the fog particles are small enough, they feel dry to the touch, enabling a dry walk-through experience. The "dry" fog evaporates quickly and does not cause significant accumulation of humidity in normal environments.

An unprotected fog flow disperses rapidly due to the turbulence induced by the dynamic pressure differences between the flow and the surrounding air, disrupting the desired smooth and planar surface and thus severely distorting the image. Even if the goal were to make a 3D or volumetric image on a particle screen, this is best accomplished with a very thin, non-turbulent flowing particle screen aided with proper viewer tracking.

Creating a thin, uniform, lasting particle screen is essential for good image quality. Even if the fog flow is non-turbulent when ejected, it will disperse rapidly, and will not create a thin and long screen. Some patents have tried to solve the planarity/image quality problem by using various kinds of air curtains etc. to protect the planarity of the particle flow, but even so the fog flow and the two protecting flows have some dynamic pressure differences.

The optimal method for forming a particle display (in terms of image quality) is the FogScreen (Palovuori & Rakkolainen, 2004). It forms only one wide, non-turbulent flow, within which there is a thin fog flow, being a part of the other flow. The injected particle flow is protected by the surrounding airflow, thus keeping the screen flat and enabling high-quality projected images hovering in thin air. Separate air curtains are not required at all, and the one flow containing the projection screen in itself is adequate.

These fogscreens (Fogio, 2014) create stunning effects among the general public or performers on stage. To some degree, the fogscreen is always a living surface, as the fog flow tends to get slightly turbulent further away from the device and eventually starts to break up. Nevertheless, it creates a concise and thin particle projection screen and produces superior image quality compared to previous methods.

The FogScreen enables high-quality images to float in free space. The images can be walked or reached through, as the screen is unobtrusive and "immaterial", and consists of a thin sheet of dry fog. The light from a rear-projection is scattered through this sheet of fog, creating an image in mid-air. The general public and media often describe these walk-through mid-air images as "holograms".

Any standard projector can be used, even though ultra-short throw projectors are not recommended, as it reduces the visual quality significantly. A dark backdrop is very useful for the mid-air effect. A window or bright lights behind the screen are not good for the experience. The fogscreen also passes some of the projected light, so a slightly brighter projector than usually is needed. Laser projections can be extremely bright and truly impressive.

The challenge for *interactive* fogscreens is to robustly track a pointer or a finger of a person standing in front of the FogScreen to implement reliable and accurate touch screen functionality. Many types of sensors can be used to create interactive displays (Benko, 2007; Buxton, 2014). However, there are no off-the-shelf user tracking solutions for the fogscreen. Some tracking products are fairly suitable, but typically modifications for them are needed due to the immaterial nature of the mid-air screen or disturbances caused by the fog. Also the accuracy, price or other features of various trackers often leave much to be desired.

Previously we have tested and adapted a low-cost eBeam whiteboard tracker (Luidia, 2014) for the fogscreen (Palovuori & Rakkolainen, 2005). The accuracy of the tracking with eBeam is reasonable (typically ±2cm on a 2 m wide screen), and the tracking system works reliably. The tracking range is not fully adequate for the far end of the standard FogScreen size. It is fairly robust, but it requires a hand-held pointer and some custom buttons to simulate a mouse. A hand-held pointer is good if only one master user at a time is wanted. However, plain hand drawing and operation is not possible with the system.

For many applications a plain finger pointing would be preferable. Custom software enables the use of the Sick LMS-200 laser range scanner (Sick, 2014) for plain 2D hand pointing. The scanner itself is reasonably reliable, but it is expensive and limited to 2D scanning, and misplaced fog flow may cause disturbances.

3D and gesture tracking of the user enables many things. Several *3D fogscreen* laboratory setups employing stereoscopy, mixed reality, virtual reality (VR) and augmented reality (AR) (e.g., DiVerdi et al., 2006; Rakkolainen et al., 2009) have been implemented earlier. Making the FogScreen as an autostereoscopic display has also been tried (Lee et al., 2007), but it is not very feasible due to stringent tracking requirements, the size of the setup, and a very limited number of fog projection layers.

We have tested many 3D trackers to enable mid-air virtual reality. The WorldViz PPT 3D tracker (WorldViz, 2014) uses infrared light on a pointer and a set of IR-cameras for tracking. While being very accurate and fast, the cost is prohibitive and the setup with calibration is too difficult for most real-world uses. Also a simple webcam-based tracking (Rakkolainen, 2010) has been implemented, which was very low-cost, but not very robust. None of these 3D tracking methods have been commercially feasible, as the tracking equipment have been too expensive or the tracking accuracy has been too low.

In order to make mid-air VR and AR displays more feasible, unobtrusive and low-cost, we have implemented Kinect-based (Microsoft, 2014) 2D touch screen interaction and 3D walk-through virtual reality for the fogscreen display. In the following we describe our Kinect-based work, results and conclusions for 2D and 3D tracking and desktop fogscreens.

IMPROVED INTERACTION FOR MID-AIR SCREEN

Nowadays, Kinect is a widely used tracker for many kinds of applications. Even though the fogscreen is fairly transparent from the projector's (and Kinect's) side, Kinect cannot directly be used for tracking through the fogscreen due to the signal back-scattering caused by the screen.

Very thin fog density makes black areas of the image virtually invisible (see Figure 1 a), and thus enables presenting 3D objects floating in thin air, instead of them being confined within the traditional rectangular screen. Dense fog (Figure 1 b) makes images brighter.

The Kinect works fairly well through thin fog, as the slight back-scattering of its laser marker projection from the fogscreen is negligible. This is due to the strong anisotropy of the light scattering from fog (Rakkolainen, 2010). Unfortunately if the fog density is high (and thus also its brightness is high), some Kinect infrared tracking pattern reflections appear on the screen, and tracking beyond the screen plane becomes unreliable. Figure 2 illustrates the Kinect depth map corresponding with thin and dense fog in Figure 1.

We integrated the Kinect for Windows sensor to the fogscreen (Palovuori & Rakkolainen, 2013a) in Windows 7 environment, which has a software development kit for Kinect. The system connects to Kinect's depth data stream and analyzes it in real time. Figure 3 shows our setup.

The depth map clutter due to the fog is very well behaved, consisting only of randomly occur-

Figure 1. The visual brightness and opaqueness with (a) thin and (b) dense fog

Figure 2. The Kinect reported depth maps corresponding with fog densities of Figure 1

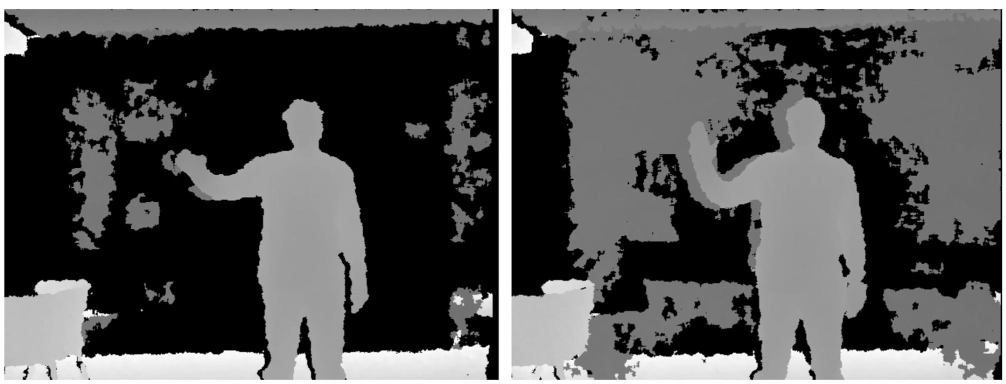
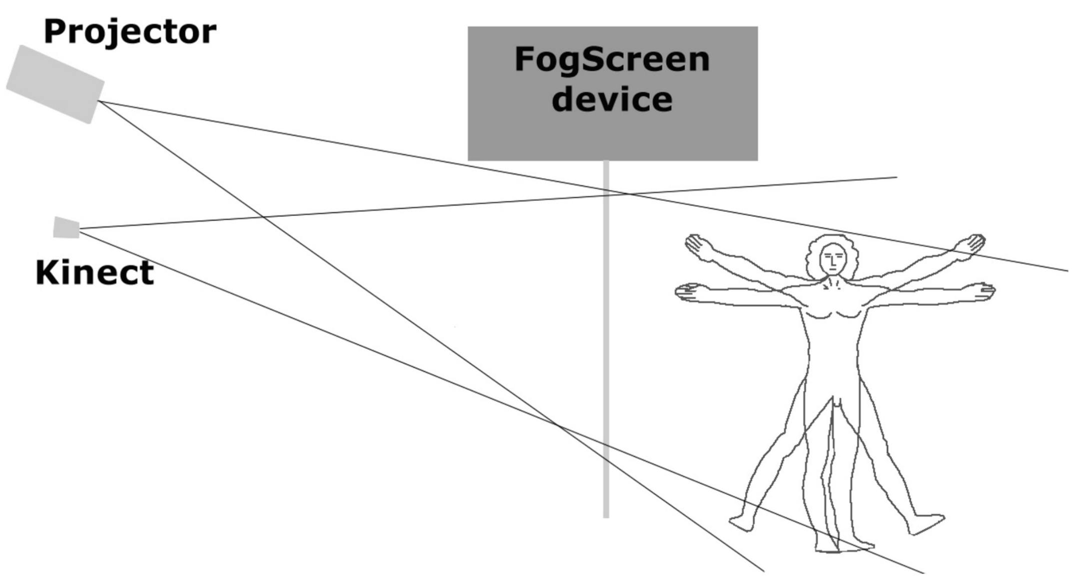


Figure 3. The setup for Kinect-based user tracking through the mid-air fogscreen



ring pixel-wise measurements of the fogscreen itself. Otherwise Kinect reports the correct measurement of the background. Therefore by simply removing the measurements at the screen distance and replacing them with previous values at the corresponding pixel location we were able to remove all of the fog-induced error (Figure 4) for 2D hand interaction. As a side-effect, the tracking then ignores objects at the screen plane, so that the user interaction has to occur slightly in front of the image (i.e., behind the fog when seen from the viewpoint of Kinect).

Unfortunately the current official Kinect SDK does not support depth map filtering before skeleton extraction, so the depth-based filtering improvement is limited to other processing chains. The built-in skeleton tracking is still useful either as a complete tracking solution for thin fog, or as a starting point for image-based tracking. It does not however track people from back.

For VR tracking, we used the skeleton head position as a starting point, and then reduced the errors caused by dense fog with tracking the user's eyes from the color image and with depth map of Kinect. We first rejected near fog plane values and patched the missing depth samples by in-painting from correct neighbors. We used a single Haar-like T-shaped feature filter to find the eye-nose-brow region from the depth map (Figure 5).

Figure 4. (a) raw depth map from Kinect. (b) depth map after filtering out the Kinect signal reflections from the fogscreen

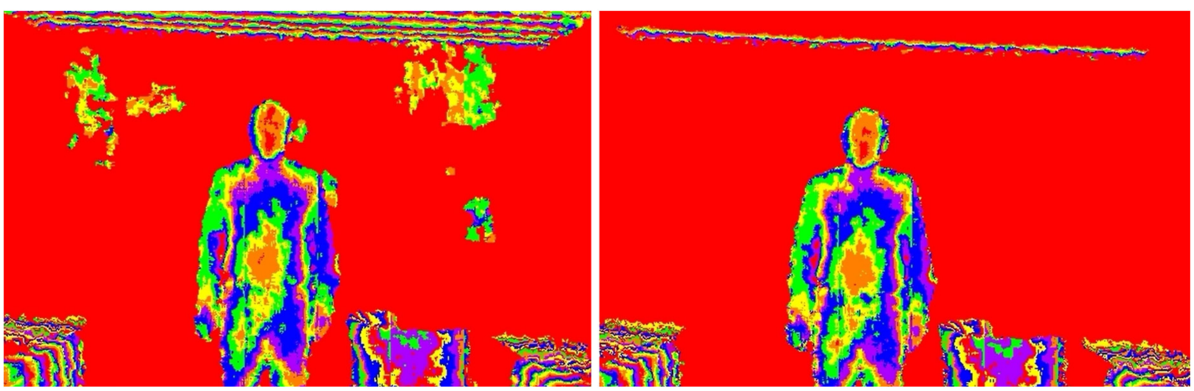
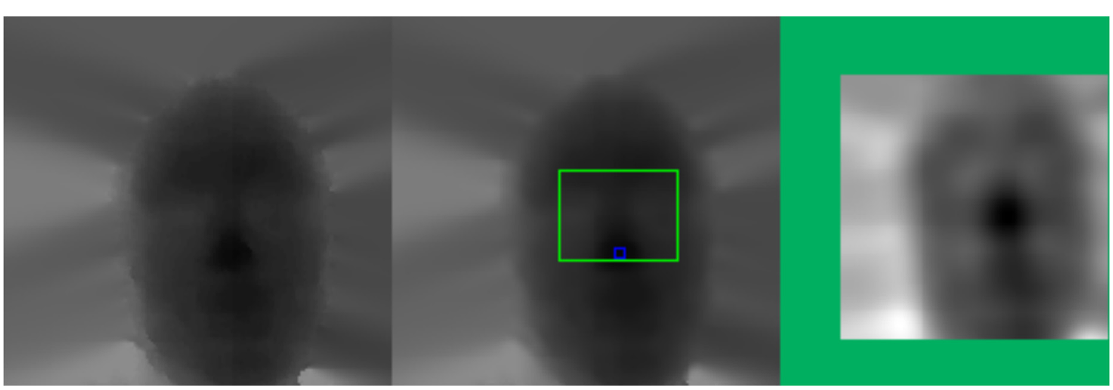


Figure 5. Results from tracking augmentation by the depth data. (a) raw data with missing pixels patched. (b) Region of Interest found with Haar T, nosetip flagged. (c) Haar correlation map, darker is stronger.



Our approach works real-time on a mid-range PC and is tolerant to fog-induced depth errors. The tracking was accurate and robust when evaluated with plain eye with our various test applications.

Additionally the actual IR camera image with tracking markers could be used to enhance tracking accuracy, with the help of some third-party drivers and middleware. Additional accuracy could also be gained possibly by using several Kinect sensors.

Touch Screen Functionality

The improved Kinect solution enables low-cost user tracking, embodied and gestural interaction and advanced features for the fogscreen. For example, moving the mouse cursor with or without clicking or dragging, or double clicking become possible, which were impossible with the planar laser range scanner. Figure 6 shows typical 2D touch screen usage with a hand-drawing application. In our tests we used an early prototype screen, which has lower image quality than the current screens.

As the mouse emulation is fully functional, the use of any normal Windows applications becomes possible. In addition, the Kinect can provide richer interactive modality such as differentiating between users and their finger, wrist and hand postures, and handedness (Murugappan et al., 2012). This allows different response (e.g., pencil versus eraser) for different people, hands or postures.

Zero Latency Gaming Interface

We developed also a Kinect-based gaming interface for target throwing (Palovuori & Rakkolainen, 2013b). The thrown objects are tracked in-flight and the predicted trajectories are calculated before the actual hit. By extrapolating these trajectories, true zero latency and good accuracy was demonstrated in proof-of-concept games. The gaming experience becomes more intense and immersive when there are no noticeable feedback delays. The full spatiotemporal accuracy of this low-cost system is in the order of 10 mm and 1 ms, with up to 50 ms predictability.

Figure 6. Kinect-based mid-air touch screen, here with a fiery hand-writing application

Ballistic trajectories of most objects can be reliably predicted in real time to achieve true zero or even *negative* latency. We created some simple games, where the player throws soft balls or plush toys at the projected targets through the mid-air screen. The player scores on accuracy and timing when hitting the targets, on the object speed, and on other criteria. In some of the games only throwing accuracy was measured, while in others also timing was important. The latter games were tuned to operate on zero latency hit information, i.e. with predicted hit position and time.

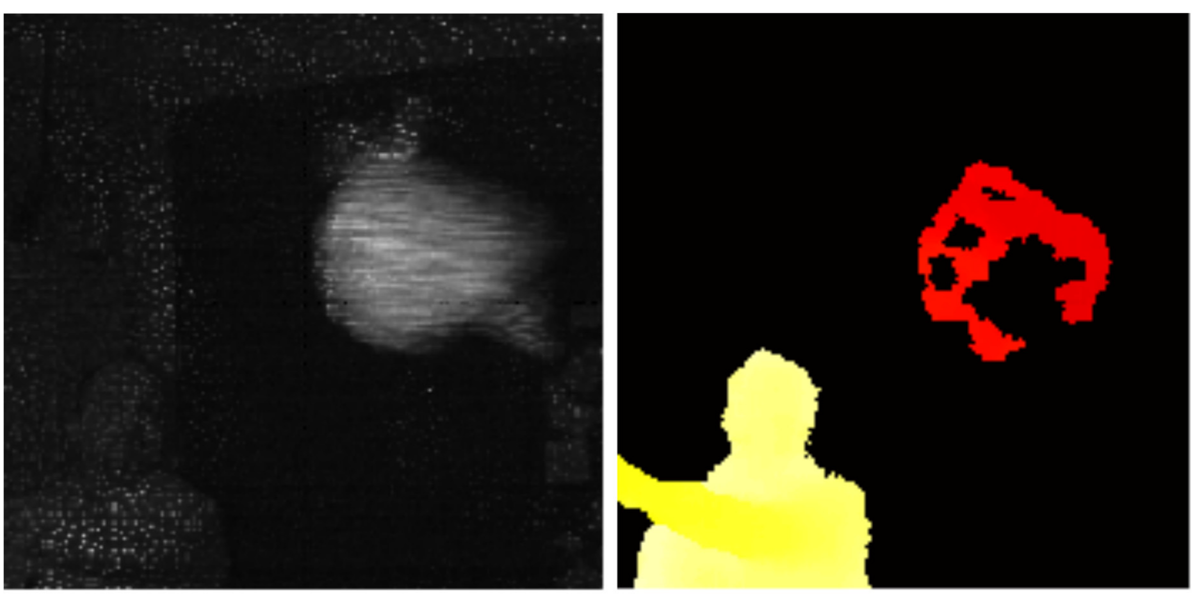
The depth accuracy of Kinect varies greatly with the object distance and needs processing to yield a better approximation of true depth. The ballistic trajectory is estimated to be undisturbed and aerodynamically straight, and it is fitted to the measured object positions, further improving the results.

The long exposure time of Kinect camera results in significant motion blur in the depth map, which deforms the measured shape from sphere to an oblong shape (Figure 7a). Motion blur may also obfuscate the depth measurement in some cases (internal parts of the object in Figure 7b).

The raw depth data is first filtered to exclude pixels with depth values outside the fly zone. Objects are then recognized from the filtered Kinect depth map as image blobs within the distance range of interest. The blob size is calculated from the known physical object size relative to the average blob distance, and the object position and velocity are solved. The typical object throw velocities were found to lie between 5 and 15 m/s. As the Kinect provides new measurements at 30 Hz, there are between 4 and 12 unique in-flight measurements to use for curve fitting in our setup.

For the lateral (x) component and the depth (z) component, linear best fitting lines were calculated. For the height component (y) a second-degree curve was used to account for the gravitational acceleration. The hit position and time was extrapolated after the last measurement was closer than 1 m to the screen, yet still further than 30 ms from the hit.

Figure 7. A near, high-velocity plush toy. (a) Kinect infrared tracking pattern blur. (b) Partial depth value failure for the same frame.



We tested the system with some test persons to characterize its performance. From the collected database of throw events, the standard deviation of both x and y error of hit position estimates is less than 9 mm. The tracking accuracy could also be improved with post-hit measurements of the flying object. As the fog screen does not alter the trajectory of the object, more measurements would yield a more precise estimate. Also the upcoming HD Kinect and similar devices may improve tracking accuracy and speed in the near future.

The trajectories of curveballs and aerodynamic objects such as paper planes are exceptions which do not match with our current algorithms. These can be customized when needed and curve fitting for most objects is fairly easy. While not implemented yet, the system seems to be easily expandable to track several flying objects at the same time. For very high-velocity and/or very small objects the current Kinect is not a viable option. Finally, as the hit location and time can be predicted, the targets could also e.g., dodge the flying object to increase difficulty of the game.

Tracking for Virtual Reality

Our custom 3D Kinect tracking software enables mid-air virtual reality, where the viewer's head position is tracked in three dimensions within the visual range of the tracker. The projected 3D graphics is updated accordingly in real time. The virtual objects in mid-air can be interacted with directly.

If a background image is projected to infinity, even a single panoramic photograph creates an extraordinary sense of presence for a casual passer-by, as if he would see the distant scene through a window. This is depicted in Figure 8.

The tracking is robust and fast, and it enables to blend the mid-air 3D graphics objects on thin

Figure 8. Kinect-based mid-air VR screen. A virtual scene to the Seattle skyline adjusts to the user's position.

fog with a normal office room. The mid-air 3D objects become embedded visual elements of the environment as if they would really float in thin air (see Figure 9). This would make possible e.g., futuristic mid-air gaming, next-generation digital signage, "holograms" in thin air, or intriguing walk-through stereoscopic visualizations from molecules to galaxies.8

The Kinect-based setup allows the user to "touch" and interact with the projected objects and scenes, which leads to more immersive experiences. The setup can optionally be two-sided with different images on both side of the screen, without them getting blended together.

Also stereoscopic viewing is possible, using stereoscopic eye-wear. All the common stereoscopic methods (e.g., anaglyphic, polarizing and shutter glasses) work well. Still, even a non-stereo VR image with user tracking produces a very convincing 3D-perceived image since the tracking is fast and accurate.

As the projection fogscreen is planar 2D, the eyes can't usually accommodate to the right distance. According to our preliminary tests, this seems to be a very small problem and the users almost immediately adjust to the situation.

Multiple Kinect trackers could be used to widen the field-of-view and range of tracking.

Figure 9. Screenshots from a video sequence of the Kinect-based mid-air VR screen. As the camera moves, the augmented mid-air 3D object is "locked" to its real-world position and it seems to be a natural part of the environment.

Multi-Kinect systems are possible and supported by the official drivers. Kinect to Kinect crosstalk error can be easily mitigated through slight device shaking (Butler et al., 2012; Maimone & Fuchs, 2012).

Some special properties of fogscreens must be considered especially with VR applications. The apparent screen resolution is spatially and temporally variable [2]. It is the highest on the part of the screen closest to the device or when viewed towards the projector. The usable screen height is about 1-2 meters. The resolution also degrades if the if the image is viewed or projected very off-axis, as the fogscreen scattering plane has a thickness of about 1 cm and thus the neighbouring pixels blend with each other. Also the brightness is reduced significantly if the viewing or projection angles are very oblique. The brightest image can be seen ±30° towards the projector, and thus rear-projection results in much brighter images. The colors are well preserved and not subject to dispersion. The light scattering properties of fog even enable different images to be projected on each side without interfering with each other (i.e., two-sided screens). Thus with VR applications it would be ideal to have a rotating screen and projectors, if the viewer's movement area is very large.

Fogscreens can also be combined with other types of displays. MisTable (Martinez-Plasencia et al., 2014) is a system which combines two vertical fogscreens with a horizontal interactive tabletop display.

Removal of the Hotspot of a Projector

Facing a projector causes glare, which is very inconvenient for the eyes and distracts the viewers, even though they largely focus on the screen content. For example U.S. patent 6,945,653 describes a projector with glare and hotspot attenuation for presenters in front of a screen.

The hotspot of a projector is an especially amplified problem for the mid-air fogscreen, as it requires rear-projection and passes most of the light through the screen towards the viewer's eyes. This can be partly masked by placing the projector up behind the screen device, so that hotspot can be seen only near the screen.

A low-cost infrared webcam-based tracking for an augmented reality fogscreen (Rakkolainen, 2010) has been implemented. It also removed the hotspot of a projector. However, the tracking was not very robust.

Kinect enables a low-cost and robust way to attenuate the hotspot of the projector. Our custom software tracks the viewer and attenuates the projector's hotspot for a viewer in real time. A small gradually darkening ellipsoid is placed on the image to block the line-of-sight between the eyes and the projector. An ellipsoid or two black spots are needed, as the viewer has two eyes. The darkening is based on light scattering measurements. Theoretically perfect attenuation would require intensity correction over all of the screen, but in practice only a small area around the hotspot is needed.

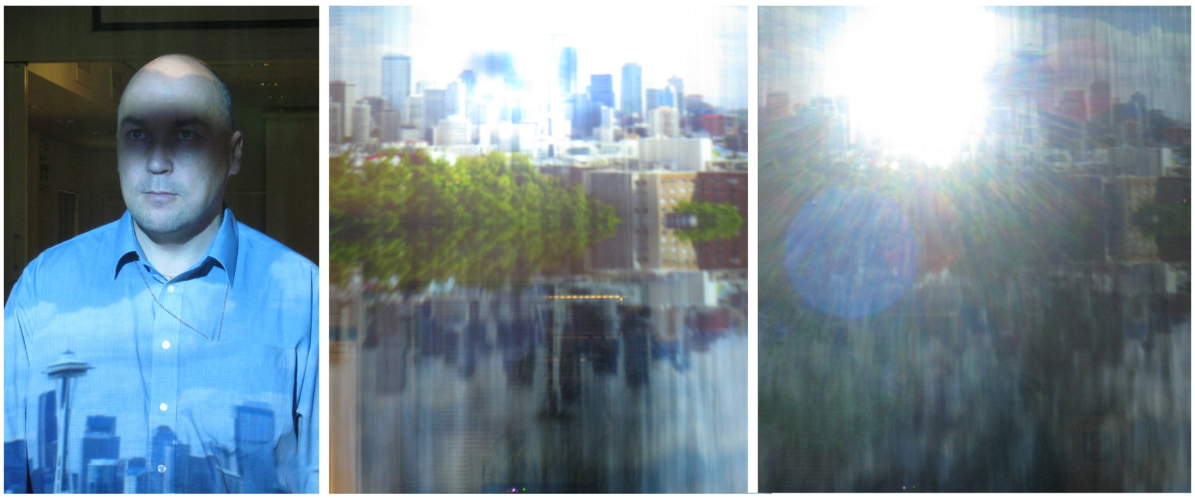
Typically the FogScreen attracts a flock of people, so multi-user tracking and individual hotspot attenuation should be done. Unfortunately, all the viewers could then see also all the other dark ellipsoids, but that drawback would probably be negligible.

Figure 10 shows the hotspot attenuation implementation. The actual result depends on the contrast ratio of the projector, tracking accuracy, etc. The implemented attenuation removes the hotspot sufficiently. The Kinect-based face tracking is robust and fast for the purpose.

Volumetric Mid-air Displays

A recent development in the mid-air display technology is a hand-held volumetric display (Rakkolainen & Sand, 2013; Sand & Rakkolainen,

Figure 10. (a) the projector's hotspot is blocked on the line-of-sight. A virtual scene (b) with and (c) without hotspot attenuation.



2014). The previous walk-through FogScreens have been large, fixed installations for theme parks, museums, special events and trade shows. Our recent proof-of-concept prototypes of an ultra-light, hand-held mid-air screen can radically change the use of mid-air screens. Our prototype is the first mobile, hand-held FogScreen.

We have constructed a proof-of-concept immaterial hand-held display. The fogscreen flow unit, pico projector, and an Android smartphone (for tracking and rendering) are all merged to a light-weight hand-held unit, and only the fog is generated in a small separate container. The hand-held unit is roughly the size and weight of an ordinary toaster. The device can be used in any orientation (upside down, sideways, etc.). Figure 11 shows prototypes of various sizes.

The device (Figure 11 at left) can be lifted and swiped with the fitted handle fairly easily and can be held for a moderate duration of time. Holding the current prototype with one hand can, however, be strenuous in longer sessions. The device can be made smaller and lighter, allowing operation for longer durations of time with less strain to the user's hand. Future versions could also have more ergonomic and aesthetic design.

Usually volumetric displays produce the images in a confined space, which does not allow touch. Various kinds of volume slicing displays (e.g., Cassinelli & Ishikawa, 2009) enable volumetric slices on a diffuse plastic sheet in a very limited range near the projector.

When the hand-held mid-air display is tracked, the ultra-light screen can be used also as a slicing volumetric display. When fog plane is swiped within a tracking volume, it renders slices of volumetric visualizations (e.g., MRI or CT scan datasets). The hand-held proof-of-concept display enables the user to reach through the image, as there are no physical obstacles.

A smart phone with camera tracks the device and also serves as an image source for the Microvision ShowWX+ pico projector. Figure 12 shows the prototype. Initially we used AR markers for tracking. A small depth camera could additionally be used for improving the tracking or for interaction on the display volume.

Figure 11. Prototypes of small-size, ultra-light mid-air displays

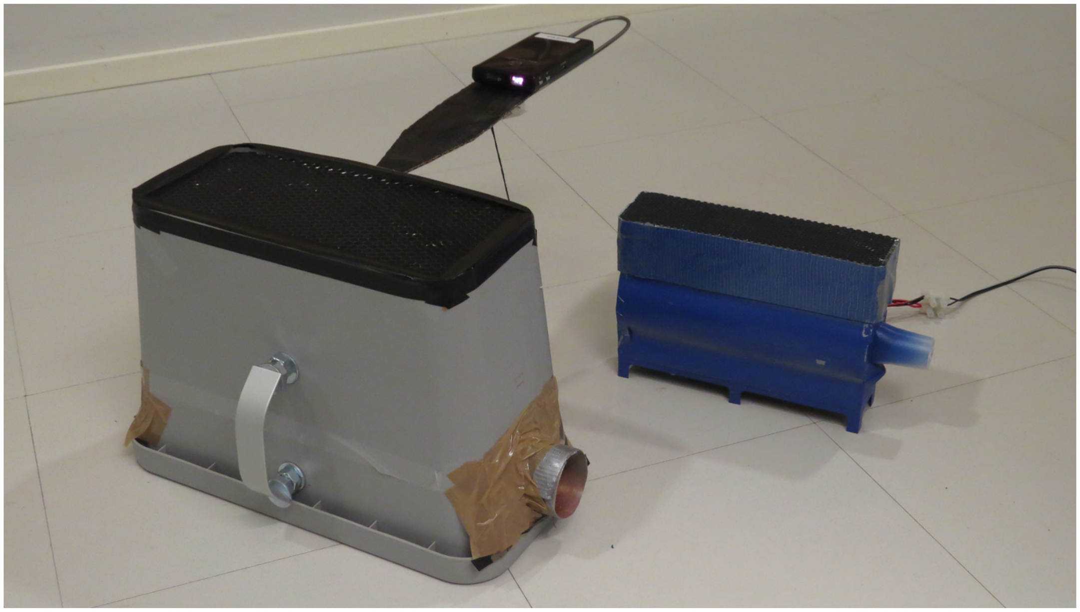
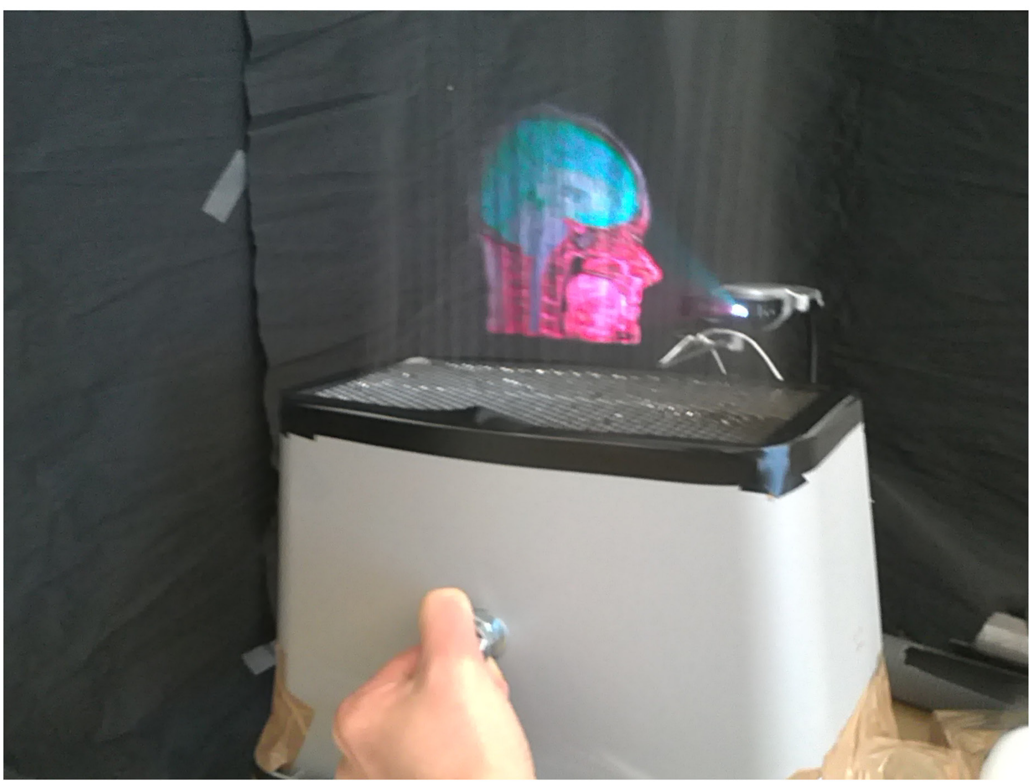


Figure 12. A prototype of the volumetric mid-air display



The proof-of-concept display provides an easy way to visualize volumetric objects in mid-air. The range is not as limited as with other projector-based systems, as the projector moves with the screen. Our prototype construction is still very crude, but the device can be made significantly lighter, smaller and better.

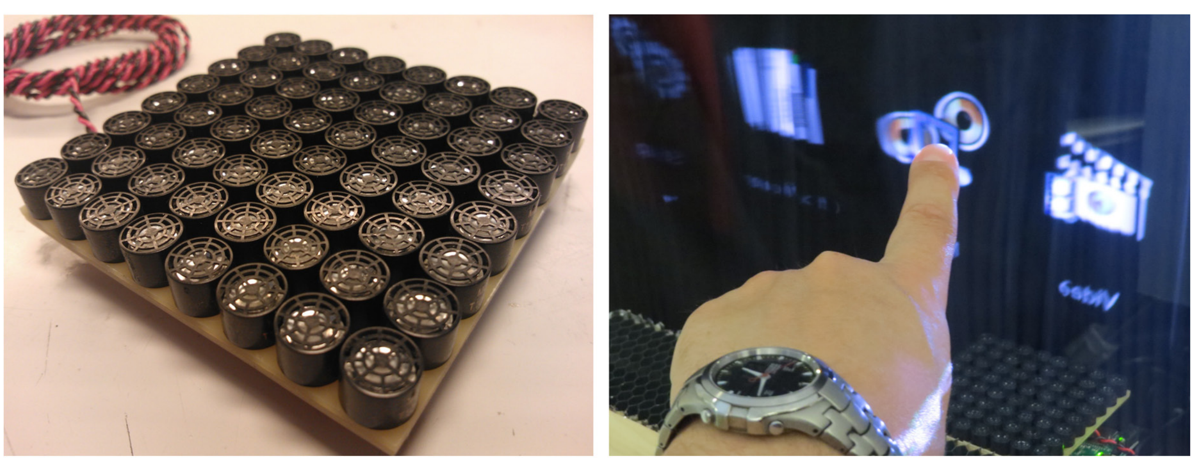
A tracked hand-held mid-air display can also show augmented reality on top of real objects. Unlike tablets or other solid screens, the mid-air displays enable to interact directly with the real and virtual objects in the actual spatial location. Solid display materials may be too cumbersome or may harm delicate physical objects. The mid-air screen can pass through real objects without touching them, which is useful for some augmented reality applications (delicate objects, visualization of magnetic fields, etc.).

In our setup the viewer looks always roughly towards the projector, which produces higher brightness due to the high anisotropy of Mie scattering of light from the fog, and also high resolution, as the neighboring pixels do not blend visually together. It is not advisable to place the projector very off axis, as this would reduce apparent brightness and resolution. The slightly annoying hotspot of the projector can be removed with user tracking and proper rendering.

TACTILE FEEDBACK FOR MID-AIR SCREENS

It is possible to create mid-air tactile feedback with focused ultrasonic transducers, and even combine the tactile sensation with 3D displays (Hoshi et al., 2009). Mid-air tactile feedback uses an array of ultrasonic transducers to vibrate air in focused points, which creates a sensation of touch in mid-air. Based on that, we have implemented a touchable mid-air user interface for the fogscreen. Figure 13a shows the ultrasonic transducer array, and Figure 13b shows it together with a tabletop fogscreen. This is still work in progress, but the initial results are very promising. The tactile sensation is clear and it enhances the feeling of touch, even though the fogscreen is "immaterial". The ultrasonic vibrations do not interfere with the fogscreen, and they also pass through the screen without any problems.

Figure 13. (a) the transducer side of the self-contained ultrasonic tactile module. (b) a prototype of the tactile mid-air display. The array of ultrasonic transducers can be seen behind the fogscreen.



Our approach to providing the ultrasonic tactile feedback was to create a self-contained, modular and tileable phased transducer array unit. For each 40 kHz transducer, the unit contains a dedicated transistor amplifier and a signal generator with fully adjustable phase and amplitude. The 64 signal generators necessary are realized on a single FPGA together with a marshalling soft processor providing a control interface to the next system level. The modules can be tiled to form a uniform transducer plane of unlimited size. The module is fully steerable and can thus produce *any* spatial interference pattern for the given number and placement of the sources. Still, the main line of operation has been to turn single, low frequency modulated focal points in given coordinates on and off. This creates an intuitively recognizable singular tactile feedback event of immaterial button ‘click’.

NOVEL MID-AIR USER INTERFACES

User interfaces (UIs) are limited by the properties and performance of the available information and communication technologies at the time, and by the input and display technologies in particular. For a very long time the keyboard and mouse were the dominant methods of input. This has changed with mobile computing, touch screens and tracking devices such as inertial sensors, miniature gyroscopes, Kinect, speech-based interfaces such as Siri, near-to-eye displays, and many others. In fact, we are witnessing a revolution of user interfaces. A computer 10 years from now may not look, feel or resemble the current PCs or smart phones much.

The interactive fogscreen may be a small part of this UI revolution. They can create computer-generated imagery in open spaces, inviting people to gather around them or display contextual information in doorways and hallways, and act as reach-through augmented reality displays.

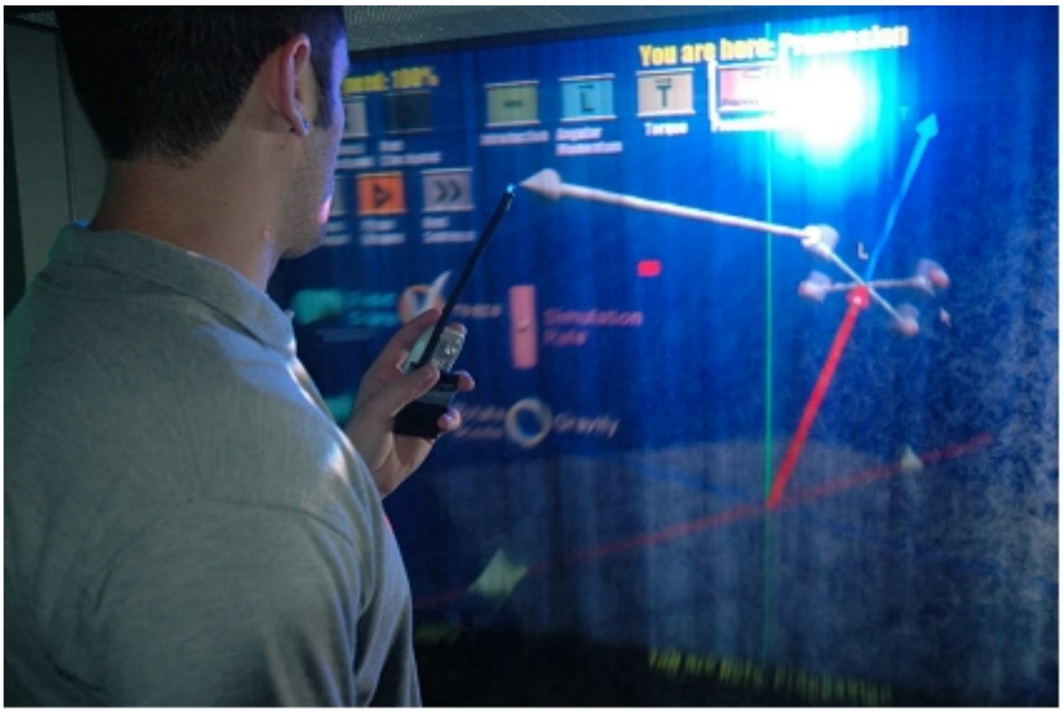
An early educational system for 3D fogscreen was implemented for physics students (Breisinger et al., 2006). It is an interactive multimodal learning application, designed for teaching various kinds of knowledge with 3D visualizations (Figure 14). The 3D position of the user’s marker is projected orthogonally onto the screen. Virtual objects are highlighted when the marker is nearby, and fully lit while dwelling, indicating that they can be interacted with. Because of the immaterial nature of the screen, the vector can easily be pushed through to point away from the user with a one-to-one absolute mapping, providing a clear way to estimate the vector’s magnitude along the third dimension.

The usability was evaluated in a study with 13 undergraduate physics students with varying levels of experience with 3D interaction. All subjects found the interface very easy to use. With only a very brief explanation, none of the users had a problem understanding the concept and all of them were able to solve the given tasks with ease. The concept of a reach-through screen was so new that not all of them easily realized that vectors could also be pulled through the screen, which would have been one of the major advantages of the screen.

One interesting approach for mid-air screens would be to use head-mounted projectors. Head-mounted pico projector (HMPP) without retroreflective material placed in the environment is little explored display concept, which is well suited to mixed reality and collaborative work. Hand-held or body-mounted pico projectors are used on many AR experiments. For example OmniTouch (Harrison et al., 2011) uses a body-worn projection / sensing system. SixthSense (Mistry & Maes, 2009) projects information on basically any near-by object. Pico projectors are also embedded to some modern smart phones.

HMPP can show augmented information onto unprepared surfaces in the real world. It doesn’t create immersive worlds or block the real world out, but it rather integrates the augmented infor-

Figure 14. The 3D physics tutorial relied partially on the FogScreen, enabling direct interaction with the objects, e.g., to pull force vectors unobtrusively also through the screen



mation with the real world. It also leaves user's hands free for interaction with the real and synthetic objects, and the displayed information with HMPP can be shared with multiple participants.

Instead of moving the mid-air screen, we tested to move the projector along with the user. We have constructed a proof-of-concept prototype of HMPP (see Figure 15), which we used on a FogScreen (Sand & Rakkolainen, 2013). We fitted a webcam and a pico projector to a cap, and used AR software and markers to position the augmented information to correct locations.

Our proof-of-concept HMPP prototype works relatively well. The visual AR tracker works real-time and it could be enhanced with other camera technologies, e.g., small depth cameras. Haptic and other multimodal feedback could increase immersion and enhance interaction.

Normally a ceiling-mounted projector is used for the FogScreens, but a HMPP moves with the user. It can supplement normal projection. Due to scattering of light from the screen droplets there is a very faint picture on the viewer's side, but viewers on the other side of the screen see a significantly brighter image. HMPP alone is too weak for a primary user. It can however supplement and augment a brighter projection.

As pico projectors evolve and diminish, a HMPP will be an obvious way to implement AR. Near-to-the-eye displays enable virtual and private viewing of information, whereas mid-air screens and HMPPs suit better for sharing views with groups on top of real objects. They all are good for merging virtual and real worlds (i.e., mixed reality).

The HMPP used with a FogScreen suits well e.g., to classroom situations, where the teacher is on the other side of the screen than the students. The teacher can show things on the unobtrusive mid-air screen and interact with the projected

Figure 15. (a) HMPP display with a FogScreen (teacher's view) (b) HMPP display with a FogScreen (students' view)

objects, while teacher and students are continuously facing each other. Mid-air projection onto the FogScreen could be useful for meeting rooms and other social, collaborative or teamwork situations.

Mid-air particle displays enable to break free from the constraints of physical displays. The display can be seen in mid-air or on top of physical objects, and also interaction can take place in mid-air. The user occupies the same space as the display, reducing the conceptual and cognitive gap between the real object and the virtual information. This allows the objects of interest to be enveloped by the display surface, bringing the augmented reality information closer to the object. The small-size desktop or hand-held fogscreen enables many new applications in this field. It could be used even as an external display for a smart phone.

CONCLUSION

We have implemented low-cost Kinect-based tracking for the mid-air particle display, and the results are promising. Convincing touch screens, 3D objects and virtual environments can be presented seemingly in mid-air. This opens up many new possibilities for engaging display and interaction in advertising, gaming, and other applications.

As the default Kinect tracker software does not work robustly with the fogscreen, we needed to improve the tracking accuracy by removing the disturbances caused by the fog. The implemented tracking through the fogscreen plane enables also e.g., touch screen applications, elimination of projector's hotspot, ballistic tracking and walk-through virtual reality. The new Kinect One will improve camera resolution, tracking accuracy, and other features. However, the Kinect is not the only possibility for 3D tracking. Similar systems are coming to market in many models and properties. Leap Motion is one interesting tracker. We have recently implemented finger tracking applications for the desktop fogscreens using the Leap Motion controller. For example selection can be made using hand position tracking and gestures, such as a grabbing. Also 3D pointing is possible.

Mid-air screens with 2D or 3D tracking have potential for new types of games, digital signage, entertainment, interaction methods and mid-air user interfaces (Rakkolainen et al., 2009). For example they could provide augmented reality advertisement similar to transparent LCD panels, except that they are unbreakable, untarnishable, penetrable and in mid-air. The implemented work can bring the interactive mid-air display to wider audience. Some applications will become possible when the technology becomes more feasible or when emerging technologies enable new features. With mass production also the price of the fog-screen could go down.

Immaterial mid-air displays are more suitable for many situations than impenetrable monitors or display walls. The user can easily interact with any physical object or virtual information, as the screen is permeable. Any real objects can be seen and interacted with through the screen, instead of e.g., through a video-based augmented reality screen. It creates a mixed reality setup where both the real world object and the augmented reality content can be viewed and interacted with simultaneously.

Further development of 2D interactivity and 3D tracking / VR will be our main focus. Among the things to be done are novel content and applications, e.g., a simple 3D paint application. Also the hand-held volumetric displays and desktop fog-screens may be important for future applications.

Multi-touch applications are under development. Kinect provides the added benefit of recognizing the users for multi-touch applications, which is unusual for multi-touch systems and enables new types of intelligent screen manipulation. Also other depth cameras, smaller and brighter pico projectors, and other emerging technologies will help our future work.

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KEY TERMS AND DEFINITIONS

3D Display: A display which gives an effect of depth for the viewer. Technologies include holography, volumetric, multi-view and stereoscopic displays.

Autostereoscopic Display: A display which produces an effect of depth for the viewer without any glasses.

Embodied Interaction: Interaction between user and artifacts which contains creation, manipulation and sharing of meaning.

FogScreen: A mid-air, walk-through display. The screen consists of thin mist, which enables to walk or reach through it.

Gestural Interaction: interaction with digital systems through gestural, bodily movements.

Mixed Reality: A continuum from real world to virtual world, where reality is augmented with synthetic elements in various proportions.

Stereoscopic Display: A display which produces an effect of depth for the viewer by means of stereo image pairs and glasses.

User Interfaces: The means by which a user and a computer system interact, in particular the use of input devices and software.

Virtual Reality: Computer-generated 3D environment that can be interacted with in real time. It tries to replace reality with a synthetic one.

Chapter 7
Methodology for Transformation of Behavioural Cues into Social Signals in Human–Computer Interaction

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ABSTRACT

This chapter presents the methodology for transformation of behavioural cues into Social Signals (SSs) in human-computer interaction that consists of three steps: acquisition of behavioural cues, manual and algorithmic pre-selection of behaviour cues, and classifier selection. The methodology was used on the SS class {hesitation, no hesitation} in the interaction between a user and video-on-demand system. The first step included observation of the user during interaction and obtaining information about behavioural cues. This step was tested on several users. The second step was the manual and algorithmic pre-selection of all cues that occurred into a subset of most significant cues. Different combinations of selected cues were then used in verification process with the aim of finding the combination with the best recognition rate. The last step involved the selection of an appropriate classifier. For example, a logistic regression model was obtained in combination with four features.

INTRODUCTION

The user's interaction with communication devices in the user's natural environment is still not a totally user-friendly experience and requires much of the user's attention. Most approaches that can improve human-computer interaction (HCI) in handling a communication device are socially ignorant and there has been no attempt to use the user's social signals (SSs) expressed during the user's interaction with communication devices.

Social signal processing is a new research domain that aims to provide computers (systems) with the ability to sense and understand human

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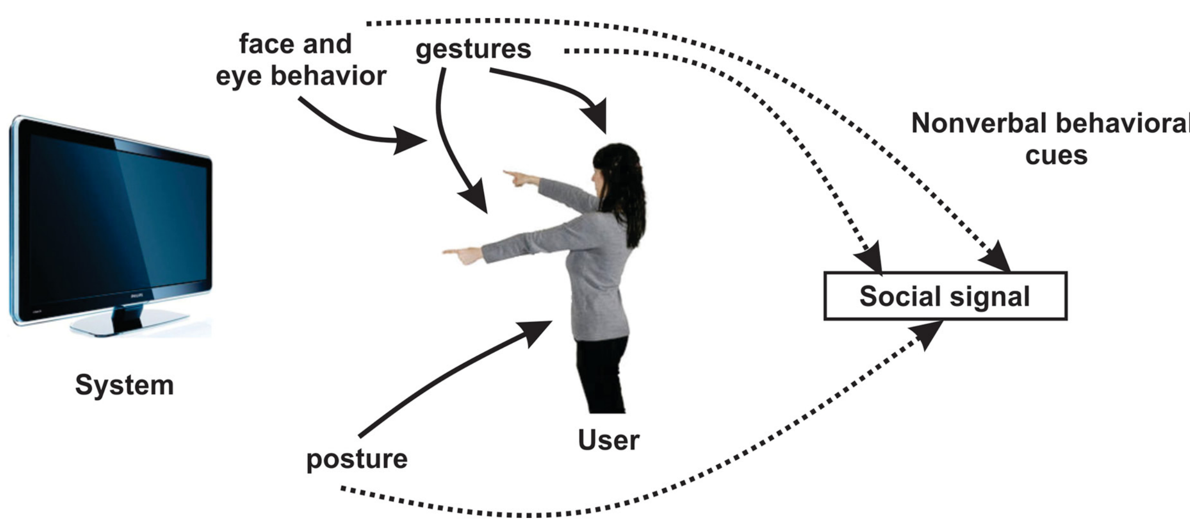
SSs (Pantic, Nijholt, Pentland, & Huang, 2008; Vinciarelli, Slamin, & Pantic, 2009). SS can be expressed through a multiplicity of nonverbal behavioural cues initiated by the human body as a reaction to the current situation in everyday life. A behavioural cue is an atom action, which is atomic movement that can be described at the limb level (Poppe, 2010), or a micro movement such as a facial expression or head movement (Jokinen & Allwood, 2010). In human-to-human interaction, one person can easily 'connect' all expressed behavioural cues of his/her interlocutor and interprets them as an SS, because the communication between two people is a natural process and human social intelligence allows people to do that. Even if the SS is expressed in many different ways, people will know how to interpret it correctly. In HCI (Figure 1), however, the computer does not know how to comprehend all the different combinations of behavioural cues that express the same SS because it is socially ignorant.

CAN WE TEACH THE COMPUTER TO UNDERSTAND HUMAN SOCIAL INTELLIGENCE?

One way to do so is to make a collection of all possible combinations of behavioural cues that express the same SS and teach the computer to understand them. It is evident that this option is time consuming and difficult to implement since we need a large amount of input data about behavioural cues and the SS. Another way to deal with this problem is to perform a case study on a small amount of data for several combinations of behavioural cues that present the same SS, where we search for the similarities among different combinations of behavioural cues.

The aim of the study is to extract a small number of the most representative behavioural cues that present the SS and use them in a decision model with a high recognition rate. As an example, we present the methodology for the transformation of behavioural cues into an SS class {hesitation,

Figure 1. The SSs are most distinctly expressed in human-to-human interaction. If we replace one person with communication device (system), we get HCI. In that case, communication device recognises the user's SSs and uses them in interaction.



no hesitation} in interaction between a user and video-on-demand (VoD) system (Vodlan, Tkalčič, & Košir, 2014).

To the best of our knowledge, there have been no attempts to use user SSs in the domain of VoD system. The methodology used in this paper presents a new possibility of using SSs in a VoD system, which can improve the interaction quality of experience.

The reminder of this chapter is summarized as follows. At first, we present the problem addressed in this study and proposed solution to a problem. In the next section, experimental design and experimental user scenario are provided. Methodology section describes methodology for transformation of behavioural cues into SS, while the results are presented in the next, consecutive section. The penultimate section provides a discussion of the results, while the last section concludes the study.

PROBLEM STATEMENT AND PROPOSED SOLUTION

The problem addressed in this chapter is how to determine a small number of significant behavioural cues that describe an SS in particular HCI and use them in a decision model with a high recognition rate. Since we observe the user via a camera, only behavioural cues demonstrated through visual features (such as the speed of a hand movement) are applicable. The number of cues used in the model must match the ability of human perception to recognize these cues and the reporting of decisions through a user interface in real time.

To design the decision model for SS extraction, we propose a methodology for the transformation of behavioural cues into an SS. The first step in developing a decision model is observation of the user during interaction and obtaining information about behavioural cues. The second step is the manual and algorithmic pre-selection of all cues that occurred into a subset of most significant cues. Finally, the last step involves the selection of an appropriate classifier. Employing the experimental design presented in next section, we describe the methodology for an SS class {hesitation, no hesitation}. We chose SS of hesitation because our preliminary work showed that the SS of hesitation is manifested frequently through behavioural cues when a user interacts with video items.

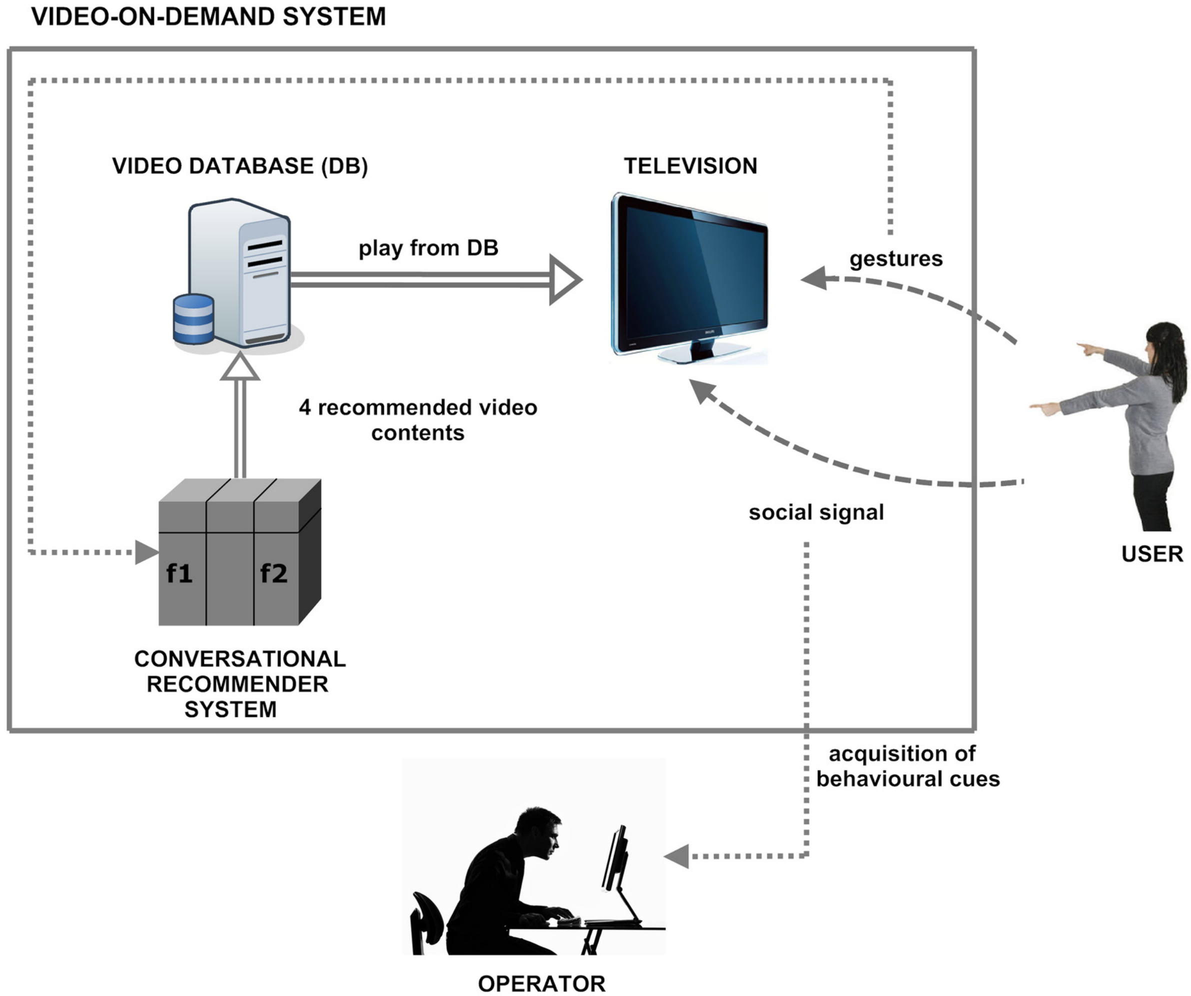
EXPERIMENTAL DESIGN

We modelled an experimental design for SS extraction as illustrated in Figure 2. The experimental scenario was a gesture driven VoD system with a conversational recommender system (RS) where the user selected one video clip among several presented on the screen (Vodlan et al., 2014). User interacts with gestures to select one among four videos. At each step, the user selects only one video and, according to the selection, new videos are displayed. The system randomly provides three similar and four diverse items (videos) related to the initially selected item. Generation of similar and diverse items were based on selected videos from the LDOS-CoMoDa research dataset (Košir, Odić, Kunaver, Tkalčič, & Tasič, 2011) and matrix factorization-based recommender algorithms (Koren, 2008). Interaction stops when the user selects a video to watch. We observed the users, while they interact with our VoD system to obtain valuable information about behavioural cues for both SS classes {hesitation, no hesitation}.

METHODOLOGY FOR TRANSFORMATION OF BEHAVIOURAL CUES INTO SOCIAL SIGNALS

As mentioned, the methodology for the transformation of behavioural cues into an SS consists of three steps (Figure 3). The first step includes the acquisition of user behavioural cues expressed dur-

Figure 2. The proposed design of our experiment. User interacts with the VoD system. Videos on screen are recommended by conversational RS (function f_1 provides similar items according to the selected video, while function f_2 provides diverse items according to the selected video). The video database (DB) contains the video trailers that are played on screen. Operator observes the user to obtain valuable information about the behavioural cues expressed by the user.

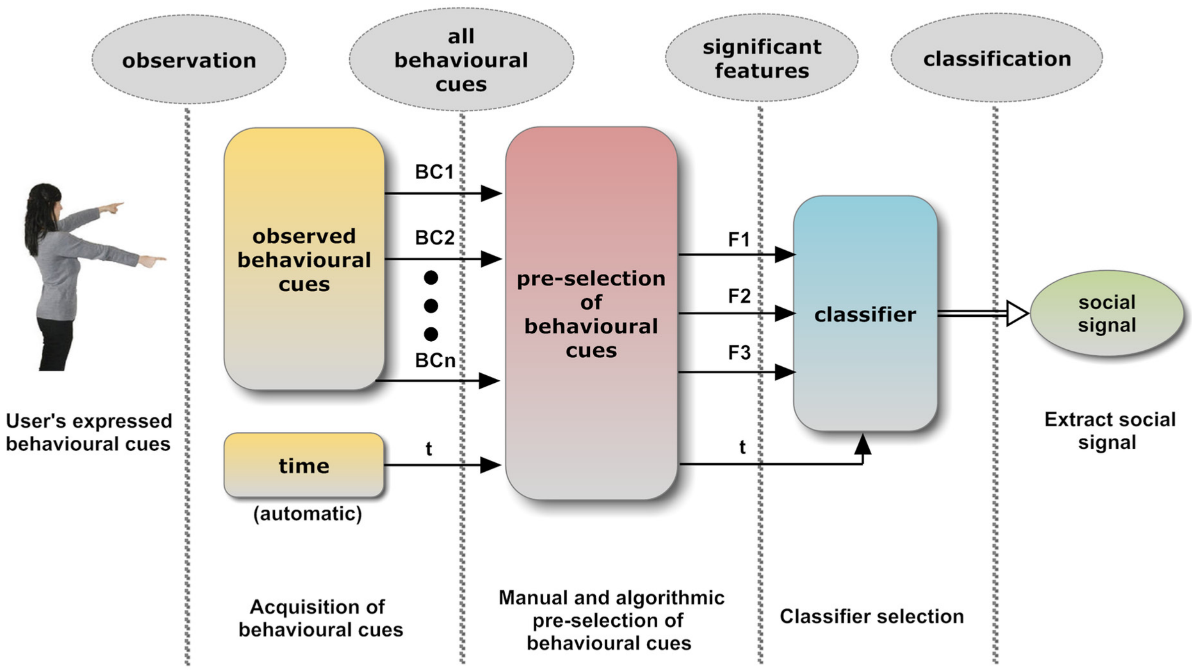


ing interaction with the VoD system. The second step is manual and algorithmic pre-selection of all behavioural cues that occurred into a subset of the most significant cues. The third step is the selection of the most appropriate classifier. All three steps are briefly described for the example of the SS class {hesitation, no hesitation} in the sub-sections below.

Acquisition of Behavioural Cues

Our first task was to observe the users while they interacted with our VoD system to obtain valuable information about the behavioural cues for both SS classes {hesitation, no hesitation}. In our study, seven users (N = 7) interacted with the VoD system. We analysed all behavioural cues expressed during user selection of on-screen video content. Altogether, users made over 30 selections

Figure 3. Methodology for the transformation of behavioural cues into SSs. There are three steps: (i) the acquisition of behavioural cues based on user observation, (ii) manual and algorithmic pre-selection of behavioural cues, and (iii) classifier selection.



of video items, with there being more than four video selections per user, until a final selection was made. An operator observed the user's selections and noted each behavioural cue made. Each selection was assigned one SS class. From these observations, we obtained 45 unique behavioural cues for both classes of SS with more than 110 occurrences in total. Obtained behavioural cues are presented in Table 1.

Manual and Algorithmic Pre-selection of Behavioural Cues

After all occurrences of behavioural cues were collected, we employed dummy encoding (IDRE-UCLA, 2013), where only ones and zeroes are used to convey all the necessary information regarding behavioural cue membership. However, hesitation can also be measured according to unusual delays in response time; therefore, we included the time between two selections in our pre-selection procedure. From here on, behavioural cues will be referred to as features. Occurrences of all observed features are shown in Figure 4.

In our next step, we applied known feature selection procedures to narrow down and identify the best of all 45 behavioural cues, but we were unable to find a small subset with which to predict hesitation accurately enough. Therefore, we manually preselected 12 features that had more than one occurrence and had the largest difference between hesitation and no-hesitation classes. We then used a forward selection (Wald) method (Bewick, Cheek, & Ball, 2005) to rank features according to significance. Using this small subset of features and the additional feature of time, we manually verified the recognition rate for combinations of three, four and five features for different types of classifiers. We obtained the

Table 1. Table of obtained behavioural cues. The first column gives unique ID of behavioural cues, while the second column gives the description of the behavioural cue.

ID	Behavioural Cue
1	Right hand made into a fist
2	Right eyebrow lower than left eyebrow (right eyebrow in a lower position than the left eyebrow)
3	Right side of mouth slightly downturned (left side in a natural position)
4	Right side of mouth lower than left side (both sides in an unnatural position)
5	Right side of mouth slightly upturned (left side in a natural position)
6	Hand of the arm used to select made into a fist
7	Spends more time looking at the content that is ultimately selected
8	Additional hand gesture after selection
9	Raising of both eyebrows
10	Selection gesture – hand brought up close to the body and only then extended towards the selected content
11	Selection gesture – extension of the arm followed only then by pointing at the selected content
12	Slow selection gesture with the hand (hesitation, pausing the hand movement)
13	Quick selection gesture with the hand (no pausing of the hand)
14	Very rapid selection of content (as soon as new content appears)
15	Rapid selection of content (after a few seconds, < 5 s)
16	Extended index finger in content selection
17	Brief swing with the right arm away from the body – shortly before selecting content
18	Brief swing with the left arm away from the body – shortly before selecting content
19	Left cheek blown out
20	Left eyebrow lower than right eyebrow
21	Left side of mouth slightly upturned
22	Slight lip movement
23	Tiny outward turn of right palm
24	Opening of the mouth, movement of lips (speech)
25	Creased chin
26	Only index finger extended at the beginning of selection, followed by the unclenching of other fingers
27	Index finger semi-extended in the selection of content
28	Both hands made into fists
29	Blown out cheeks
30	Both sides of the mouth slightly upturned
31	Eyes not completely open
32	Thumb of left hand in pocket
33	Expression of surprise (raised eyebrows, eyes wide open)
34	Shifting the eyes between two pieces of content, followed by alternate watching of the selection (for half the time)
35	Shifting the eyes between a number of pieces of content, followed by not watching the selection for an extended period

continued on following page

Table 1. Continued

ID	Behavioural Cue
36	Movement of the left buccinator muscle
37	Arm fully extended when selecting content/quadrant
38	In the moment of selection, all fingers except for the index finger are slightly bent
39	Faint smile (eyes slightly drawn together, both sides of the mouth slightly upturned)
40	Faint shuffling in one place
41	Faint nodding (head going up and down)
42	Sucking on the lips
43	Moderately quick selection gesture (user not completely sure about his/her selection, the gesture is not quick although the hand does not stop)
44	Slight sideways cant of the body upon the selection of content
45	Briefly looks at the ultimately selected content (~3 s)

best results for a combination of four features (see Section Results).

Classifier Selection

As mentioned, we verified different classifiers for different combinations of the most significant features. Table 2 presents the results of classification for the combination of features that gave the best recognition rate of the classifiers (four features, as described in a later section). For evaluation, we used basic measures such as precision, recall, accuracy, and the F-measure (Powers, 2011).

As seen in Table 2, logistic regression gives the best evaluation results. It provides the best accuracy and its balance between precision and recall is good. The latter is important to our application as both types of classification errors mislead the system trying to help the users.

According to the obtained results, we applied a logistic regression (logit) model to estimate the absence/presence of selected features:

$$\beta_0 + \beta_1 F_1 + \beta_2 F_2 + \ldots + \beta_m F_m = \ln \frac{p}{1-p} \quad (1)$$

where β_0, β_1, β_2 and β_m are coefficients of the dummy features and F_1, F_2, and F_m are selected dummy features and finally p is the probability that the SS of hesitation is expressed.

RESULTS

We used different combinations of features to build the most reliable logistic regression model. Employing the forward-selection method, we obtain the best result by combining four features (Vodlan et al., 2014):

- The user watching video content, which is then selected for a longer viewing time (F_1),
- The user making a quick gesture when selecting video content (F_2),
- The user watching all video content, but non content for a longer time (F_3), and
- The time between two selections (F_T).

In Figure 4 feature F_1 is denoted as *Feature ID 7* (Table 1), feature F_2 as *Feature ID 13* (Table 1) and feature F_3 as *Feature ID 35* (Table 1). Table 3 is a confusion matrix for the logistic regression model of the proposed combination of features.

Figure 4. Number of occurrences of the features that present the SS class {hesitation, no hesitation}. Variable Feature ID (unique ID of the feature, Table 1) is on the y-axis, while the number of occurrences of each of the features is on the x-axis. Yellow-shaded(brighter)columns represent feature occurrences for the hesitation class and the blue-shaded (darker) columns represent feature occurrences for the no-hesitation class.

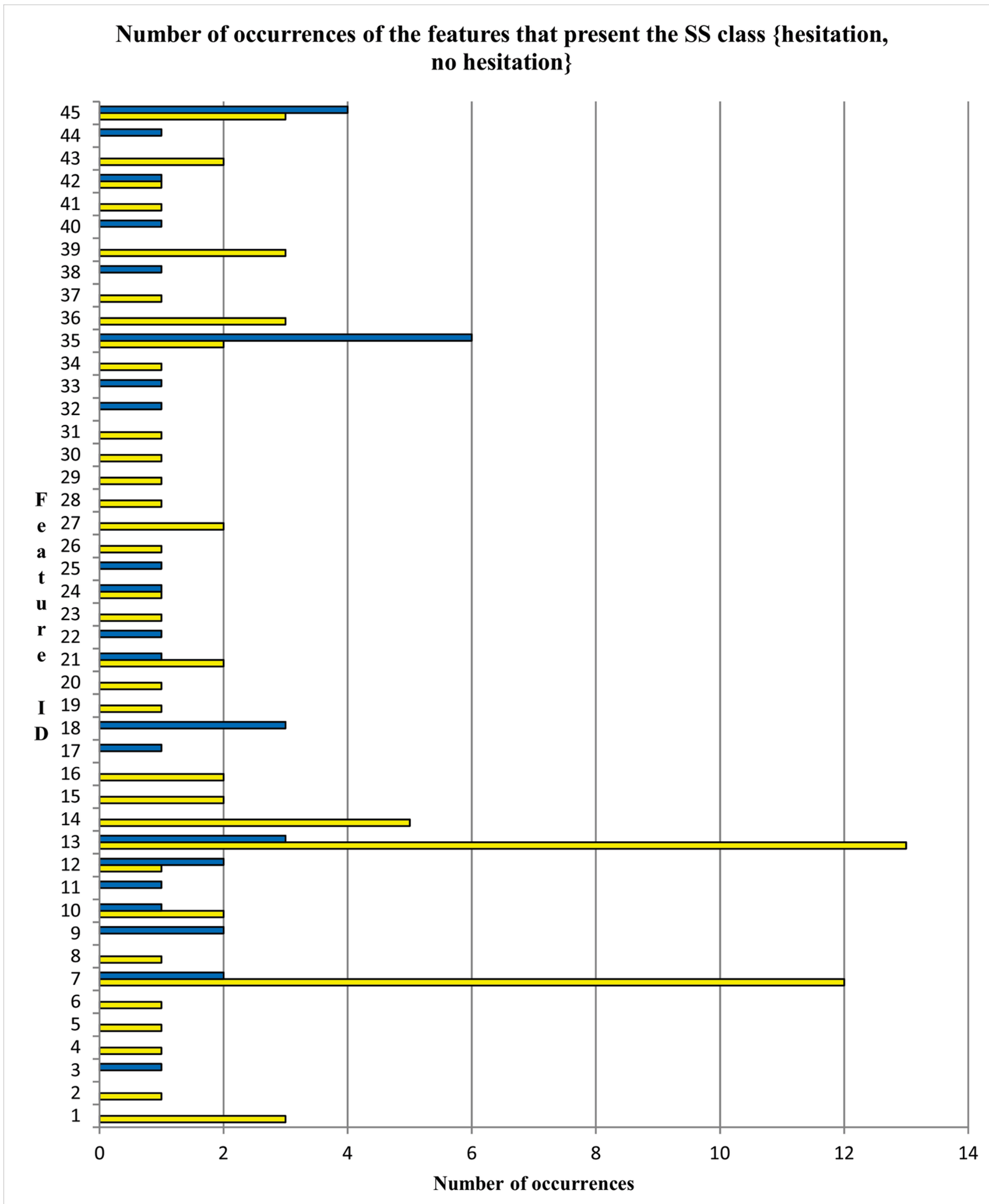


Table 2. Results of the evaluation of classifiers given with standard measures (precision, recall, accuracy, and F-measure)

Classifier\ Measure	Precision	Recall	Accuracy	F-Measure
Logistic Regression	0.882	0.833	0.910	0.857
SVM	0.727	0.222	0.721	0.340
Multilayer Perception	0.759	0.611	0.811	0.677
Naive Bayes	0.611	0.306	0.712	0.407
AD Tree	0.818	0.750	0.865	0.783

We see that the model achieves a 91% recognition rate with only four selected features.

From the SPSS software (IBM Corp., 2012) results, we can present the logistic regression (logit) model for the proposed combination of features as:

$$\mathrm{logit(p)} = -5.64 - 5.90F_1 - 1.26F_2 + 1.84F_3 + 0.36F_T \quad (2)$$

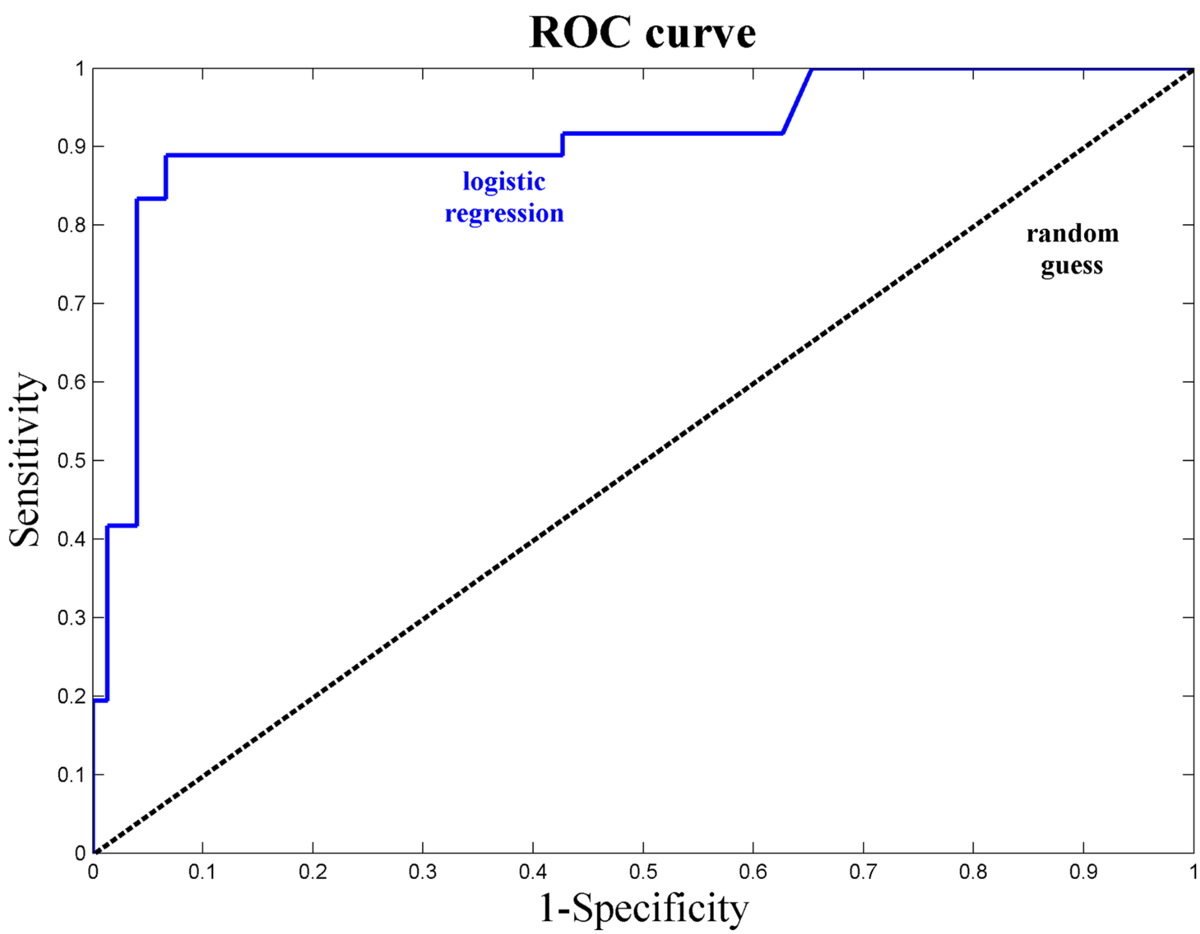
where F_1, F_2 and F_3 have binary values 0 for "not expressed" and 1 for "expressed", and F_T is the absolute time between two selections in units of seconds. After establishing the model, we can calculate the probability *p* that tells us if the user is hesitating. If *p* is equal to or greater than 0.5, then the user is hesitating; otherwise the user is not hesitating (*p* less than 0.5). The optimal threshold value (0.5) was obtain from receiver operating characteristic (ROC) of a selected classifier (Figure 5).

When the time (F_T) is much longer than the mean time, the effect of this variable on the final result of Equation 2 is too great in relation to the effects of other variables; therefore, we must limit the effect. We replace F_T by the threshold times for all possible combinations of values of the variables F_1, F_2 and F_3. If the time for selected combinations of values F_1, F_2 and F_3 is longer than $\mu + 1.96\sigma_T$ then the mean time (μ) is used as F_T (Table 4). Interval $\mu + 1.96\sigma_T$ represents the confidence interval for a normal distribution of time F_T where σ_T denotes the standard deviation of time F_T. Why do we use this interval? The probability of a random deviation in the case that the user is not hesitating is exactly 5 percent, which is the standard risk level. The logistic regression model obtained in this study is used in human-operator interface application (Vodlan et al., 2014).

Table 3. Confusion matrix for the logistic regression model where two SS classes are included {hesitation, no hesitation}. The number denotes the quantity of classified examples. The overall recognition rate (Rec. rate) is presented at the bottom of the last column.

		Classified as		
		No Hesitation	**Hesitation**	**Rec. Rate (%)**
True Classification	**No Hesitation**	71	4	94.7
	Hesitation	6	30	83.3
				91

Figure 5. ROC curve for logistic regression model



DISCUSSION

To the best of our knowledge, the SS of hesitation has not yet been analysed through expressed gestures and behavioural cues. On this basis, we performed a preliminary test where we selected the most significant behavioural cues to describe the SS class {hesitation, no hesitation}. The aim of this test was to develop a methodology for the transformation of behavioural cues into an SS where only a few behavioural cues are used as input information for a decision model with a high recognition rate.

One of the important assumptions related to the design of the experiment was the use of binary features. In this section, we discuss about the reasoning behind this decision, we address the limitation of the present work and provide future work directions.

Justification for Selecting Binary Features

Most of the analysed (and selected) features are not binary by nature and the classifiers might perform better using non-binary inputs. We decided to use binary features for two reasons: (1) the human-operator interface must be manageable in providing real-time responses to the observed users SSs (i.e., the human operator cannot manage

Table 4. Prediction of cut-off times for feature F_T. The first three columns give binary features F_1, F_2 and F_3, while the fourth column gives cut-off times for feature F_T. The cut-off time is the threshold on which the decision model bases a decision according to the binary combination of features F_1, F_2 and F_3. Column 5 gives the mean value of time F_T, while column 6 gives standard deviation of time F_T.

F_1	F_2	F_3	F_M [s]	μ [s]	σ_T [s]
0	0	0	15.84	14.44	8.37
0	0	1	10.66	17.99	10.60
0	1	0	19.39	14.16	8.23
0	1	1	14.21	17.85	10.09
1	0	0	32.41	14.66	8.41
1	0	1	27.24	15.50	9.60
1	1	0	35.96	14.34	8.25
1	1	1	30.78	15.94	9.56

the interface and concentrate on user interaction at the same time if the complexity of recognized features is too high) and (2) the overall complexity of the experiment was already very high and we attempted to simplify the experiment to allow a better interpretation of the results. Regarding reason 1, current state-of-the-art automatic human SS recognition systems have relatively low recognition rates and the introduction of a human operator is unavoidable.

Figure 6 shows the technical implementation of the human-operator interface that can be divided into three phases: input of information, classification, and output of information. The output information from the interface is then used as input information for the conversational RS. The red (upper) path indicates the use of binary features (used in our implementation), while the blue (bottom) path indicates how non-binary features can also be used. In our case (red (upper) path), human *'binary perception'* is used to detect if a user expresses any of the three selected significant features. The status of whether a feature is observed can only be "expressed" or "not expressed". The values of the three features are then together with time used as input information for the classifier. Since we use a binary output class {hesitation, no hesitation}, the output from the classifier (probability p) is linked with a threshold value (0.5) that decide which class is expressed. Therefore, we need only two video selection functions provided by the conversational RS (one function if the user is hesitating and another if it is not hesitating).

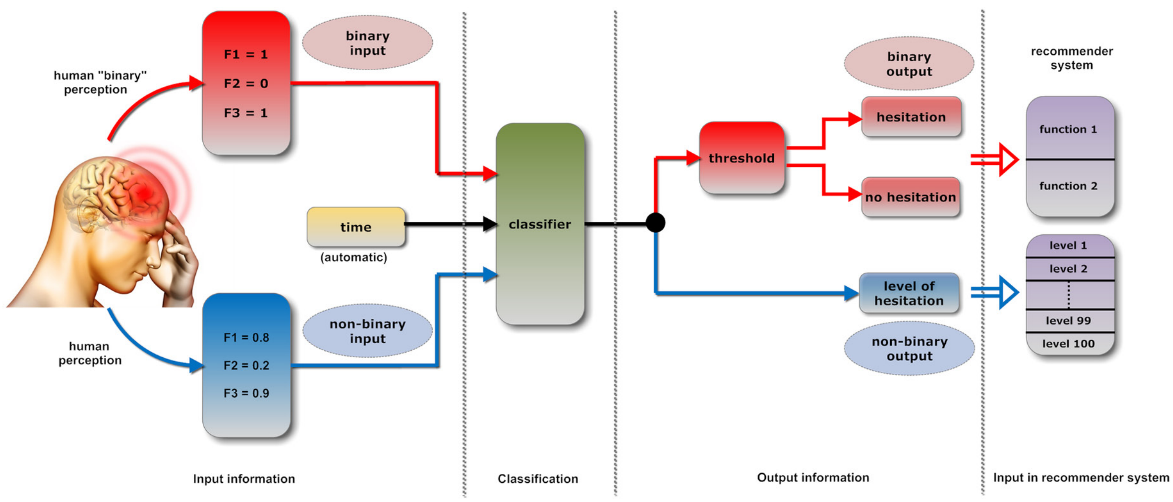
Non-Binary Input

The blue (bottom) path in the input information phase (Figure 6) shows how non-binary input information can be used. The input information for the classifier should be the feature level of expression (e.g., the level of expression for feature 1 is 80%). If the human operator provides the expression-level recognition, the response time will be greatly lengthened. Consequently, the user's flow of thought can be interrupted and his/her expressed behavioural cues may not reflect only satisfaction or dissatisfaction with the items on screen but also dissatisfaction with the system response time.

Non-Binary Output

The blue (bottom) path in the output information phase (Figure 6) shows how non-binary output

Figure 6. Technical implementation of the human-operator interface consisting of three phases: input of information, classification and output of information. The output from the interface presents the input for conversational RS. Our current version of implementation is represented by the red(upper) path (binary input and binary output), while the blue (bottom) path represents a possible upgrade with non-binary features of the input, output or both.



information can be used. The output information from the classifier represents the level of hesitation (e.g., when $p = 0.4$, the user is hesitating with a probability of 40%). Since the output information from the classifier is used to recommend the most suitable items according to the expressed SS, the recommendations from the RS should be adjusted on the level of the expressed SS. However, the implementation of a selection function that recommends items according to the level of SS expression exceeds our current time capabilities, and binary output was therefore used.

LIMITATION AND FUTURE WORK

One of biggest limitations of the present work is the size of the sample of users. The presented work should be replicated for a larger sample of users. The current decision model was built on seven users. With a larger sample, we would obtain results that are more credible. Therefore, our future work should focus on increasing the size of the sample of tested users.

CONCLUSION

In this chapter, we proposed a methodology for the transformation of behavioural cues into an SS in HCI. According to the experimental design discussed at the beginning of this chapter, we presented an example of behavioural cues that describe the SS class {hesitation, no hesitation}. The methodology comprises three steps. The first step is the observation of the user during interaction and the obtaining of valuable information about behavioural cues. The second step is the manual and algorithmic preselection of the most significant cues that describe the observed SS. The third step is a test of different classifiers and application of the most appropriated one. In our specific case, we preferred binary features because of the complexity of our experiment. Results of this study were used to model the application in our experimental design through which a human operator recognizes the user SS.

We expect that all findings related to our methodology apply to other SS classes. Our methodology allows SS extraction with a high recognition rate using only the few most significant behavioural cues that describe the SS.

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KEY TERMS AND DEFINITIONS

Behavioural Cue: A behavioural cue is an atom action, which is atomic movement that can be described at the limb level, or a micro movement such as a facial expression or head movement.

Experimental Design: Design of experiment deals with planning, conducting, analysing and interpreting controlled tests to evaluate the factors that control the value of a parameter or group of parameters.

Human-Computer Interaction: HCI involves the study, planning and design of interaction between users and computers. It is divided in simple and intelligent HCI.

Logistic Regression: Logistic regression is a type of regression analysis used for predicting the outcome of categorical dependent variable based on one or more predictor variables.

Recommender Systems: Recommender systems are software tools and technologies that predict user preferences and suggest useful items to a user.

Social Signals: Social signals are initiated by the human body and present reactions to current social situations. They are expressed with non-verbal behavioural cues.

Social Signal of Hesitation: Social signal of hesitation belongs to a type of micro-movement (microslip) and can be expressed through facial expressions, head movements, etc.

Social Signal Processing (SSP): SSP is a research domain that aims to understand social interactions through machine analysis of nonverbal behaviour.

Video-on-Demand (VoD): VoD is a service that enables users to select one video content from among others.

Chapter 8
Methods of Skull Implants Modeling with Use of CAx and Haptic Systems

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ABSTRACT

This chapter deals with four exemplary methods of virtual skull implants modeling. These methods combine simultaneous usage of three modeling systems: reverse engineering system, surface modeling system, and haptic modeling system, and their characteristic modeling methods and techniques. Using three different modeling systems, the authors obtain a synergy effect of the implant shape and model quality increasing. The target virtual model of the implant is always well suited to the coastline of bone lack in the skull. Additionally, time of the virtual model developed is very short compared to use of only one of the standard engineering CAx systems. The chapter describes four original methods developed by the author.

INTRODUCTION

The need to remove a bone piece in neurosurgical procedures or the occurrence of the loss as a result of mechanical trauma are the causes of a need to restore the natural shape of the skull bone. In the majority of patients who have experienced the loss of cranial bones, proper supplementing the appropriate implants, giving the desired aesthetic effect, so-called cranioplasty surgery (Karbowski, Urbanik, & Wyleżoł, 2010), is an important psychological factor in the recovery and return to normal life in society. Performing trial fit implant constructed should precede the cranial implant implementation. This process can be carried out in two stages: in the virtual world (using 3D models of the skull and of the implant, Figure 1a), and in the real world with the use of physical models of the skull and implant using techniques such as incremental 3D printing, Figure 1b.

The selected illustrations of the human skull in the chapter text were derived from real data (courtesy of Jagiellonian University, Medical College at Cracow, Figures 12-15) and serve to illustrate realization process of this method. Other skull models are based on the digitization of their physical models.

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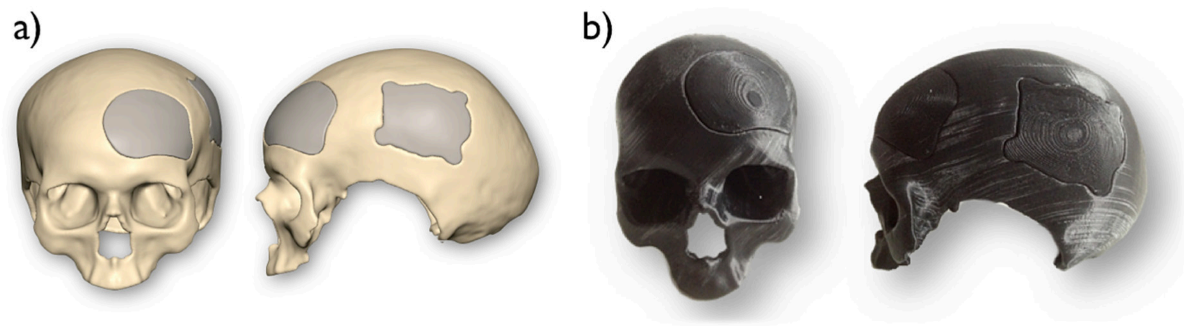
Figure 1. Virtual model of a skull with implants (a) and their physical models made by 3D printing (b)



BACKGROUND

Modeling objects with forms that contain no standard geometry (i.e.: plane, patch of analytical surface, sphere, cylinder, cone, etc.) is a very difficult process to achieve using conventional surface or solid modeling systems and its tools (Wełyczko, 2009). One of the solutions of this modeling problem is to use the free surface modeling (nonparametric), where the elements allow you to control the shape of the surface patches using e.g. control points of the surface (Kiciak, 2000; Wełyczko, 2009). However, such modeling methods are not suitable to solve problems, which concern the scope of this article, i.e. whether the modeling implants match the difficult skull shape.

In this case (i.e. modeling human skull implants based on a discrete skull bone model with a missing piece), the input element to modeling process of a skull implant is a surface mesh model of the skull obtained from computed tomography (CT) (Eufinger, 1995; Karbowski, Urbanik & Wyleżoł, 2010; Wyleżoł & Otrębska, 2013). Note: the description of computed tomography (CT) or magnetic resonance imaging (MRI) is not the purpose of this chapter. Despite, the author will briefly describe the process of obtaining models based on medical imaging.

Digital images obtained with the type of medical computed tomography and magnetic resonance imaging are stored in the standard DICOM (Digital Imaging and Communications Medicine) images (DICOM, 2013). It is a standard developed by ACR/NEMA (American College of Radiology/National Electrical Manufacturers Association) to harmonize worldwide recording medical data. Images stored in the extension of the DICOM contain not only graphical data i.e. flat images, but also include patient information and parameters of the medical study. Using the mentioned above study we receive flat sections of an organ of the human body. The number, size and quality of these cross-sections depend on the settings selected in the medical study. Ideally, when the sections are spaced apart by about 0.5 mm (or less), because then we are able to correctly reconstruct the three-dimensional model of the human body (Cierniak, 2005; Wyleżoł & Otrębska, 2013).

DICOM images for obtaining and processing three-dimensional models are imported into a specialized program such as Mimics (Materialise, 2013) or Osirix (Osirix, 2014). DICOM images imported to the mentioned program (or some others for DICOM files viewing) are displayed in three planes: frontal, transverse and sagittal. The sections are generated with a suitable mask Hounsfield scale setting. Hounsfield scale is a quantitative scale that describes the density of the radiation corresponding to the absorption coefficient of X-rays by the body (Cierniak, 2005). For example: a value of 0 (HU) indicates water, about -1000 (HU) corresponds to the air, and 400 ÷ 1000 (HU) corresponds to the human bone. To illustrate these values, grayscale (0 to 256) is used, where the paintings of black color corresponds to the low value of the Hounsfield scale, while the white color - means high value such as bone (Figure 2).

After generating the appropriate masks of the selected area on the bones of the skull layer and after removal of artifacts and performing segmentation (on every DICOM flat images on the three main planes: frontal, lateral and sagittal), we can create a three-dimensional model of the skull firstly as a voxel model, and next as a STL mesh models (STereoLitography). This process is reconstructive, as reverse engineering (Cierniak, 2005). Exemplary STL model of human skull after neurosurgical surgery is shown in Figure 3.

Described modeling method, which combines the capabilities of reverse engineering (computed tomography is treated as reverse engineering technique giving the mesh model) and surface modeling systems, in terms of creating and editing 3D curves (Piegl & Tiller, 1997; Kiciak, 2000; Wełyczko, 2009), but also adds many new and - unprecedented in the other engineering CAx systems (i.e. all engineering Computer-Aided systems) – possibilities to shape the virtual models - is a haptic modeling (ISoF, 2013) using voxels models (Bordegoni & Cugini, 2005; Geomagic®Claytools®, 2013; Wyleżoł, 2009).

By the author, the combination of these three modeling methods and systems, gives us the synergy effect. Thanks to the synergy, it is possible to make the models of complex shapes faster and simpler (particularly anatomical models, where there are no classic geometric objects).

Mentioned haptic modeling systems are less known in the world of technology (and even less known in the world of bioengineering), and that is the reason why the author focuses on more accurate presentation of them.

The haptic system (a touch system) includes a set of: computer, software and working with the device - a tactile articulated arm (called: haptic device), as a coupling element of the user and software. Some information about the modeling arm called PHANTOM Omni

Figure 2. View of three planes of human skull (made from DICOM files) after neurosurgical surgery (Osirix, 2014)

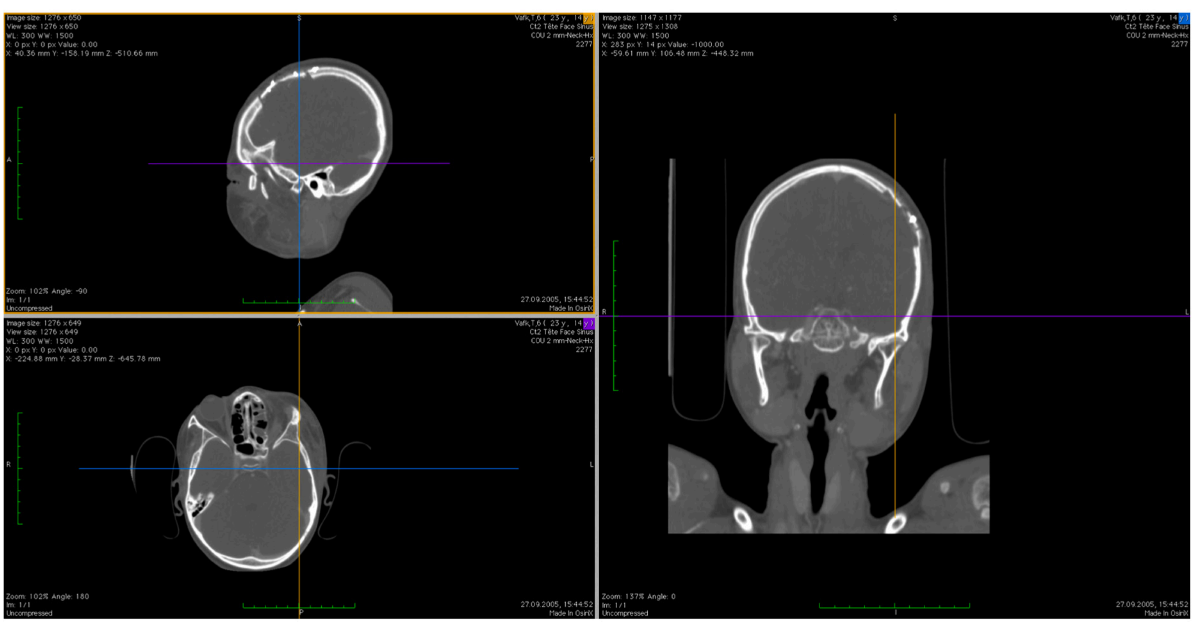
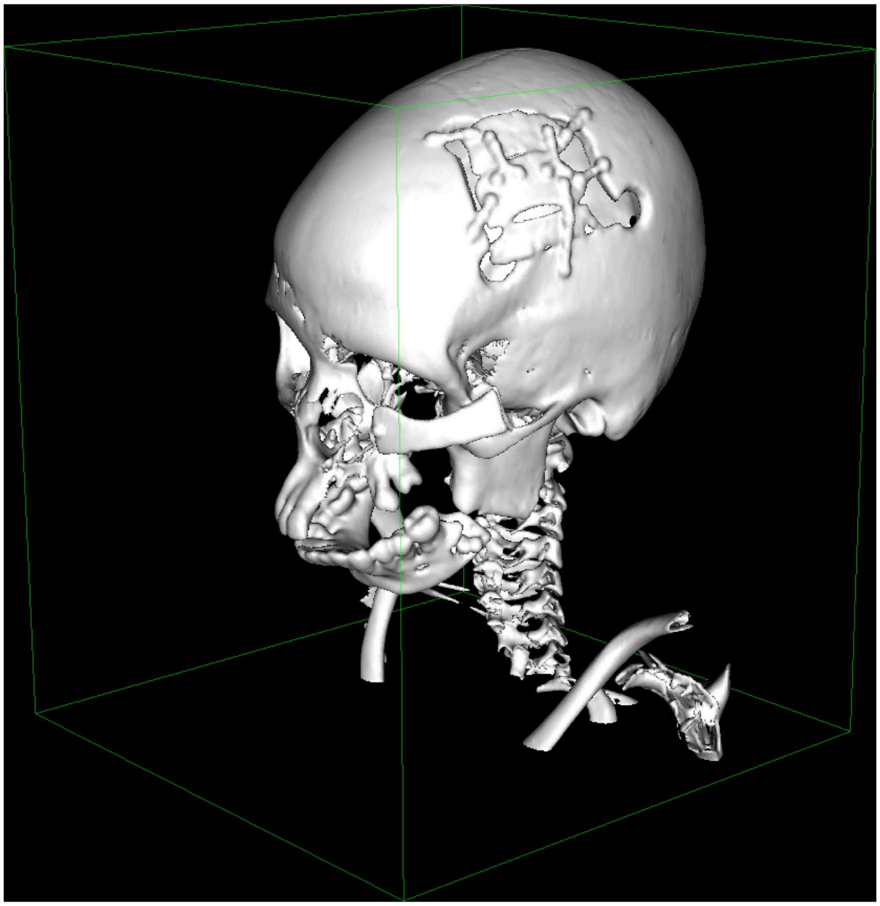


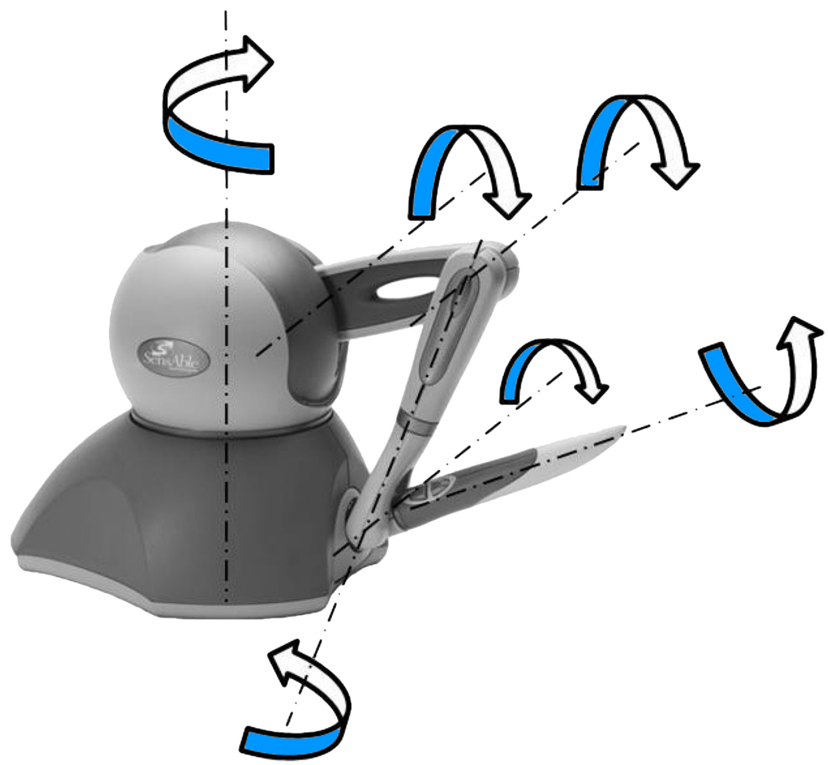
Figure 3. View of the STL mesh models of human skull (made from DICOM files) after partial neurosurgical reconstruction (Osirix, 2014)



(Geomagic®Claytools®, 2013): this device consists of a fixed base and rigid arms pivotally connected. The entire system provides the angular movement of the arms relative to the 6-axis (which gives the 6 degrees of freedom, Figure 4). Joints of the arm are equipped with the sensors recording parameters of realized working movements of the user hand (the direction of rotation, angular velocity and torque). Additionally, the device has an electrically-controlled clutch responsible for generation of friction in the joints, used to obtain a feeling of resistance of the shaped virtual object material (the value of generated friction force in the couplings is to 0.26 N).

All required information signals are transmitted in real-time, bi-directionally between the haptic device and its operation control system (via IEEE-1394a FireWire, providing the required bandwidth transmission of information). Information about the operating parameters of the haptic arm movements are transferred in the direction of the arm-to-computer model, and the feedback signals - in the opposite direction. All signals sent to the haptic modeling arm give rise to relevant force feedback, noticeable by the user as a resistance in places where the virtual working tip of the arm touches the surface of the virtual voxel model.

Figure 4. Haptic modeling arm (6-axes of rotation visible)



Main elements of the previously described haptic modeling system are shown in Figure 5.

Haptic modeling software tools used to shape virtual models so-called "*virtual clay*" (popular name of the voxel volumetric model). Voxel is a separate volume element, representing a value on a regular grid in 3D space. This is analogous to a 2D pixel element, which represents image data in a raster graphic. The name derived from the two words: volumetric & pixel (Figure 6). In other words: voxels are isotropic smallest, indivisible particles, which, arranged in three-dimensional array, create a volumetric form of the model. Spatial representation of the voxel is mainly a cube or a rounded cube. Depending on the number of used voxels and their size, representation of the model can be more or less accurate.

Voxel representation of model provides not found in other modeling methods (and using other representations of models) ways of shaping the form of models. This advantage is derived from the discrete representation of the model using isotropic voxels. All activities related to the shaping the voxel model, are associated with individual voxels and their groups. Voxels can be: added to model, subtracted from the model (Figure 7), moved in the model and scaled in the model.

Voxel modeling reminds shaping plastic materials. There is an analogy to the molecular structure and the characteristics of plastic materials such as clay. Because of this analogy, it is convenient to use just haptic modeling. Haptic modeling allows speeding up the modeling process of very complex shapes (especially with no typical geometric shapes), in comparison to the other mentioned modeling systems. They allow us to perform even operations completely inaccessible in these systems, e.g. CAx systems. For example: we can shape the virtual model like a real piece of clay, using special programing functions cooperating

Figure 5. Haptic modeling system – main elements, connections and direction of signals flow

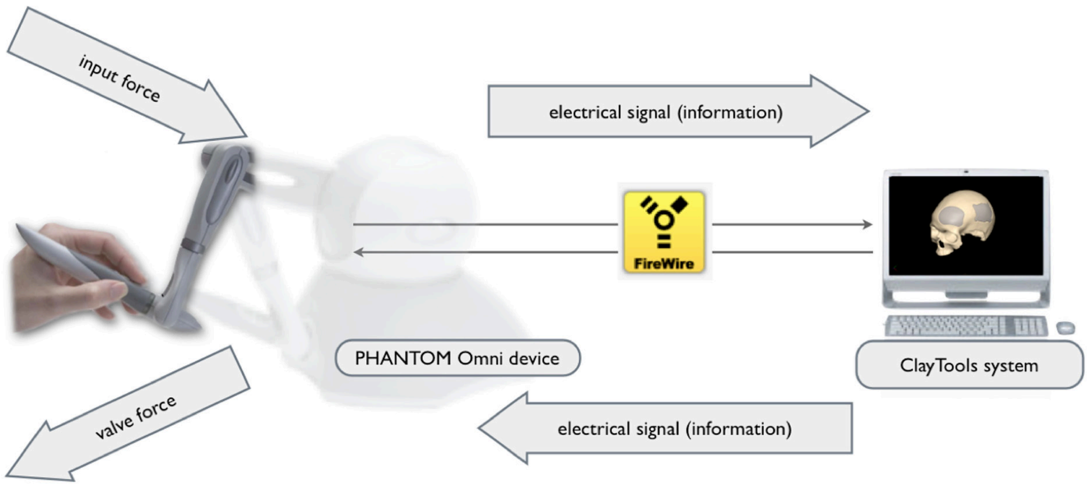


Figure 6. Comparison: the 2D pixel raster (a) and 3D voxel volumetric set (b)

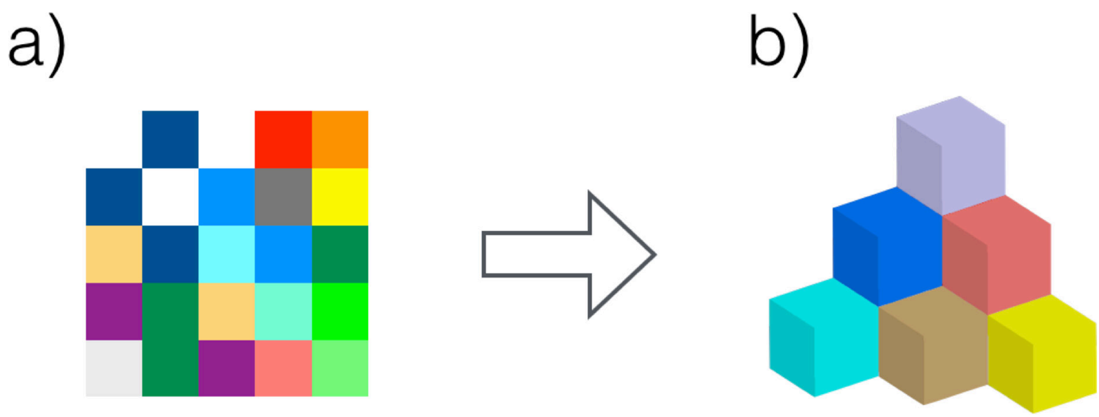
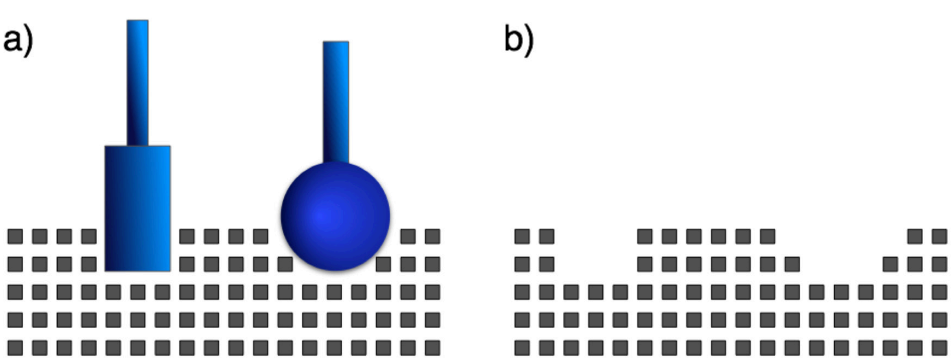


Figure 7. Examples of voxels deleting: simplified view of the model section and two tools with different penetrative tips (a), simplified view of the model section after deleting some voxels (b) (Adapted from [Wyleżoł, 2013])



with the - previously mentioned - special modeling arm - PHANTOM Omni (Geomagic®Claytools®, 2013). Several examples of their use to form a "virtual clay" model are shown in Figure 8.

The author's proposal goes in the direction of obtaining a synergy effect of use three mentioned different virtual modeling systems, therefore:

- Reverse engineering (in this case it is a computed tomography - CT),
- Surface modeling (Kiciak 2000; Wełyczko 2009),
- Haptic modeling (Wyleżoł, 2009).

The effect achieved by the consistent application of these systems is a very high probability of receiving a good result (as virtual implant shape precisely matched to a skull hole), then using only one of the systems.

The scope of the particular systems, directions of models transformations and destination models obtained from them are shown in Figure 9.

MODELING METHODS OF SKULL BONE IMPLANTS

As mentioned in the Introduction, surgical implantation of human skull (Karbowski, Urbanik & Wyleżoł, 2010) can be planned and its simulation carried out using virtual models of the skull with decline and the implant. Therefore, in the next part of this chapter, attention will be paid to few modeling processes of the 3D skull models implants.

Generally accepted assumption of these methods of cranial implants modeling is to have a STL (mesh made) model of the skull with the lack (e.g. a hole after neurosurgery or mechanical trauma). The skull model is created using the computed tomography (CT) or magnetic resonance imaging (MRI). The task of obtaining STL (mesh surface) skull model of a medical imaging is not in the author's interest area. Examples of its realizations are described in other sources (e.g. Eufinger, 1995; Song, Cheng, Wang & Huang, 2011; DICOM, 2013).

Method No. 1

The implementation basis of the follow-up to the creation of the implant model matched to the skull bone with defect (as a hole) is the use of superficial interpolation spline curves (Kiciak, 2000; Piegl & Tiller, 1997). The possibility to create them on the surface of "virtual clay" (properly: voxel model) is given by the haptic system ClayTools (Geomagic®Claytools®, 2013), too.

Realization of modeling was divided into three main stages (Wyleżoł, 2013):

1. Obtainment of surface spline curves based on the voxel skull model,
2. Implementation of redundant implant model,
3. Implementation of matched implant model.

A scenario can also describe the modeling process structurally. In the scenario we can distinguish: input and output format of the

Figure 8. Several specific tools of haptic modeling in use (Adapted from [Wyleżoł, 2013])

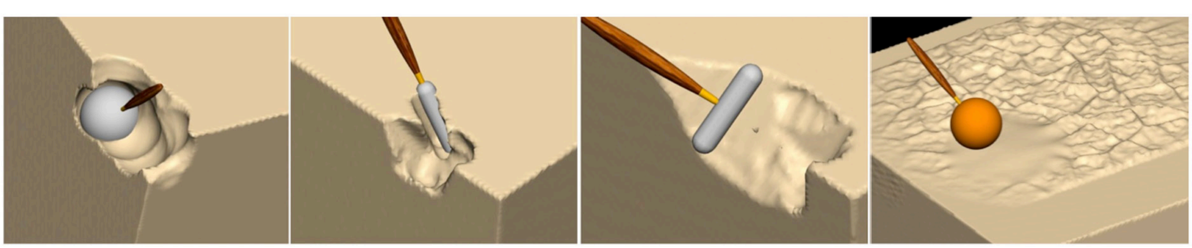
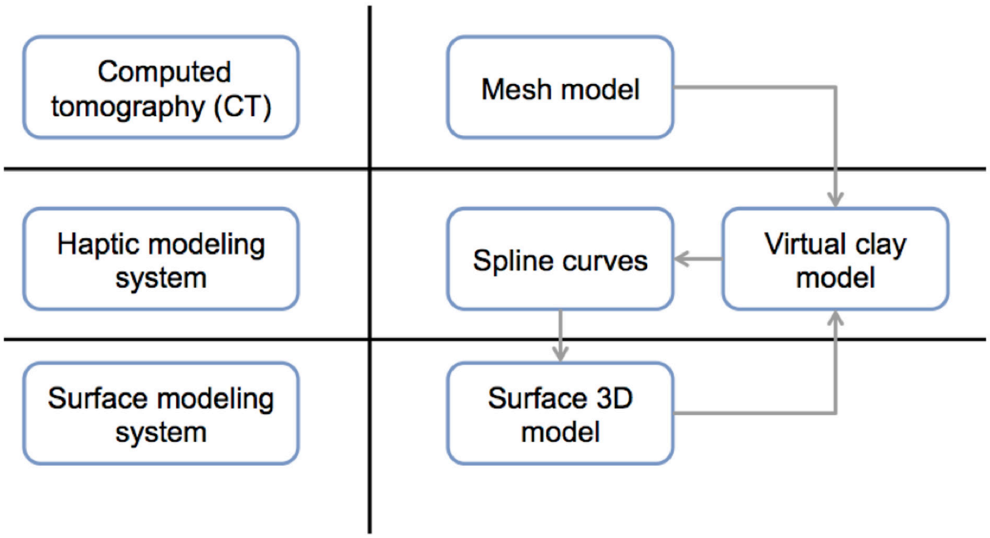


Figure 9. Computer systems, corresponding models and transformations between them (Adapted from [Wyleżoł, 2013])



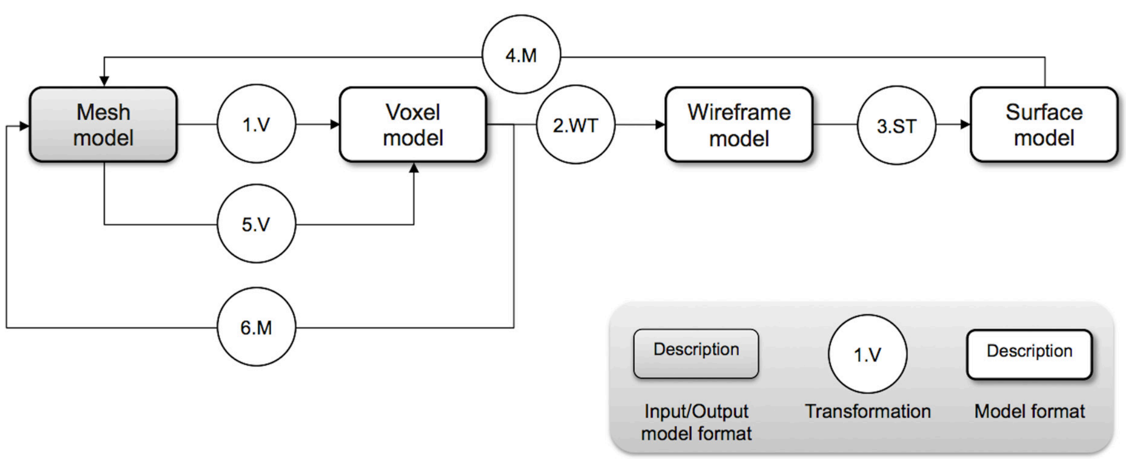
virtual models, transitional models formats and transformational actions (V – voxelization, WT – wireframe transformation, ST – surface transformation, M - meshing). Scenario of the modeling method No. 1 is shown in Figure 10. Others, more complicated scenarios of modeling processes developed by the author were described in other source (Wyleżoł, 2013).

Stage No. 1

At the first stage of the modeling process, we must generate the following features characterizing the spline curves:

- Generated spline curves are tangent to the surface of the skull model, where the surface between these nodes exist, which curves are tangent to the surface over its

Figure 10. The scenario of the modeling process realization (Adapted from [Wyleżoł, 2013])



entire length, and not only on the nodes specified by the user, but also where its absence occurred (in our case it is a fragment of the skull hole after the removal of a bone piece), the form of curves is interpolated between the existing neighboring nodes, so that the resulting spline curve passes "smoothly" by all appropriate points (Figure 11);

- The user indicating selected nodes (as points) on the skull model surface to form the spline curve, feeling clear indication of the resistance in place, but also feels - in the form of resistance on the mentioned device PHANTOM Omni - a kind of "stress" generated by the curve (which is a physical reflection of the process of transformation of mathematical formulas that define spline curve formed splines). It can be controlled in such a way as curves generated so as to be best matched to the surface of the skull model (Figure 12).

Figure 11. The section view of skull bone voxel model and the exemplary surface spline curve

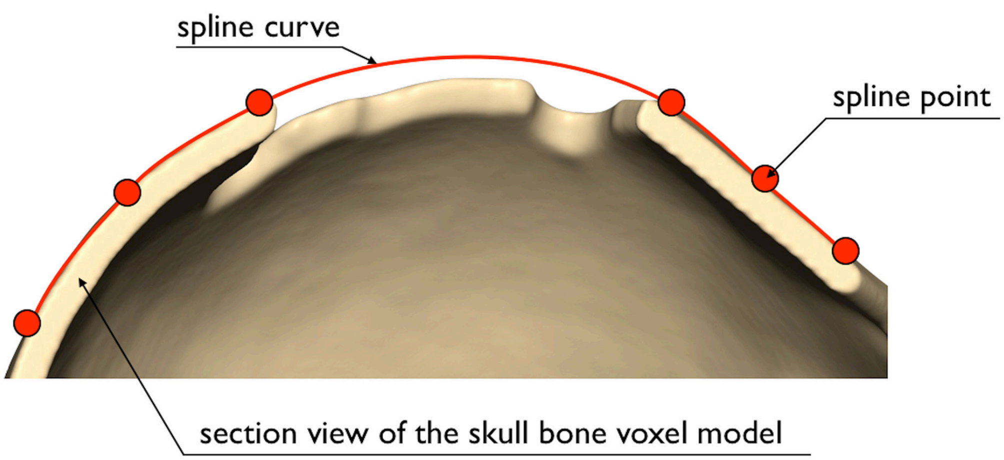
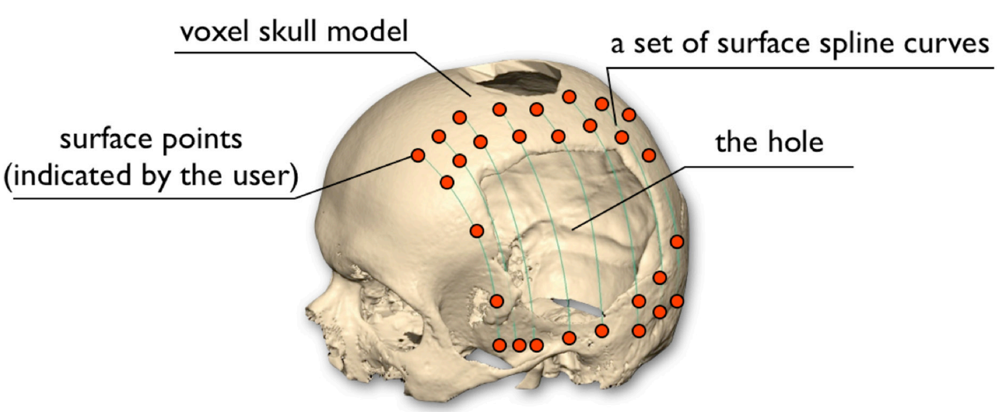


Figure 12. The skull bone voxel model and the surface spline curves



Stage No. 2

Thus obtained spline curves (Figure 13b) were used to perform the patch of surface (the second stage of modeling process begins). To do these splines, they must be first exported to the general format, such as IGES (Initial Graphics Exchange Specification). Saved set of spline curves has been used to model a smooth patch surface stretched between several splines [9]. The surface modeling process has realized in the environment of module *Generative Shape Design* of the CAx *CATIA v5* (Dassault Systèmes, 2013) system. With the appropriate software module tools, the surface patch has received adequate thickness (proportional to the thickness of the skull in place where the implant should be inserted, Figure 13c).

As shown in Figure 13c, the created model of surface patch is much larger than the hole in the skull (Figure 13a) and has a different shape of the coastline, so it does not seem to fit. At this stage of the action, the surface model is actually redundant, but – what is very important – includes the desired missing part of the skull.

Thus formed surface model is transformed into a "virtual clay" (through intermediate conversion into a STL file), to give the model the final shape into the environment of haptic system. Now, we can begin the third stage of the modeling process.

Stage No. 3

Obtain the desired form of the implant model was made thanks to the "Boolean" subtraction operation. The volume of the skull model (Figure 14b) was subtracted from a "redundant implant model" (Figure 14a). In other words, the existing model of the skull was used to cut the excess volume of the implant model. This way, the effect of implant model matching to the existing skull defect, was obtained (Figure 14c).

Due to the fact of using pre-modeling of the implant interpolation curves, the implant model shape was a bit redundant and unmatched in several places. This applied particularly to its shape at the edges (constant thickness across all the area). Therefore, the final form of implant fit was achieved using selected software tools of the *ClayTools* haptic system (including the thickness of the implant matched to the thickness of the skull bone). Furthermore, the model was enhanced with a set of small through holes. They are necessary to accelerate the reconstruction of bone tissue. The entire destination model was additionally completed with the elements fixing the implant. All models are shown in Figure 15.

The voxel model of implant usually is exported to the destination general file format, as STL. This format is useful for CNC (Computerized Numeri-

Figure 13. The first skull bone modeling stages: a) voxel model of the skull, b) set of surface splines, c) initial redundant surface model of the implant (Adapted from [Wyleżoł, 2013])

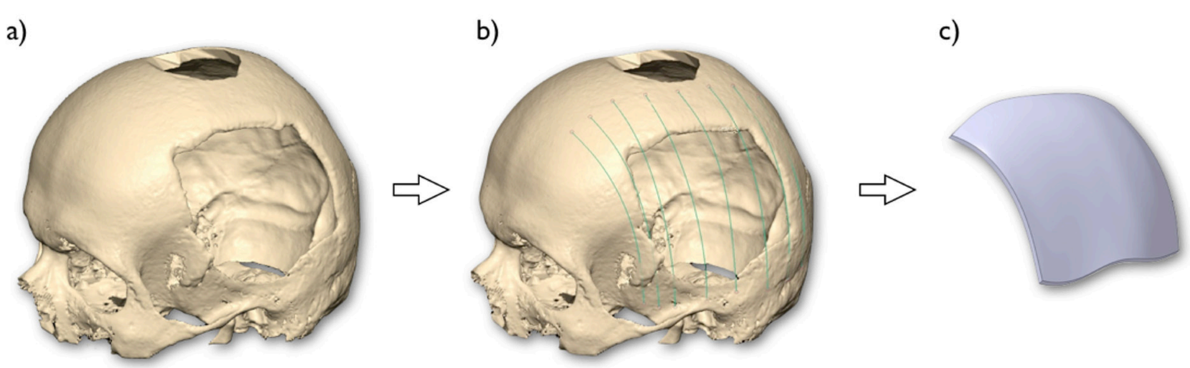


Figure 14. The Boolean subtraction (Adapted from [Wyleżoł, 2013])

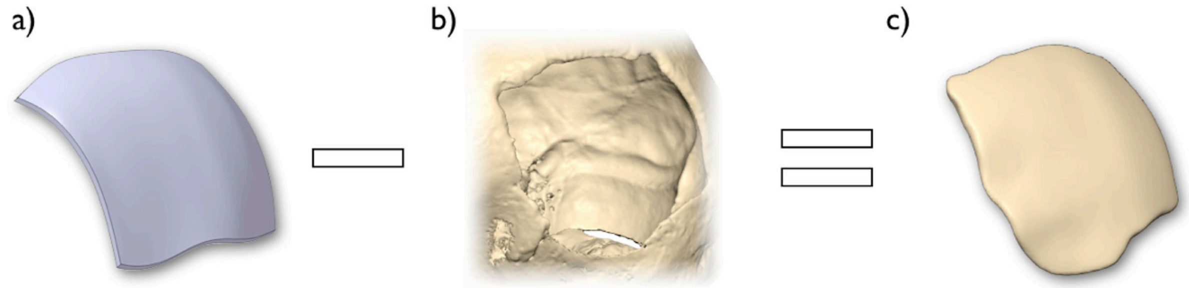
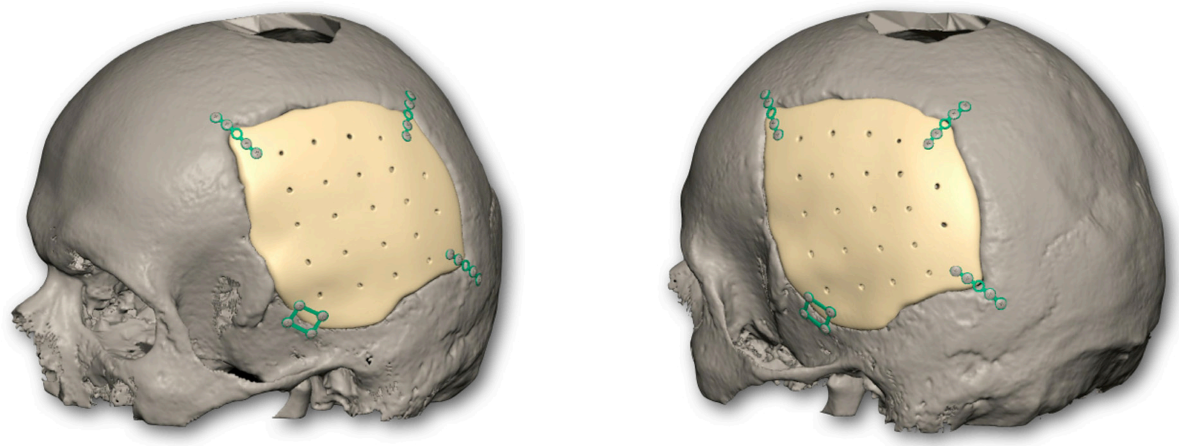


Figure 15. The skull and matched implant model



cal Control) lathe as well as for 3D printing (or other generative technologies) – to produce useful material models.

Estimated duration of the implant modeling process is about 1-2 hours.

The final verification of the implant shape should be performed by a neurosurgeon before producing and implanting it.

Method No. 2

In a clinical case where there is a bone defect (e.g. as a result of accident damage) only on one side of the skull (Figure 16), it is possible to use modeling methods called "adding a local surface patch". This method, in its original form, was described by the author (Wyleżoł, 2013). A modified version of this modeling method will be presented later in this part. The main amendment concerns the revision of the method so as it is sufficient for only one modeling system which will be implemented. It is a haptic modeling using voxels models (Bordegoni & Cugini, 2005; Geomagic®Claytools®, 2013; Wyleżoł, 2009). In the earlier described modeling method (No. 1), it was necessary to use two different computer systems.

This process does not need to describe it using a scenario, like the method No. 1. This is because all the activities are realized using haptic modeling system only. The target model of implant will be transformed to STL format.

Figure 16. The skull bone voxel model with defect (hole)

The input object of the implant modeling process – in this case – is a mesh skull model with lack represented as a STL. The skull mesh model was made using the 3D scanning a physical model of an educational physical skull. Before the start of the modeling process, the STL file was transformed to a voxel form by use of the ClayTools system (Geomagic®Claytools®, 2013). It is a precondition of the modeling process using the haptic modeling system. Form of the skull model after the conversion is shown in Figure 16.

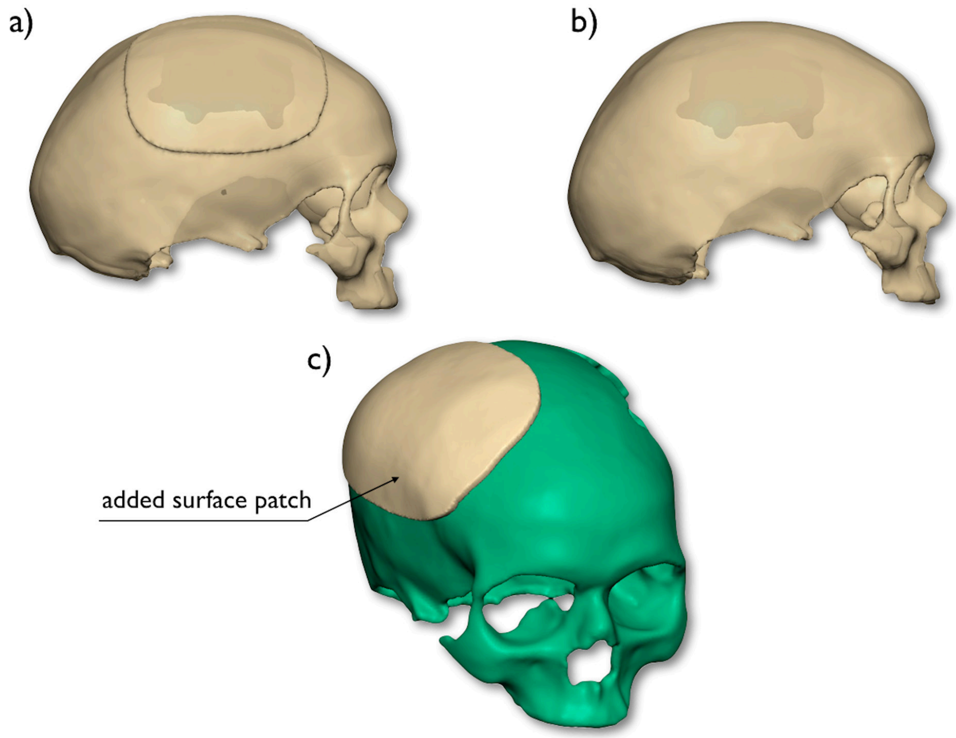
Realization of modeling process was divided into five main stages:

1. Creation of an additional surface patch on the model solid disposed on the opposite side of the skull (in relation to the position of the skull defect), with respect to the sagittal plane,
2. Separation of the additional surface patch from the bone model as a separate body,
3. Creation of the symmetric copies of the additional surface patch relative to the sagittal plane,
4. Adjust the position of the additional surface patch relative to the location of a defect in the model,
5. Boolean subtraction execution of the skull and additional surface patch models, and the final adjustment of the implant model.

Stage No. 1

In the first stage, we make a copy of the input model skull. On the obtained copy of the model, using appropriate software tool ClayTools system, we perform an additional local surface patch placed on the surface of the model (integrated with the model of a skull solid). We create this surface patch (as an additional layer) on the opposite side of the existing lack of bone (relative to the sagittal plane – Figure 17a). To facilitate location of the new layer (surface patch) we must to activate the

Figure 17. The first stages of the implant modeling process: a) view of the added surface patch on the skull model external surface, b) view of the defect of bone from the undamaged parts of the skull, c) view of a separate body of the added surface patch



transparency of the model view options (Figure 17b). The size of the surface patch should be created as redundant, relative to the size of a hole in the skull.

Stage No. 2

Created redundant surface patch is an integral part of the model solid of the skull copy. Further in the modeling process, only the separate surface patch is required. Therefore, in the next step of implementation of the modeling method, we should, using Boolean adjustment, subtract the volume of the input model skull from the skull model with the additional surface patch (the previously created duplicate of input skull model). The result of this operation is shown in Figure 17c.

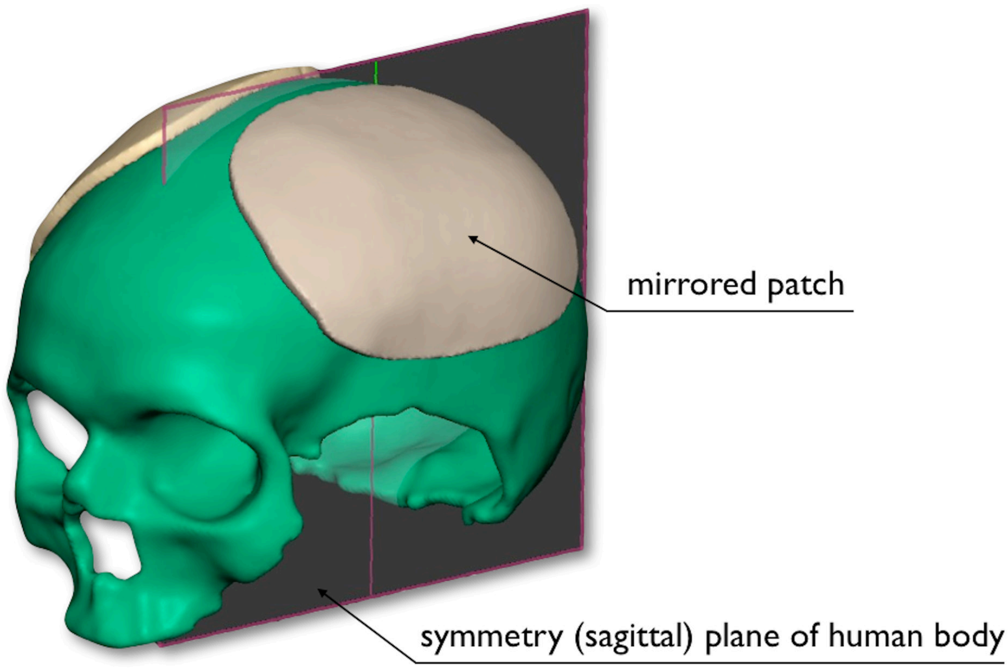
Stage No. 3

The separate surface patch is located on the opposite side, relative to the sagittal plane and relative to the position of the lack in the skull. Therefore, we should create its copy by using mirror (relative to sagittal plane, Figure 18). Primary surface patch must be removed, because it will be required later in the modeling process.

Stage No. 4

Location of a redundant copy of the redundant surface patch relative to the defect (bone lack) in the skull model is not yet appropriate. This is because the sagittal plane is only an imaginary - not geometrically perfect - the plane of symmetry

Figure 18. View of a copy of the mirrored surface patch from the side of skull part with lack



of the human body; besides, the redundant surface patch is dimensionally slightly scaled relative to the actual size of the skull bone. It is therefore necessary to transform its position, so that it can fit into an existing lack (hole) in the skull model. The redundant surface patch should cover all the volume of the hole in skull model.

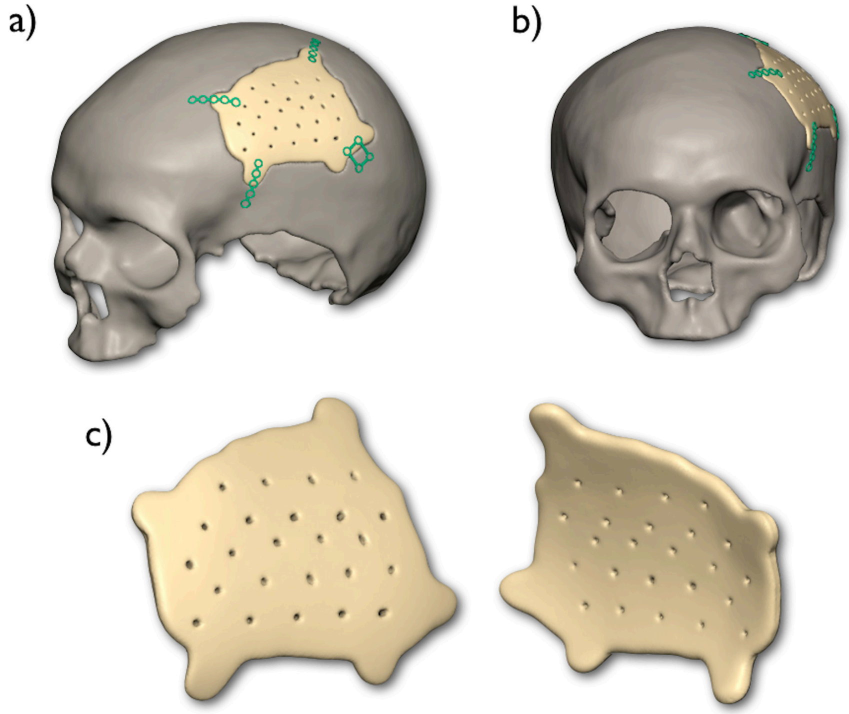
Stage No. 5

After determining the location of a redundant surface patch in the skull model, the Boolean subtraction must be performed again. This time, we have to subtract from a redundant surface patch solid – the solid of skull model. The result is a target shape of the implant model. Because of some shape differences between the two skull sides (lack of perfect symmetry) and imperfect matching of the target implant position - during this operation, there may be some artifacts. Using the corrective tool of the haptic modeling system, the artifacts should be removed. The implant model has yet smoothed in places where they can arise small burrs. Furthermore, if it's necessary, we also have to locally fit the implant to the shoreline hole in the skull model. The implant model was enhanced with a set of small through holes, too (these holes significantly accelerate the bone overgrowth). The results of these operations are shown in Figure 19 (the entire model was additionally completed by standard elements fixing the implant).

The obtained voxel model of implant usually is subject to re-converting to STL mesh format, useful for CNC lathe as well as for one of generative technologies.

The final verification of the implant shape and its other properties should be performed by a neurosurgeon before producing and/or implanting.

Figure 19. Views of the good matched cranial implant model into the skull solid



Estimated duration of the implant modeling process is about 1-1.5 hours.

Method No. 3

The basis for the implementation of the follow-up to the creation of the cranial implant model matched to the skull bone with a defect (as a large hole), is the use of superficial interpolation spline curves placed on the inner side of a skull model. The possibility to create them on the surface of "virtual clay" (properly: voxel model) gives the haptic system ClayTools (Geomagic®Claytools®, 2013). All modeling process is realized together with CATIA v5 – a very advanced engineering system (Dassault Systèmes, 2013). The final implant model is the result of the ability of both of these systems.

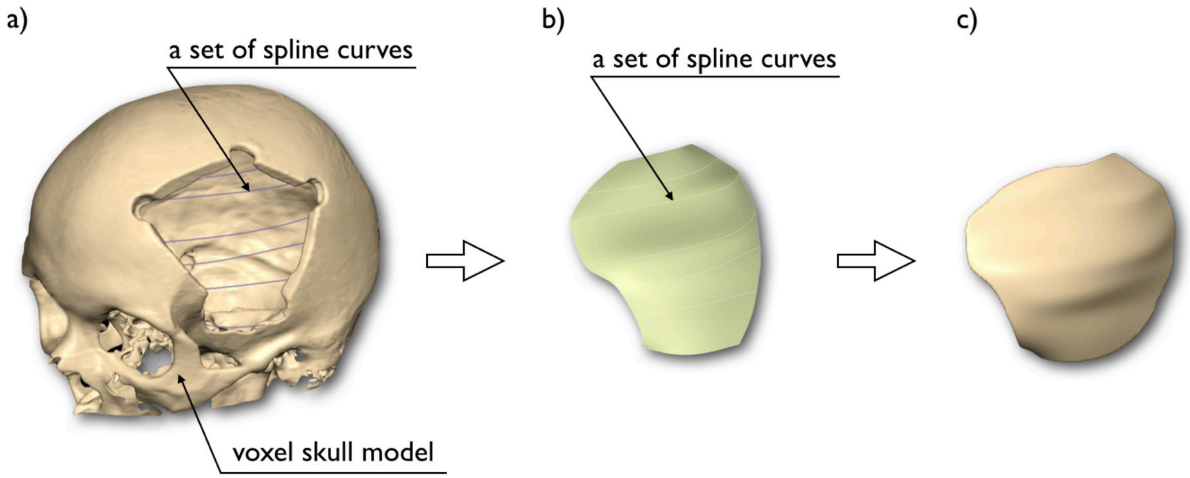
Realization of modeling process was divided into five main stages:

1. Obtainment of internal surface spline curves based on the voxel skull model and implementation of surface patch,
2. Transformation the surface patch to a constant thickness voxel model
3. Adding layers in place on one side blinded hole in the skull
4. Boolean subtraction execution of the skull and additional redundant surface patch.

Stage No. 1

The first stage of this method is similar to the equivalent stage of the Method No.1 (creation local surface curves). The difference consists of that we create a curve on the inner surface of the skull model. Obtained spline curves (Figure 20a) were used to make a model of the auxiliary surface patch. To make this possible, the curves have been previously exported to a neutral format, such as

Figure 20. The first stages of the implant modeling process: a) view of the added spline curves, b) surface patch, c) voxel form of the surface path



IGES. The set of curves has been used to model a smooth surface patch, stretched between the curves (Figure 20b) and next - to give it a constant thickness (Figure 20c). This process has been made in the environment of CATIA v5 Generative Shape Design module (Dassault Systèmes, 2013).

Stage No. 2

The surface patch was directly converted to a voxel model (without the loss of shape), using the haptic modeling system ClayTools. This voxel surface patch was combined with model using Boolean adding.

Stage No. 3

The next stage of implementation of the method is roughing fill the hole depth of the defect (Figure 21b). This process is performed on a copy of the current model (i.e. a separate model of the same geometric form). Incremental layering is performed using software tools of the haptic modeling system. Implant model and the model of the skull are a unitary body. Obtaining the target implant model is done by Boolean subtracting the model with a hole of a model with a layered filling. So obtained implant model is redundant (mainly in the coastal zone), so we should make its final edit.

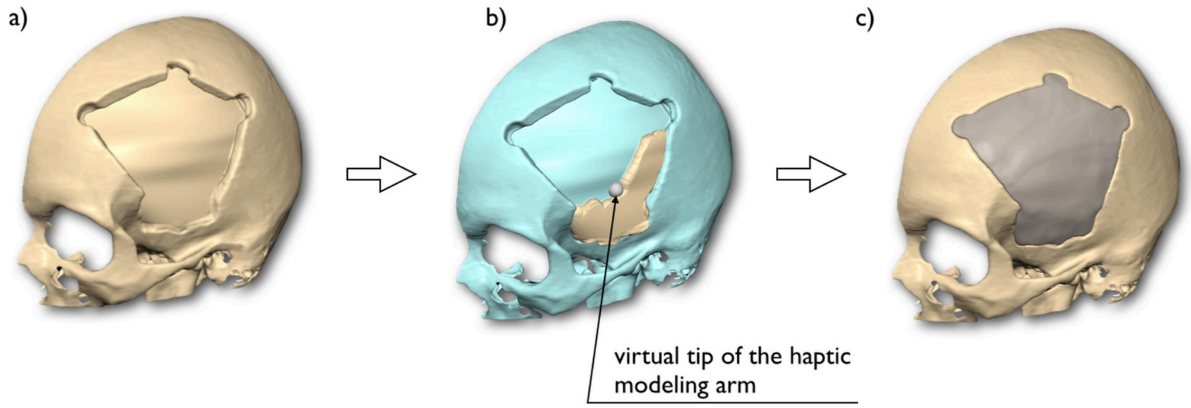
Stage No. 4

The final stage of the method is the manual removal of redundant fragments of the implant model (using the selected software tools of the haptic modeling system) and the execution of the final adjustment to the base model of the skull (model with the hole, Figure 21c).

The presented method is universal and independent from the place of occurrence of the skull bone loss. Its use is particularly recommended when there is a need to fine-tune the outer part of the implant to the local non-standard (e.g. degenerative) deformation of the bones of the skull. Estimated duration of the implant modeling process is about 1.5 hours.

The obtained voxel model of the implant usually is subject to re-converting to STL mesh format, useful for CNC lathe as well as for one of generative technologies.

Figure 21. Views of next modeling stages: a) inner surface of the skull hole, b) adding layer upon realization, c) good matched cranial implant model into the skull solid



The final verification of the implant shape and its other properties should be performed by a neurosurgeon before producing and/or implanting.

Method No. 4

The basis for the implementation of the follow-up to the creation of the following cranial implant model matched to the skull bone with a defect (as a large hole) is the use of superficial interpolation spline curves connected in a net and placed on the surface of the "correct" side of a skull model. The haptic system ClayTools (Geomagic®Claytools®, 2013) gives the possibility to create them on the surface of "virtual clay". All modeling process is realized together with CATIA v5 system (Dassault Systèmes, 2013).

Realization of modeling process was divided into three main stages:

1. Obtainment of surface spline curves connected in a mesh and placed on the surface of the "correct" side of skull model,
2. Implementation of redundant implant model,
3. Final model fitting the implant.

Stage No. 1

In the first stage of this method we must obtain a net of surface splines placed on the surface of the "correct" side of skull model. For this purpose we use special tools of the haptic modeling system – ClayTools (Geomagic®Claytools®, 2013). The exact location of net curves on the skull model surface is not required. However, one is important: the area "covered" by net curves must be redundant in relation to the area of a hole in the skull (Figure 22).

Stage No. 2

The input object to implementation of the redundant model of the implant is a net of surface spline curves. Using software tools (available in Generative Shape Design module of CATIA v5 system), we create patch surface, stretched between the curves of the net (Figure 23a). The resulting surface patch should be replicated by a mirrored plane (in this case it is a sagittal plane, Figure 23b). The mirror copy of surface patch (Figure 23c) will be used to obtain a redundant implant model (the input surface patch must be deactivated).

Figure 22. Views of created spline net on the "correct" side of the skull model surface

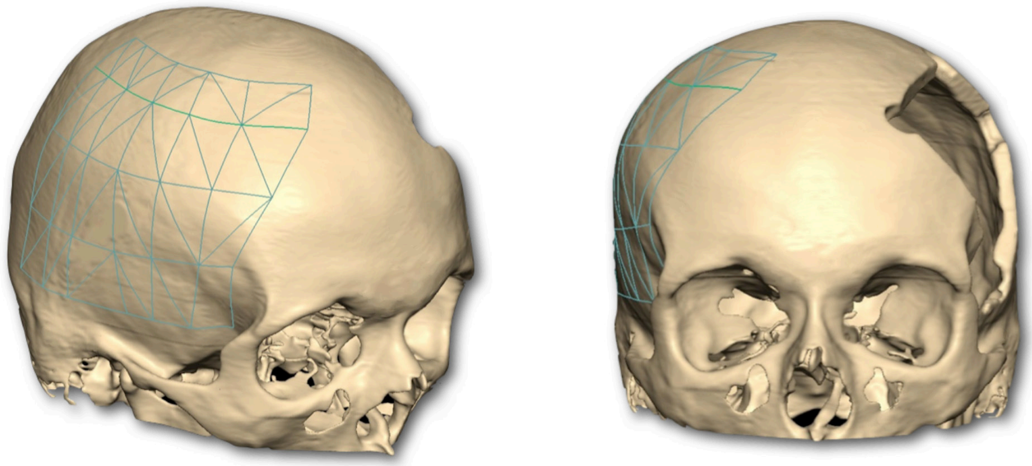
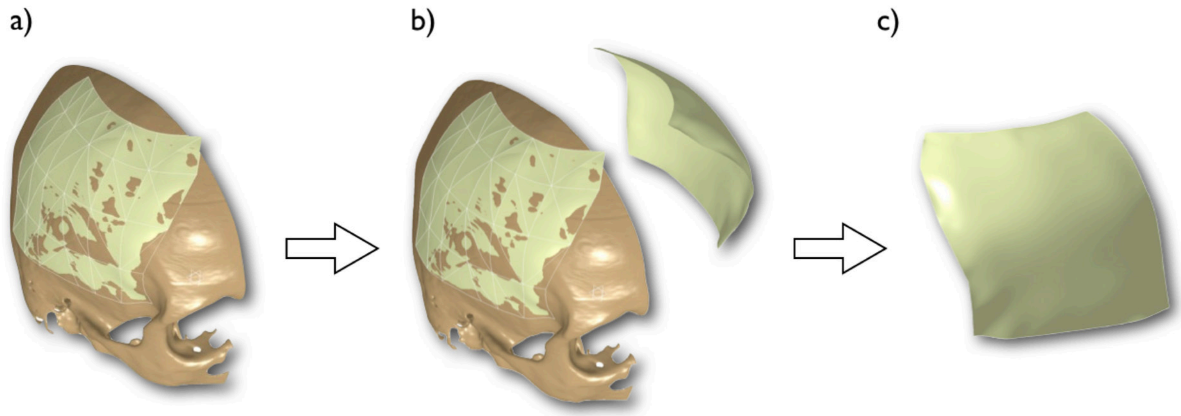


Figure 23. Views of subsequent stages of surface patch modeling process



Before the final stage, the surface model will be converted to the form of voxel with a uniform wall thickness (dependent on the thickness of the skull bone).

Stage No. 3

The last stage of the implementation of this method is the same as in the descriptions of the previous methods. Therefore, we use Boolean subtraction: from the redundant model of the implant (Figure 24a) the volume of the skull with loss (fig. 24b) has been subtracted. The result is a model of the implant (Figure 24c), which requires making only a minor correction of shape and position.

The last presented method is a universal and independent of the place of occurrence of the skull bone loss. Estimated duration of the implant modeling process is about 1.5-2 hours.

The obtained voxel model of the implant usually is a subject to re-converting to STL mesh format, useful for CNC lathe as well as for one of generative technologies.

Figure 24. The Boolean subtraction (Adapted from [Wyleżoł, 2013])

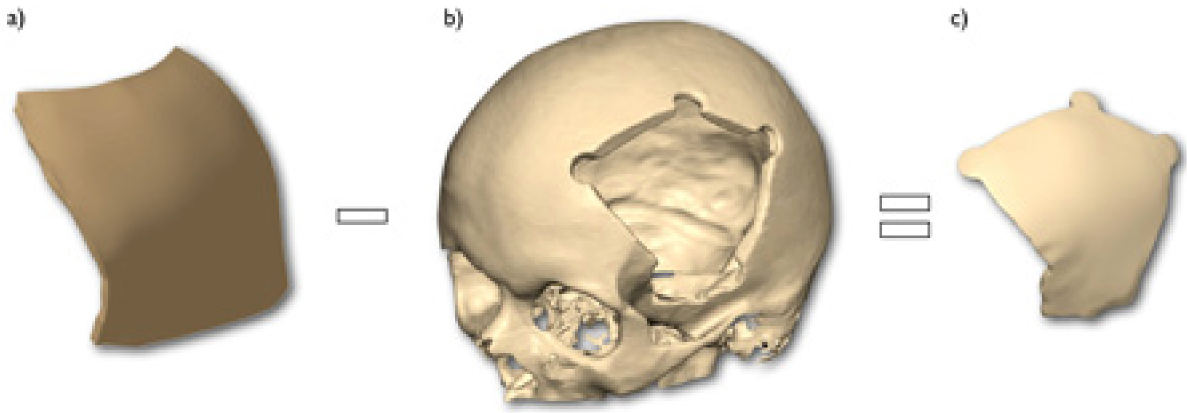
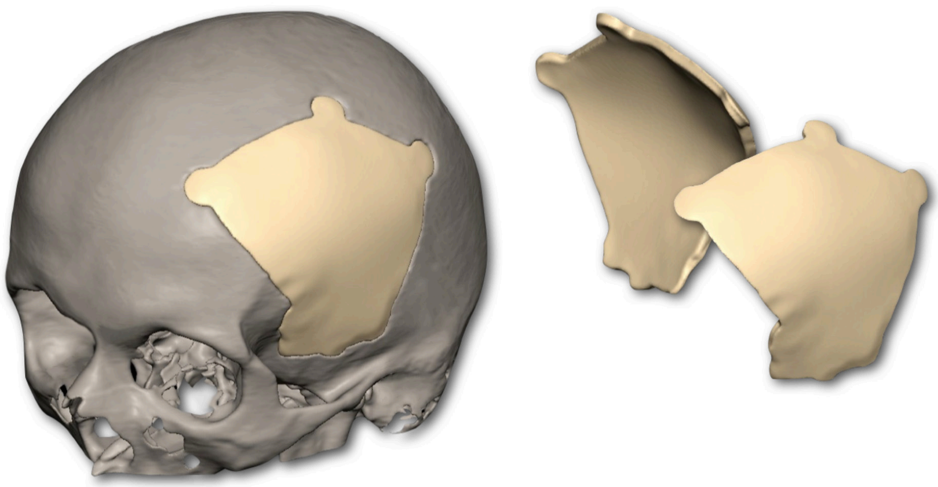


Figure 25. Views of good matched cranial implant model into the skull solid (and separate views of the implant model)



The final verification of the implant shape and its other properties should be performed by a neurosurgeon before producing and/or implanting.

FUTURE TRENDS

Nowadays, the author is co-operating with one Polish bioengineering company, which plans lead to production of the implants on the basis of such a process modeling. So far, only few material models were produced using generative technologies (which are the verification of the assumed modeling process), like those shown in Figure 1b. The author predicts that more and more often these implants (also the all skeletal system) will be performed with the use of generative technologies. The author also provides that in the near future, there will be significant growth in the production of implants matched for a particular patient. Today, in many countries, the legal conditions for the manufacture of such implants are still a problem.

CONCLUSION

Our main conclusions could be summed up in the following manner:

1. Described modeling methods of implants No. 1, No. 3 and No. 4 are universal, i.e. their use is independent from the place of a skull gap (hole).
2. The modeling method No. 2 is limited only to those cases where the gap of skull is only at one side of the skull (with respect to the sagittal plane).
3. Time of the implants modeling (excluding time of obtaining the STL skull model) is very short: about 1-2 hours.
4. Implementation of presented methods requires having three computer systems: system to DICOM images analysis and synthesis (as accessory of CT) and its transform to 3D STL file (not used by the author), surface modeling system (as a part of CX class system) and a haptic modeling system.
5. Performance of the shape of the implants – according to the author's opinion – it is impossible using only one classic 3D modeling system.
6. The combination of mentioned three modeling systems gives a synergy effect.
7. Thanks to the synergy, it is possible to make the models of complex shapes faster and simpler (particularly anatomical models, where there are no classic geometric objects).
8. Such made models of the implants are suitable for neurosurgery operations planned in the virtual world.
9. Using virtual models of implant and skull, it is possible to consult a virtual medical case with other doctors.
10. Such made models of the implants are also suitable for neurosurgery operations planning in the real world, using material models (e.g. as shown in Figure 1b).
11. Trial exercise neurosurgery intervention using material models significantly reduces the operation time of the target neurosurgery.
12. Neurosurgical intervention using implants exactly matched the hole in the skull bone are much reducing the time of its realization.
13. Using good matched implants to make the neurosurgery operations, it is possible to faster the recovery of the patient.
14. Using good matched implants to make the neurosurgery operations, shortens the time being of the patient under general anesthesia.
15. The elaboration deals with the geometrical shapes of cranial implants only; the problem of material selection to made implants is a separate subject (e.g. Chen, Liu, Li & Wang C.-T., 2006).
16. The author has not performed stress analysis of modeled implants.

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KEY TERMS AND DEFINITIONS

CAx Systems: Is generally abbreviation of all Computer Aided computer systems, the "x" replaced other designation (e.g. Design, Manufacturing, Engineering, etc.).

ClayTools: It is a haptic modeling system to use with the modeling arm (e.g. PHANTOM Omni).

Cranioplasty: Is a neurosurgical repair of a defect or deformity of a skull (e.g. by means of implants).

Haptic Modeling: It is a new tactile feedback technology, which takes advantage of the sense of touch by applying forces, vibrations or motions to the user by a special device, e.g. a modeling arm. In modeling process there are only forces used.

Voxel Model: It is a volumetric model built with voxels.

Voxel: A separate volume element, representing a value on a regular grid in 3D space. This is analogous to a 2D pixel element, which represents image data in a raster graphic. The name derived from the words: volumetric & pixel.

Chapter 9
Efficient Prefix Scan for the GPU-Based Implementation of Random Forest

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ABSTRACT

The random forest ensemble learning with the Graphics Processing Unit (GPU) version of prefix scan method is presented. The efficiency of the implementation of the random forest algorithm depends critically on the scan (prefix sum) algorithm. The prefix scan is used in the depth-first implementation of optimal split point computation. Described are different implementations of the prefix scan algorithms. The speeds of the algorithms depend on three factors: the algorithm itself, which could be improved, the programming skills, and the compiler. In parallel environments, things are even more complicated and depend on the programmer´s knowledge of the Central Processing Unit (CPU) or the GPU architecture. An efficient parallel scan algorithm that avoids bank conflicts is crucial for the prefix scan implementation. In our tests, multicore CPU and GPU implementation based on NVIDIA´s CUDA is compared.

INTRODUCTION

In the first chapter the evolution of implementations of random forest algorithms that can be executed on the graphics processing unit (GPU) are described. Random forests are ensemble learning methods for classification that constructs a set of decision trees at training process (Breiman, 2001). The output class is calculated from the classes output by individual trees. Advantages of training algorithms that can produce compact random forests composed of many, small trees rather than fewer, deep trees form a solid foundation for the GPU implementation. Pros and contras of depth-first and bread-first search are presented.

For better understanding of next chapters a short description of the GPU architecture is given. The GPU Architecture allows the possibility to program GPUs using a master-slave computing model (Knuth, 1974). PC´s central processing unit (CPU) works as the master and the GPU processors act as the slaves. The host invokes kernels (C

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functions) that run on slave processors. Kernels can be executed as threads.

In the third chapter theory and implementations of the prefix scan algorithm on the GPU is presented. The performances of prefix scan algorithms are measured by different criteria: computational complexity, memory usage, stability, recursion etc. (Cormen, Leiserson, Rivest, & Stein, 2001) and (Knuth, 1973). The speeds of the algorithms depend on three factors: the algorithm itself, which can be improved, the programming skills, and the compiler. In parallel environments things are even more complicated and depend on the programmer´s knowledge of the CPU or GPU unit (Govindaraju, Gray, Kumar, & Manocha, 2006). Particularly when the architecture of GPU changes, this happens almost every year, as programs are no longer optimal.

Follows the chapter about random forests ensemble learning with the GPU version of the prefix scan method. The efficiency of the implementation of the random forest algorithm depends critically on the scan (prefix sum) algorithm. The prefix scan is used in the depth-first implementation of optimal split point computation. Described are different implementations of the prefix scan algorithms. Follows some performance tests for multicore CPU and GPU implementations based on NVIDIA´s CUDA platform on the medium size data set MNIST and the large Poker hand dataset. The experiments were performed on the PC with Intel I7 920, 2.66GHz CPU, and NVIDIA GTX TITAN GPU.

In the next chapter some future direction of development of the proposed algorithm for the multi GPU environment is discussed when the new NVLink, a high-speed interconnect will be available.

In the last chapter a short summary of theory and benchmark results are presented. Follows some additional explanation of achieved results. Given are some advices of the proper use of the GPUs version of the algorithms.

RELATED WORK

Random forest classification is a machine learning technique that generates classification of an input sample by the majority classification by the ensemble of decision trees named as "forest". One of the earliest paper on this subject was written by Sharp where a method for implementing the evaluation and training of decision trees and forests entirely on a GPU, and it was shown how this method can be used in the context of object recognition in the computer vision (Sharp, 2008). Traditional random forest classifiers can be highly effective, but classification using a random forest is memory bound and not typically suitable for acceleration using field-programmable gate array FPGAs or GP-GPUs due to the need to traverse large, possibly irregular decision trees. At Lawrence Livermore National Laboratory researchers had developed several variants of random forest classifiers, including the Compact Random Forest (CRF), that can generate decision trees more suitable for acceleration than traditional decision trees (Van Essen, Macaraeg, Gokhale, & Prenger, 2012). They made a comparison of the effectiveness of FPGAs, GP-GPUs, and multi-core CPUs for accelerating classification, using models generated by compact random forest machine learning classifiers. Taking advantage of training algorithms that can produce compact random forests composed of many, small trees rather than fewer, deep trees. But the depth-first algorithm is efficient during the early stages of tree construction, when large numbers of examples are being processed. As trees become deeper, however, the overhead of invoking GPU kernels to evaluate small numbers of samples becomes dominant (Yisheng & Rubinsteyn, 2013). Breadth-first construction is less efficient at the top of a tree and decreases the kernel launch overhead significantly by processing many sites on a tree at the same time. The strengths of both strategies are combined into a hybrid tree construction algorithm. This strategy starts tree construction using the depth-first algorithm. At the end of growing smaller sub-trees it switches to the breadth-first algorithm.

Splitter selection for a single node of the decision tree can be implemented as depth first build tree where each CUDA tread block performs computation on a subset of the samples for a single feature. A label count histogram is performed with GPU implementation of parallel prefix scan. Different software implementations of the prefix scan algorithm and implementations exists, depending on the architecture, which can be multicore, or GPU. Implementation on the GPU is the fastest but unfortunately the most demanding one from theoretical point of view because of the GPU architecture complexity.

THE DIFFERENCES BETWEEN THE CPU AND THE GPU ARHITECTURES

The Compute Unified Device Architecture (CUDA) and Open Multi-Processing (OpenMP) development environments were use in this paper. OpenMP is an application-programming interface (API) that supports a multi-platform shared memory multiprocessing programming in C, C++, and Fortran, on various processor architectures. It consists of a set of compiler directives, library routines, and environment variables that enable the executions of programs in parallel with all available CPU cores (Jin et al., 2011). CUDA is a parallel computing platform and programming model created by NVIDIA and implemented on graphics' processing units (GPUs). CUDA gives developers access to the virtual instruction sets and memories of the parallel computational elements in CUDA GPUs. This approach of solving general-purpose problems on GPUs is known as general purpose graphics processing unit (GPGPU) (NVIDIA Corporation, 2013; NVIDIA, 2012a, 2012b). For better understanding of next chapters a short description of the GPU architecture is given. The GPU Architecture allows the possibility to program GPUs using a master-slave computing model (Knuth, 1974). PC CPU works as the master and the GPU processors act as the slaves. The host invokes kernels (C functions) that run on slave processors. Kernels can be executed as threads. The host groups the threads into blocks. The block size is specified at the time of invoking the kernel. The GPU schedules threads, so that the block runs on a core of the Streaming Multiprocessors (SM). SM executes the threads of single blocks until completion. Each SM schedules a block's threads into groups of 32 (called warps). They further split into groups of 16 threads (half-warp). In order to execute the next instruction, SM selects a warp that is ready (not waiting for a memory transaction). SM then executes the next instruction for all threads of the warp, in parallel. Proper management of the number of parallel vs. serial executions is necessary to avoid thread divergence.

The GPU hardware consists of a number of key blocks: Memory (global, constant, shared) Streaming multiprocessors (SMs) Streaming processors (SPs). The GPU is really an array of SMs, each of which has N cores (8 in G80 and GT200, 32–48 in Fermi, 8 plus in Kepler and allows scaling of the processor (Lai & Seznec, 2013). A GPU device consists of one or more SMs (Cormen et al., 2001). Add more SMs to the device and the GPU is able to process more tasks at the same time, or the same task quicker, having enough parallelism in the task. There are number of key components making up each SM. The most significant part is that there are multiple SPs in each SM. Fermi architecture has from 32 to 48 SPs and in Kepler architecture has 64 SPs (Lai & Seznec, 2013).

Each SM has access to something called a register file, which is much like a chunk of memory that runs at the same speed as the SP units, so there is effectively zero wait time on this memory. It is used for storing the registers in use within the threads running on an SP. There is also a shared memory block accessible only to the individual SM; this can be used as a program-managed cache.

Each SM has a separate bus into the texture memory, constant memory, and global memory spaces. Texture memory is a special view onto the global memory, which is useful for data where there is interpolation, for example, with 2D or 3D lookup tables. It has a special feature of hardware-based interpolation. Constant memory is used for read-only data and is cached on all hardware revisions. Like texture memory, constant memory is simply a view into the main global memory.

Global memory is supplied via GDDR (Graphic Double Data Rate) on the graphics card. This is a high-performance version of DDR (Double Data Rate) memory. Memory bus width can be up to 384 bits wide, giving a bandwidth of 5 to 10 times more than found on CPUs, up to 288 GB/s with the Kepler hardware.

Each SM also has two or more special-purpose units (SPUs), which perform special hardware instructions, such as the high-speed 24-bit sin/cosine/exponent operations. Double-precision units are also present on FERMI and Kepler hardware.

PREFIX SCAN

The efficiency of the implementation of RF algorithm depends critically on the scan (prefix sum) algorithm. In this paper it will be defined and illustrated the operation, and discuss in detail its efficient implementation on NVIDIA CUDA. As mentioned in (Sengupta, Harris, Zhang, & Owens, 2007), all-prefix-sums are a good example of a computation that seems inherently sequential, but for which there is an efficient parallel algorithm. In general, all-prefix-sums can be used to convert some sequential computations into equivalent, but parallel.

Inclusive and Exclusive Scan

All-prefix-sums on an array of data are commonly known as an exclusive scan (or prescan). An exclusive scan can be generated from an inclusive scan by shifting the resulting array right by one element and inserting the identity. Likewise, an inclusive scan can be generated from an exclusive scan by shifting the resulting array left, and inserting at the end the sum of the last element of the scan and the last element of the input array.

Sequential Scan

Implementing a sequential version of scan (that could be run in a single thread on a CPU, for example) is trivial. The loops roll over all the elements in the input array and add the value of the previous element of the input array to the sum computed for the previous element of the output array, and write the sum to the current element of the output array. This procedure performs exactly n adds for an array of length n; this is the minimum number of adds required to produce the scanned array. When developing the parallel version of scan, it has to be work-efficient. This means do no more addition operations (or work) than the sequential version. In other words the two implementations should have the same work complexity, O(n).

A sequential scan performs O(n) adds. Therefore, this naïve implementation is not work-efficient. The factor of $\log_2 n$ can have a large effect on performance. In the case of a scan of 1 million elements, the performance difference between this naïve implementation and a theoretical work-efficient parallel implementation would be almost a factor of 20.

Algorithm assumes that there are as many processors as data elements. On a GPU running CUDA, this is not usually the case. Instead, the *forall* is automatically divided into small parallel batches (called warps) that are executed sequentially on a multiprocessor. Because not all threads run simultaneously for arrays larger than the warp size, the algorithm above will not work because it performs the scan in place on the array. The results of one warp will be overwritten by threads in the another warp. To solve this problem, it is necessary to double-buffer the scanned array with usage of two temporary arrays to do this. Note that this procedure will run on only a single thread block of the GPU, and so the size of the arrays it can process is limited. Extension of scan to large arrays is discussed later.

A Work-Efficient Parallel Scan

To develop a work-efficient scan algorithm that avoids the extra factor of log n work performed by the naïve algorithm of the previous section an algorithmic pattern that arises often in parallel computing: balanced trees is used. The idea is to build a balanced binary tree on the input data and sweep it to and from the root to compute the prefix sum. A binary tree with n leaves has log n levels, and each level $d \in [0,n)$ has 2d nodes. If one add per node is performed, then O(n) adds are performed on a single traversal of the tree.

In this work-efficient scan algorithm, the operations are performed in place on an array in shared memory. The algorithm consists of two phases: the reduce phase (also known as the up-sweep phase) and the down-sweep phase. In the reduce phase the tree is traversed from leaves to root computing partial sums at internal nodes of the tree. This is also known as a parallel reduction, because after this phase, the root node (the last node in the array) holds the sum of all nodes in the array.

In the down-sweep phase, the tree is traversed back up from the root, using the partial sums to build the scan in place on the array using the partial sums computed by the reduce phase. Note that because this is an exclusive scan (i.e. the total sum is not included in the results), between the phases the last element of the array is zeroed. This zero propagates back to the head of the array during the down-sweep phase. Like the naïve scan code in the previous section, the code will run on only a single thread block.

This scan algorithm performs O(n) operations (it performs 2*(n-1) adds and n-1 swaps); therefore it is work efficient and for large arrays, should perform much better than the naïve algorithm from the previous section. Algorithmic efficiency is not enough; also the hardware efficiently must be achieved. After examination the operation of this scan on a GPU running CUDA, it was found that it suffers from many shared memory bank conflicts. This hurt the performance of every access to shared memory, and significantly affect overall performance. Some simple modification can be done to the memory address computations to recover much of that lost performance. The scan algorithm performs approximately as much work as an optimal sequential algorithm. Despite this work efficiency, it is not yet efficient on NVIDIA GPU hardware due to its memory access patterns. As described in the NVIDIA CUDA Programming Guide (NVIDIA, 2012b), the shared memory exploited by this scan algorithm is made up of multiple banks. When multiple threads in the same warp access the same bank, a bank conflict occurs, unless all threads of the warp access an address within the same 32-bit word. The number of threads that access a single bank is called the degree of the bank conflict. Bank conflicts cause serialization of the multiple accesses to the memory bank, so that a shared memory access with a degree-n bank conflict requires n times as many cycles to process as an access with no conflict. Binary tree algorithms such as our work-efficient scan double the stride between memory accesses at each level of the tree, simultaneously doubling the number of threads that access the same bank. For deep trees, as algorithm approaches the middle levels of the tree the degree of the bank conflicts increases, and then decreases again near the root where the number of active threads decreases. For example if scanning a 512-element array, the shared memory reads and writes in the inner loops experiencing up to 16-way bank conflicts. This has a significant effect on performance. Bank conflicts are avoidable in most CUDA computations if care is taken when accessing shared memory arrays. In convolution, for example, this is just a matter of padding the 2D array to a width that is not evenly divisible by the number of shared memory banks. Scan, due to its balanced-tree approach, requires a slightly more complicated approach. Most bank conflicts can be avoided by adding a variable amount of padding to each shared memory array index that is computed. Specifically, to the index the value of the index divided by the number of shared memory banks is added. The algorithms given above scan an array inside a single thread block. This is fine for small arrays, up to twice the maximum number of threads in a block (since each thread loads and processes two elements). Also, the array size must be a power of two. The algorithm can be extended to scan large arrays of arbitrary (non-power-of-two) dimensions (Blelloch, 1990), (Blelloch, 1989).

Performances of Scan Algorithm

Reduce and scan are core primitives of parallel computing. This implementation supports user-defined binary operations and defines an interface for handling different input, intermediate, and result types. Each GPU core had multiple scalar processors that executed the same instructions in parallel. The K20 had 16 scalar processors per SM, and hence a 16 wide SIMD. However, the logical SIMD width of the architecture is 32. Each GPU instruction works on 32 data elements (called thread warps), which are executed over 2 cycles. This meant for the radix sort that the scalar buffer version performed badly. Consequently, the best version was the split-based local sort that could use SIMD (Satish, Kim, Chhugani, & Nguyen, 2011). During the radix sort implementation on the GPU, optimized gather/scatter operations were implemented (He, Govindaraju, Luo, & Smith, 2007), the global prefix sum (Blelloch, 1990), (Harris, Sengupta, & Owens, 2007) and the warp scans (Chatterjee, Blelloch, & Zagha, 1990), (Blelloch, 1989), (Dotsenko, Govindaraju, Sloan, Boyd, & Manferdelli, 2008), (Sengupta et al., 2007).

RANDOM FOREST TUNED FOR THE GPU IMPLEMENTATION

Random forests are an ensemble learning method for classification (and regression) that operate by constructing a multitude of decision trees at training time and outputting the class that is the mode of the classes output by individual trees. The algorithm for inducing a random forest was developed by Leo Breiman and Adele Cutler (Cutler, & Stevens, 2012). Thus, in ensemble terms, the trees are weak learners and the random forest is a strong learner (Davies & Ghahramani, 2014).

- **Algorithm:** Sample n cases at random with replacement to create a subset of the data. The subset should be about 66% of the total set.
- **At Each Node:** For some number *m* (see below), *m* predictor variables are selected at random from all the predictor variables.

The predictor variable that provides the best split, according to some objective function, is used to do a binary split on that node.

At the next node, choose another *m* variables at random from all predictor variables and do the same.

Depending upon the value of *m*, there are three slightly different systems:

- **Random Splitter Selection:** $m = 1$
- **Breiman's Bagger:** m = total number of predictor variables

- **Random Forest:** m << number of predictor variables. Brieman suggests three possible values for m: ½$\sqrt{m}$, $\sqrt{m}$, and $2\sqrt{m}$

The structure of random forest is ideal for parallel implementation in environments such as openMP openACC, CUDA and openCL. Each forest can be computed in parallel on its own core of the CPU or GPU or hybrid (Van Essen et al., 2012). Weighted average is finally computed on the master.

Splitter selection for a single node of the decision tree can be implemented as depthfirst build tree where each CUDA tread block performs computation on a subset of the samples for a single feature. A label count histogram is performed with GPU implementation of parallel prefix scan described in previous chapter. Gini impurity and reduction is calculated in parallel to find the best pair with the lowest impurity.

Another possibility for selecting splitter is breadthfirst approach as a primary start for parallel version. Thus instead of having parent nodes in recursion and waiting for children nodes to be built, children nodes add themselves to parent nodes and fork their own children without waiting for them. So each thread block performs the optimal split for a single tree node at the current level.

Optimal performances can be achieved by hybridization of depth-first to bread-first implementation (Yisheng & Rubinsteyn, 2013).

Benchmarks

Benchmarks were performed on the medium size data set MNIST (Deng, 2012) and large Poker hand dataset (Rubin & Watson, 2011).

The *MNIST database* (Mixed National Institute of Standards and Technology database) is a large database of handwritten digits that is commonly used for training various image processing systems. Digits are scanned in 28x28 pixel black and white format.

For the *Poker hand* dataset each record is an example of a hand consisting of five playing cards drawn from a standard deck of 52. Each card is described using two attributes (suit and rank), for a total of 10 predictive attributes. There is one Class attribute that describes the "Poker Hand". The order of cards is important, which is why there are 480 possible Royal Flush hands as compared to 4 (one for each suit).

Table 1 shows the number of samples n (# of data), the dimensionality of the problem (# of features) and the number of classes a sample can belong to (# of classes)

The experiments were performed on the PC with Intel I7 920, 2.66GHz CPU, and NVIDIA GTX TITAN GPU. Tests accuracy achieved was 0.98 for the MNIST data set and 0.73 for the Poker data set.

On the first glance results were somehow confusing because of small differences between CPU and GPU times for the MNIST tests. The size of the MNIST matrix data set is 52 millions and for the Poker data set "only" 10 millions. That is the reason that the Poker hand example scales much better on the GPU, because less CPU-GPU-CPU transfer of data is necessary.

FUTURE RESEARCH DIRECTIONS

Described breadthfirst approach enables execution of the classifier in a pipelined or single-instruction multiple thread (SIMT) fashion. GPUs offer a more flexible solution with reasonably high performance that scales with forest size. Finally, multi-threading via Open MP on a shared memory system is the simplest solution and provided near linear performance that scaled with core count and is still significantly faster than the GPU version for a small data set. Further research will go into direction of hybridization of CPUs and GPUs. But here the CPU-GPU-CPU and GPU to GPU data transfer becomes critical to achieve good

Table 1. Properties of data sets

Data Set	# of Classes	# of Data	# of Features
MNIST	10	70,000	784
Poker hand	10	1,025,010	10

Table 2. Benchmark results (time in seconds)

Dataset	CPU (4 cores)	GTX TITAN
MNIST	41.52	33.44
Poker	88.33	19.22

performances. Today's GPUs are connected to x86-based CPUs through the PCI Express (PCIe) interface, which limits the GPU's ability to access the CPU memory system and is four to five times slower than typical CPU memory systems. When the NVLink a high-speed interconnect, will be available in the future GPUs, enabling GPUs and CPUs to share data five to 12 times faster than they can today. As the NVLink interface will match the bandwidth of typical CPU memory systems, it will enable GPUs to access CPU memory at its full bandwidth. This high-bandwidth interconnect will dramatically improve accelerated software application performance. Because of memory system differences GPUs have fast but small memories, and CPUs have large but slow memories. Accelerated computing applications typically move data from the network or disk storage to CPU memory, and then copy the data to GPU memory before it can be crunched by the GPU. With NVLink, the data moves between the CPU memory and GPU memory at much faster speeds, making GPU-accelerated applications run much faster. When the NVLink a high-speed interconnect, will be available in the future GPUs then a multi GPUs implementation of prefix scan and random forest would scale linearly with the number of GPUs in the same manner as openMP multicore CPU version implementation can do it now.

CONCLUSION

In general the random forest is used for classification that operate by constructing a multitude of decision trees at training time and outputting the class that is the mode of the classes output by individual trees. The algorithm for inducing a random forest was developed by Leo Breiman and Adele Cutler. The random forests ensemble learning with the GPU version of prefix scan method is presented in the paper. Described are different implementations of the prefix scan algorithm and implementations. The efficiency of the implementation of the random forest algorithm depends critically on the scan (prefix sum) algorithm. In tests multicore CPU and GPU implementation based on NVIDIA´s CUDA is compared. Benchmarks were performed on the medium size data set MNIST and the large Poker hand dataset. In the experiments were performed on the PC with Intel I7 920, 2.66GHz CPU, and NVIDIA GTX TITAN GPU. On the first glance results were somehow confusing because of small differences between CPU and GPU times for the MNIST tests. The size of MNIST matrix data set is 52 millions and for the Poker data set "only" 10 millions. That is the reason that the Poker hand example scales much better on the GPU, because less CPU-GPU-CPU transfer of data is necessary. When the NVLink a high-speed interconnect, will be available in the future GPUs then a multi GPUs implementation of prefix scan and random forest would scale linearly with the number of GPUs in the same manner as openMP multicore CPU version implementation can do it now. This high-bandwidth interconnect will dramatically improve accelerated software application performance. Because of memory system differences GPUs have fast but small memories, and CPUs have large but slow memories. Accelerated computing applications typically move data from the network or disk storage to CPU memory, and then copy the data to GPU memory before it can be crunched by the GPU.

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KEY TERMS AND DEFINITIONS

CAYMAN: The GPU architecture provided by AMD.

FERMI: The GPU architecture provided by NVIDIA.

FPGA: Field-programmable gate arrays

GPU: Graphical processing unit, suitable for the intensive computation. Mostly build by AMd and NVIDIA.

HAWAII: The latest GPU architecture provided by AMD

KEPLER: The GPU architecture provided by NVIDIA.

OpenACC: Is a programming standard for parallel computing It is designed to simplify parallel programming of heterogeneous CPU/GPU systems.

OpenCL: Is a framework for developing programs that execute across heterogeneous platforms consisting of CPUs, GPUs and FPGAs.

OpenMP: Is an application programming interface that supports shared memory multiprocessing programming in C++ and similar languages.

Chapter 10
The Future of Supercomputers and High-Performance Computing

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ABSTRACT

A state-of-the-art and a possible future of High Performance Computing (HPC) are discussed. The steady advances in hardware have resulted in increasingly more powerful computers. Some HPC applications that were years ago only in the domain of supercomputers can nowadays be executed on desktop and mobile computers. Furthermore, the future of computers is in the "Internet-of-things" and cyber-physical systems. There, computers are embedded into the devices such as cars, house appliances, production lines, into our clothing, etc. They are interconnected with each other and they may cooperate. Based on that, a new kind of application emerges, which requires the HPC architectures and development techniques. The primary focus of the chapter is on different hardware architectures for HPC and some particularities of HPC programming. Some alternatives to traditional computational models are given. At the end, some replacements for semiconductor technologies of modern computers are debated.

INTRODUCTION

High-performance computing (HPC) is the use of computers and parallel processing techniques for solving complex computational problems. HPC is used in a wide variety of fields, from engineering (e.g. in the automotive industry for complex crash simulations), bioinformatics (e.g. for protein folding), ecology (e.g. complex Earth systems modeling), etc. Another important application for HPC today is co-called Big Data. The Big Data, in general, refers to the problems where enormous amount of data must be processed and analyzed in a short time.

The high-end HPC is performed on super computers. Those are computers build as a cluster of thousand or even millions of processing elements. They are specially designed to solve specific problems, where usually the same basic computation is repeated on million pieces of data. There, a speedup is achieved by executing the same instructions on multiple data at the same time.

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Table 1. Top 10 supercomputers, as of June 2014 (from Top 500, 2014)

Name	Manufacturer Country	Processor Accelerator	Total CoresAccel. Cores	R_{max} (Pflops)	Power(MW)
Tianhe-2 (MilkyWay-2)	NUDT China	Intel Xeon E5-2692v2 Intel Xeon Phi 31S1P	3,120,000 2,736,000	33.86	18
Titan	Cray Inc. United States	Opteron 6274 NVIDIA K20x	560,640 261,632	17.59	8
Sequoia	IBM United States	Power BQC None	1,572,864 0	17.17	8
K computer	Fujitsu Japan	SPARC64 VIIIfx None	705,024 0	10.51	13
Mira	IBM United States	Power BQC None	786,432 0	8.58	4
Piz Daint	Cray Inc. Switzerland	Xeon E5-2670 NVIDIA K20x	115,984 73,808	6.27	2
Stampede	Dell United States	Xeon E5-2680 Intel Xeon Phi SE10P	462,462 366,366	5.17	5
JUQUEEN	IBM Germany	Power BQC None	458,752 0	5.01	2
Vulcan	IBM United States	Power BQC None	393,216 0	4.29	2
-	Cray Inc. United States	Intel Xeon E5-2697v2 None	225,984 0	3.14	-

This approach is referred to as single instruction multiple data (SIMD), in contrast to the single instruction single data (SISD) approach used by general-purpose central processing units (CPUs). The supercomputers are enormous, expensive and have a huge power consumption. Therefore, only the biggest corporations can afford them. There is an official web site called Top500.org (Top500, 2014), where a list of five hundred top-ranked supercomputers is maintained. The list is updated every six months. In Table 1, the top 10 computers from this list are presented. The R_{max} factor represents the speed of the supercomputers. This is the highest score measured using the LINPACK benchmark suite and it is expressed in Pflops (number of 10^{15} floating-point instructions executed per seconds). In the column beside is the power consumption expressed in mega watts.

Although the results are impressive, the future of HPC is most probably not in supercomputers. Since the first silicon chips the evolution of computer hardware was evolving on our desktops and in our pockets. According to Moore's Law, the performance of computers is steadily increasing. Every 18 months or so, the size of silicon for the same number of computer components is halved, or equally, we can put twice as much components on the silicon with the same size. The evolution of shrinking silicon is still going on and will do so for at least a decade until we reach the physical barrier. So, if we are capable of utilizing a lot more components on the same silicon die, what can we do with them? The answer is parallel computer architectures. Since 2003, multi-core solutions became available and affordable for everyone. Nowadays the technology allows for up to sixteen general-purpose CPUs or cores to be used in desktop computers and four core processors are usual for mobile devices. With them, we can do HPC which is comparable in performance of supercomputers from a decade ago. However, there are not only personal and mobile computers that can benefit from HPC. Today the vast majority of computers are embedded into some other "ordinary" devices such as cars, house appliances, production lines, etc. Those embedded computers are becoming interconnected in a so-called "internet-of-things". If we could connect all those computers and use them in cooperation with each other, they would be capable of solving even very complex problems.

Not all problems are suitable for solving with HPC. The strength and benefits of HPC relies on parallel processing. However, not all problems are parallelizable. They may be a part of the solution, which must be executed sequentially. The benefits of using multiple processors instead of only one can be expressed as a speedup. Speedup is a ratio between the amount of time needed to perform a specific task on a single processor and the time used to perform the same task on a P-processor system (Herlihy & Shavit, 2012).

$$S(P) = T/T(P) \tag{1}$$

Here P represents the number of processors and $T(x)$ is the total execution time to solve the problem with x processors. Ideally, we want to get the speedup of P (i.e., as much as there are processors available). However, in real problem situations there are always parts of the code that cannot be parallelized and must be executed sequentially. For general problems, the so-called Amdahl's law can be applied to assess this in numbers:

$$S(P) = 1/(\gamma + (1- \gamma)/P) \tag{2}$$

The term γ stands for the fraction of the code that cannot be parallelized. For big values of P, the equation simplifies to:

$$S(P) \approx 1/\gamma \tag{3}$$

This gives us the upper bound of the achievable speedup. For example, if only 10% of the code cannot be parallelized, then the speedup cannot be greater than 10, even if we have an unlimited number of processors. In other words, it is impossible to shorten the execution time of the program more than it is required for executing non-parallelizable part. However, this calculation can be somehow misleading in some cases. For example, if you take a faster processor, the overall execution time can still be shortened regardless of the code. In addition, the Amdahl's law is based on traditional computer architectures. As will be shown later in the paper, other computational paradigms can be used.

HARDWARE ARCHITECTURES FOR HPC

First Generation of Supercomputers - Customized Hardware Solution for SIMD

First supercomputers were based on special developed hardware architectures, which were capable of performing vector operations where the same instruction is executed in parallel on a large set of data (i.e. data vectors). This is in contrast to the traditional CPUs, which have been supporting only scalar operations. As an example, the first widely successful supercomputer was Cray-1, which was built in 1975. It was constructed from simple logical circuits (in all, it contained about 200,000 logical gates) and it was running with a clock cycle of 12.8 ns. (Kolodzey, 1981) Each vector can contain up to 64 elements. In comparison to other solutions at the time, the architecture of Cray-1 also introduced large register sets and it utilized pipelined execution of mathematical operations, which are the norm today.

Nowadays it is more convenient (and cheaper) to use of-the-shelf hardware components which can also be found in servers and high-end desktop computers. As an example, the newest models of Cray supercomputers are still at the top of the high-ranked supercomputers today. However, they are based on the contemporary Intel Xeon multi-core microprocessors with additional acceleration coprocessors. However, as it will be shown later, there are still some applications where customized hardware is beneficial.

Multi-Processor and Multi-Core Architectures

A microprocessor does not need to work alone. All supercomputer architectures have been based on multiprocessor methodology. The computational workload is divided between several thousand processors. Usually, several processors are put onto the same board, the boards are then put into racks and those are combined into even larger structures. In this so-called computer clusters or computer grids, each machine is largely independent and the processing elements are usually using a SISD execution model. Alternatively, the processing elements can be combined as a Massively Parallel Processor (MPP). In MPP architectures all processing elements execute the same instruction but on different data (as in SIMD computational model).

The problem is that all microprocessors must communicate with each other and they must exchange the data with the secondary data storages and the environment. Thus, it is imperative to implement a fast interconnection infrastructure with a large throughput. Most supercomputers on the Top500 list use the fast Ethernet or Infiniband interconnection. However, the top-ranked ones use customized solutions.

Multiprocessor architectures of today are utilized for other purposes. It is common that the companies and individuals transfer their hardware infrastructure into the Cloud, a large server centre. The customer does not own the hardware and only pays for its usage. The hardware architecture of a Cloud is similar to computer cluster architecture for supercomputers. However, the main intention of the Cloud and its services is not to solve complex problems in short time, but to concurrently service as many users as possible. To achieve this, the processor virtualization is usually used. In this procedure, a single physical processing core is virtually expanded to two or more cores and may execute programs from different users concurrently. Virtualization is usually not beneficial for HPC. Nevertheless, the customers, who want to execute HPC applications in the Cloud, may obtain and lease dedicated processing clusters.

As the sizes of digital components shrink, it has become possible to fit more and more components on a single die of silicon. What can we do with all those components? To some extend the extra silicon was used for more complex architectures. In the last ten years, there was a transition from 32-bit to 64-bit architectures. However, the main reason for this had not been the larger data size but a larger address space for data. Going beyond 64 bits in the near future is not feasible. Another utilization of extra hardware was the implementation of large caches inside the processor chip, which speeded up the overall performance by reducing the memory latency. However, there are practical limits and further increases of cache memory would not be beneficial anymore. The next obvious step was to put several processing cores on the same silicon die. Nowadays it is usual to have four and up-to sixteen processing cores inside a chip. The processing cores are near to each other and can communicate very fast. However, this architecture also introduces some problems. The first one is the problem with cache consistency. When one of the processing cores change, the data in the memory must also update the status of the local caches in other cores if the same data is used there. The second problem is the common data bus. All cores in multi-core processors communicate with the environment through a single bus that can represent a bottleneck. Memory access instruction from different cores must be serialized. This can be mitigated to some extent with wider data buses or multiple memory banks with independent memory access units. However, due to the number of physical connections, there is a practical limit of three or four such units. As the number of cores on a single chip is increasing, these problems will become more severe. Some solutions to those difficulties are portrayed in next section.

Coprocessors and Accelerators

The execution time of applications and data processing can be further sped-up with the use of coprocessors. A coprocessor is a computer processor used to enhance the functions of the primary CPU. A typical example for that are mathematical coprocessors. Traditionally, the main CPU was only capable to perform integer arithmetic operations. Floating-point arithmetic was implemented with software routines, which were very slow. With a coprocessor, floating-point calculations could be carried out much faster. Later, the mathematical coprocessors were integrated within the main CPU arithmetic unit. Most mathematical coprocessors today are capable to perform some basic HPC operations, like some SIMD operations on vectors. However, the sizes of those vectors are usually limited to four elements.

The other kinds of coprocessors are Graphical Processing Units or GPUs. In parallel to CPU evolution, driven by demands of a mass consumer electronic market, programmable GPUs are becoming more and more powerful. For certain types of problems the GPUs largely outperform any CPU in both computational capabilities and memory bandwidth. From the very beginning, this was acknowledged within the HPC community. The processing power of GPUs can be used to solve non-graphical problems for HPC. This is known as General-Purpose Computing on GPUs or GP-GPU. GPUs are primarily designed to generate 2D and 3D images on the computer display. To do so, they must process millions of pixels in a very short time. The pixel processing is inherently parallel and a GPU is designed to do this processing by using hundreds or thousands of simple processing elements. Consequently, GPUs are especially well suited to address problems that can be expressed as data-parallel computations – the same algorithm is executed on many data elements in parallel. This is implemented somewhat similar to early vector machines. A single control unit orchestrates the execution of several execution units at the same time, all performing the same operation. Such approach is consequently not very effective in situations where a program must execute different algorithms on the same data in parallel. For this, multi-core and multiprocessor architectures are the better choices. Another problem with GPUs is the operation on a different memory than the CPU. Prior to the execution of a HPC application the data must be transferred to the GPU. Similarly, the result must be transferred back to the CPU's memory. However, the manufacturers of GPUs are aware of that and other similar problems, so they are working towards mitigating them. The next generation of GPUs will include full-featured ARM processing cores alongside the GPU processors. The general CPU cores will have access to the same memory as the GPU cores. This would greatly improve the execution of non-realizable parts of the code and reduce the need for a data transfer. Another feature which is expected to become available in 2015, are 3D RAM architectures where the DRAM memory chip will be stacked on top of another in the same housing as the GPU. It is expected that this will triple the memory bandwidth in comparison to contemporary solutions.

In 2013, Intel introduced the Xeon Phi coprocessor. It consists of up to 61 processing cores. However, this is not a traditional multi-core architecture with a common cache and data bus. The Xeon Phi provides no shared cache between the cores. Each core is independent and has its own local memory and cache. The cores are connected with each other through a fast internal communication bus in a ring topology. The Xeon Phi's CPU cores are based on first-generation Pentium technology and additional vector units with 32 512-bit registers, able to support processing of 16 single-precision floating-point numbers or 32-bit integers in parallel. Additionally, each core is virtually expanded four times. The Xeon Phi with 61 cores can run up to 244 threads at the same time.

The two top-most supercomputers on the Top500 list, as of June 2014, use the coprocessors for acceleration. The first one (Tianhe-2 or MilkyWay-2) uses Xeon Phi coprocessors. It has 3,120,000 cores, with 2,736,000 of them within coprocessors. The processing cores are organized as clusters. The second one (Cray's Titan) uses NVIDIA K20x GPU accelerators. It has 560,640 cores altogether from which 261,632 are inside the GPUs. It is organized as a MPP. The performance of the first one is almost twice as much compared to the second one. However, the first one has six times more processing cores as the later.

Supercomputers on our Desktops and in our Pockets

Nowadays, high performance computing is not limited to supercomputer centers. Because of advances in consumer electronics, mainly in the field of graphics processing units and in the architectures of gaming consoles, high performance calculations have become available to everyone. The capabilities of ordinary computing components have caught up and even surpassed the capabilities of former supercomputers. An upper-end graphics card can achieve double floating-point calculations at the speed of one TFLOP, for a price as little as 500 US dollars. The prices are falling and the performance is increasing.

More recently, the mainstream of computing device utilization is switching from desktop computers to mobile devices. The processing capabilities of some high-end mobile devices and tablets can supersede the capabilities of former desktop computers. Quad core processor solutions are typical today. Most mobile devices also include powerful GPU coprocessors. Until recently, those coprocessors were not accessible for HPC applications. In the beginning of 2014, the Tegra K1 multi-core solution was introduced (Tegra, 2014). It consists of 4 CPU cores and 196 general-purpose GPU cores. The GPU cores are the same as their desktop computer and supercomputers counterparts and can be programmed with the same tools.

What can be done with HPC on mobile devices? For contemporary mobile applications the processing power of desktop computers are probably enough. However, with the increased processing power, new applications will emerge. An example of this would be real-time translation of a conversation between two users speaking different languages. Another possibility would be image and video processing of pictures and videos taken on camera, etc. However, nowadays it is expected that mobile devices are connected to powerful computing centers all the time and some of the HPC processing can be performed there. This approach is used for example with Siri, the application on Apple's mobile devices. Siri is an intelligent personal assistant and knowledge navigator with voice control. The audio command is recorded by device and send to the server for processing. The answer is also digitized to speech, sends back to the device and played there. The software on the server also adapts to the user's individual preferences over time and personalizes the results. In our studies described in Verber, 2014, we studied different mobile applications that are assisted with services provided by the Cloud. Most of the services investigated were HPC related, like image and video processing, face recognition for authentication, etc.

HPC in Embedded Computer Systems

Only a small portion of processors sold worldwide today are used in supercomputers, desktop computers and mobile devices. The majority are embedded inside other devices, house appliances, cars, etc. Those solutions are usually utilizing simple processing capabilities and do not require powerful processors. Similarly, multi-core coprocessors and GPUs are usually too big and consume too much power to be used in general embedded applications. However, this could change in the future as the demand for such devices is steadily increasing.

Today we are at the beginning of a new evolution. In the so-called "internet-of-things", all devices, people and things will be equipped with some sort of processing elements. These components will be connected with each other and with large service facilities, the before mentioned Cloud. In this scenario, the processing capabilities will be distributed between different peers. It is expected that new applications and services in those devices will be more complex than they are today. For this, different HPC techniques could be applied.

This can be illustrated with the computers that are used in cars. In modern cars, there are dozen or even hundreds of Electronic control units (ECUs) which consist of simple processing elements. ECUs control the motor and other devices in the car. They are also responsible for air-conditioning, entertainment, etc. For all of this there is not much processing power required. On the other end, autonomous driving is the mainstream of research in the automotive industry today. The self-parking cars are already reality and it is expected in the future that some sort of automatic steering on the road in real-life situations will be implemented. For this, the control system of a car must process a vast number of input signals, make quick and reliable decisions and produce results in real-time. Another dimension of complexity would be introduced by vehicle-to-vehicle and by vehicle-to-infrastructure communication. The primary reasons for this are to further increase road traffic safety and efficiency by means of cooperative intelligent transport systems (Car2Car, 2014). To achieve all of this, a much more powerful processing power is required than it is used today. One of the obvious inputs is the video signal of the car environment. It requires highly sophisticated image processing algorithms that are capable of procession millions of pixels every 100 milliseconds or so. Obviously, without refined hardware architectures this is not achievable. For video processing and mass data evaluation, the GPUs are the most appropriate solution. For decision logic and control, the multi-core solutions would be the best. In 2014, the car manufacturer Audi demonstrated a prototype of a self-driving car controlled with the Tegra K1 processor (Nvidia, 2014, May 1).

Alternative Computational Architectures and Programmable Hardware

Another way to improve the computing capabilities is by utilizing special hardware architectures. With this, the hardware circuits are customized for a particular use or specific application. It is also possible to implement some parts of the program code entirely in hardware. On an industrial scale, an Application-Specific Integrated Circuit (ASIC) can be fabricated. However, once they are constructed, the ASIC chips cannot be changed. For experimentation and development, the programmable hardware devices are more appropriate. For HPC, among different programmable hardware solutions, Field-Programmable Gate Arrays (FPGA) are used almost exclusively. FPGAs contain programmable logic components called logic blocks, which can be preprogrammed to perform a simple digital operation or to serve as a memory element. The logic blocks can then be interconnected with each other to implement more complex functions. Modern FPGAs also contain some amount of dedicated memory blocks and some specialized function blocks (e.g. to implement fast multiplication). The main benefits of using FPGAs are the high speed and parallel execution of all parts. The main drawbacks are their limited memory capabilities and the fact that they can only operate effectively with logical, integer and fixed floating-point data types. Because of this, the FPGAs in HPC are most suitable for streaming processing where a continuous stream of data is processed in pipeline-like fashion. In summer 2014, a future version of a Xeon processor with a FPGA on the same processor socket was announced (Bryant, 2014, Jun 18). For embedded systems, the FPGAs were already used for a long time, not only to increase computing capabilities but also to simplify the construction of digital circuits. There are already several solutions with the ARM microprocessor and FPGA on the same chip, which are suitable for embedded control applications. Example of that is a family of devices Zynq-7000 (Zynq, 2014). Those are full-featured processing platform with dual core ARM processor, floating-point coprocessors, up-to 444K FPGA logic cells and more.

HPC APPLICATION DEVELOPMENT AND PROGRAMMING

The ever increasing complexities of modern computer hardware for HPC have made development of efficient applications increasingly more challenging. Computing paradigms, development methodologies and programming languages are mostly based on the premise of serial execution of the code (Mattson et al., 2012). Direct porting of applications developed for single processor architectures would perform very poorly on multiprocessor targets. To be efficient, the program code must utilize a deeper knowledge of the used computer architecture. The existing programming code must be rewritten into a form that is suitable for the execution on specific HPC architectures. This requires special skills and specific ways of thinking. To make things even worse, each family of parallel hardware architectures requires different optimization techniques. Moreover, the proficient understanding of specific hardware solutions may be obsolete with the next generation of the same hardware.

A typical example of a parallel optimization is program loops. Under favorable conditions, as is, for example, with the addition of two vectors, the body of the loop can be executed for each iteration in parallel. The programmer may put the data in some vector registers and execute SIMD additional instructions. However, if the number of elements in the vector exceeds the number of elements in the vector register, the operation must be split into sequential steps. In each step, another portion of data can be processed. In the case of multi-core architectures, the program code of the loop itself can be split into separate program segments, which then can be executed in parallel on different cores. In the case with coprocessors, the data must be first copied into the memory of the coprocessor and results must be copied back into the main memory of the CPU. In distributed multiprocessor solutions the data most be distributed properly between the cluster's nodes. Each node can process a portion of data. However, at the end the results must be gathered on a single node. Even more diverge programming is needed if we want to implement the given example with FPGA circuits. Currently, no single programming framework can support all of those scenarios. Nevertheless, a lot of effort today is put into the research on how to overcome those differences.

For the solutions with heterogeneous architectures with many CPUs and GPUs, an OpenACC programming model was developed by several major companies related with supercomputers and HPC (OpenACC, 2014). OpenACC is a programming standard for parallel computing in C/C++ and Fortran. The ordinary source code can be annotated with special directives (pragmas) which tell the compiler how to build the code that can be executed on several CPUs or GPUs. This can be demonstrated on the sample Fortran code segment used for matrix multiplication:

```
!$acc kernels
do k = 1,n1
   do i = 1,n3
      c(i,k) = 0.0
      do j = 1,n2
            c(i,k) = c(i,k) + a(i,j)
* b(j,k)
      enddo
   enddo
enddo
!$acc end kernels
```

All is needed is the "!$acc kernels" directive. The compiler automatically analyzes whole program structure and split portions of the application between the available CPU cores and accelerator devices. With non OpenACC compliant compilers, the code is still working correctly. Such compilers would simply ignore the directives.

At the time, the OpenACC project is still in an early phase of implementation. OpenACC will simplify the porting of existing application code to parallel architectures. However, low-level programming will still be needed to maximize the efficiency of specific hardware.

Another way to utilize the capabilities of parallel hardware architectures is by means of special programming libraries. In this approach, the main application code is executed on a single CPU. However, through modified library calls the compute intensive parts of the code can be executed on the GPU for example. The developer of the original code does not need to know the particularities of parallel programming. Based on the current hardware configuration, the development environment may determine which particular version of the library code should be used. For example, BLAS (Basic Linear Algebra Subprograms) is a well-known programming library for linear algebra. A special version of this library exists that is optimized for the execution on GPUs (cuBLAS, 2014). In most cases, the only difference in using cuBLAS instead of BLAS functions is in the prefix of function names. However, the programmer is still required to write an extra code to move the data between CPU and GPU.

Alternatively we may abandon the traditional computation models altogether. Other computational paradigms can be beneficial for some classes of problems. For example, machine-learning algorithms can be used to extract useful information from data under noisy conditions and without deep knowledge of the controlled systems. Most of the machine learning algorithms are inherently parallel and well suited for MPP architectures. A way to implement a specific machine-learning algorithm is well known and can be implemented effectively for the specific hardware platform in advance. In our research, we tested such a solution with the implementation of massive Artificial Neural Networks (ANN) on GPUs (Verber, 2014). In the experiments we try to mimic the visual processing in the retina of the human eye. A human eye has 130 millions of different photoreceptors. The data from those photoreceptors are preprocessed and send to the brain in parallel-like fashion especially suited for HPC. In the process the amount of data is reduced 100 times. With the usage of GPU, it was possible to mimic this processing in real time. Nevertheless, the processing was done in software. Instead, we can implement entire computational architectures in the hardware, either with programming of FPGA devices or with prefabricated hardware solutions. As a part of aforementioned studies we also try to implement the ANN with pure digital circuits by means of FPGA devices. For the FPGA solution, we were forced to use a linearization of higher mathematical functions and limited accuracy. The silicon consumption in this case is probably too high. On the other hand, there is a commercially available ASIC chip for ANN. It features 1024 neurons working in parallel by implementing two well-known non-linear classifiers (CM1K, 2014).

Another alternative computing paradigm used with HPC today is data-flow computing. In this computing model, only data-processing function blocks exist, which are connected into the computing mesh and processing data in a pipeline fashion. In HPC applications, this is usually implemented with FPGA or GPU coprocessors (Flynn et al., 2012). The code generation for specific function blocks and for proper interconnection between the blocks is straightforward. In our early research described in Verber et al, 2006, an implementation is presented of the disjunctive dataflow execution model for distributed control applications. The prototype was implemented in FPGA and automatic HDL code generation was considered.

BEYOND SILICON

The scientists today are working hard to sustain the expectations of the Moore's law by exploring new materials and new manufacturing processes. However, we cannot shrink the components beyond the size of a molecule or an atom. Beyond that, the further improvement in HPC would be probably accomplished only with the retirement of traditional Von Neumann computing model. Some of the mostly spoken about technologies, which can replace traditional computing model and which also have significant financial support are DNA computing, quantum computing and cognitive computing.

DNA computing is based on principles of molecular biology and chemistry inside the living cells. Deoxyribonucleic acid (DNA) is a molecule that encodes the genetic information of all known living organisms. DNA is a very dense and durable molecule. Parts of DNA serve as instructions for protein production. The production of a specific protein can be switched on and off by means of chemical processes. Therefore in a broader sense, DNA is already a programming code which is executing conditionally on different organelles in the cells. The speed of DNA computing is based on very long DNA molecules, where billions of operations can be performed at the same time. Moreover, we can have billions of DNA molecules in a drop of water.

DNA computing is in its infancy and its implications are only at the beginning to be explored. As of now, the DNA computer can only perform rudimentary functions and it has no practical applications. The encoding of programs and extracting the results can take several hours or more. In addition, it is very doubtful that DNA computing will be useful for general computing even in the long run. It is hard to imagine how to connect the DNA molecule to its physical environment. Nevertheless, it can be used as a sort of chemical processing unit which may be beneficial for some problems, especially in pharmaceutical and biomedical applications.

The same laws of physics that will someday stop the shrinking of hardware components also provide us with an alternative way of solving some classes of problems. On a lower scale, at the size of atoms and elemental particles, the traditional Newtonian mechanic does not work anymore. Here the so called quantum mechanics become involved. Unlike classical computing that represents information as bits of either a zero or the number one, quantum computers uses quantum bits (called qubits) that can exist as both a zero and one at the same time. When an operation is performed on a qubit, it calculates the results for both states at the same time. Moreover, if we combine N qubits, 2^N different states can be processed as the same time. That means quantum computing holds the promise of tackling problems with exponential complexity that would take classical computers a very long time to solve.

However the practical implementation of quantum computing is still years away. Most quantum computing labs have only built devices consisting of a few qubits. One of the main problems is how to write, read and process the quantum states correctly. Due to the laws of quantum physics, this is very error-prone and some sort of error-correction techniques must be applied.

The ultimate parallel computers are the human brains. Recently a lot of financing and research is put into the understanding the working of human brains. In Europe, the Human Brain Project (HBP) has united hundreds of scientists from more than 20 countries (HBP, 2014). The vision of HBP states: "Understanding the human brain is one of the greatest challenges facing 21st century science. If we can rise to it, we can gain profound insights into what makes us human, build revolutionary computing technologies and develop new treatments for brain disorders. Today, for the first time, modern ICT has brought these goals within reach." Although some research areas are more related to biological matter of the human brain and the medicine, the important part of HBP is focused on HPC issues. One of the goals of HBP is to develop new types of supercomputers with faster computing speeds at a lower cost and with less energy needs. Technologies being explored include nano-based computing, quantum computing and intelligent computing (Hickey, 2014).

CONCLUSION

The future of HPC is probably not in the advancement of supercomputers. Currently, the situation in this field is stagnating. The list of top-most supercomputers has remained the same for the last two years. The main reason for this is probably the state of the global economy. The costs of supercomputers are enormous. On the other hand the advancements in hardware allow for implementations of more and more HPC problems with ordinary computers. Furthermore, it was become feasible to introduce the multiprocessing architectures and complex computations into mobile devices and embedded control applications. Nowadays the primary focus of HPC is shifted from the raw computing power to other issues, like power consumption and heat dissipation, simpler program development, new applications, etc.

Lower power consumption and reduced heating is achieved with the reduction of the clock frequencies. The obvious consequence of this is the reduction in computational speed. However, this is compensated with a much larger number of processing cores. To simplify development of applications that are capable to run effectively on parallel architectures we need to improve the code generation of compilers. The OpenACC approach seems to be very promising. It will probably replace some other contemporary development frameworks. Utilization of alternative computational paradigms is feasible even today. However, the applications of these solutions are limited to specific problems.

The hardware evolution and Moore's law are not slowing. It will take at least another decade or so before the shrinking of computer components will be abandoned because of the laws of physics. Moreover, the contemporary digital chips are built in two dimensions; we are just beginning to employ the third one. In the future, we will see further increases in the number of processing cores on the same silicon die. The mainstream CPUs will be improved with support for HPC, for example with larger vector registers and greater number of SIMD instructions. The manufacturers of GPUs are also making continual improvements. Future versions of GPUs will increase support for the execution of non-parallelizable code and will be directly connected to the input/output devices.

From all the possible alternatives for a replacement of digital computers, only quantum computing shows some promises for practical usage in the near future. A lot of money is invested in the research. However, even when quantum computing will be realized, it will not replace the current application overnight. The application of quantum computers will be probably limited only to a small class of problems.

The ultimate computer is the computer that can mimic the working of the human brain. The Human Brain Project and similar research undertaking have gained a lot of momentum recently. However, it is not clear how and when such computer will be realized.

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KEY TERMS AND DEFINITIONS

Cognitive Computing: A form of computing that mimic the cognitive capabilities of human brains.

CPU: Central Processing Unit. A part of traditional computer architecture that controls and performs the execution of program applications.

DNA Computing: A form of computing which based on biochemistry and molecular biology of living cells. The DNA plays a role of computer program, which is executed by the organelles in the cell.

Embedded Computer System: A computer system in which the computer is encapsulated into the device it controls. It is usually dedicate to a specific task.

GPU: Graphical processing unit. A specialized processing unit used for fast rendering of images on the computer display. GPU usually consists of several hundred processing elements. GPUs can also be utilized for general computing.

High Performance Computing: A set of technologies in computer sciences that delivers much higher performance than one could get out of a typical computer in order to solve large problems in science, engineering, or business.

Internet-Of-Things: A conceptual model in which objects, animals or people posses some sort of embedded computer, which have ability to communicate and cooperate with each other over a network.

Multi-Core Processors: An implementation of multi-processor architectures with several CPUs put on the same silicon die.

Multi-Processor Architectures: A computer architecture that contains several CPUs. CPUs are interconnected and may cooperate with each other.

Quantum Computing: A computing paradigm based on the laws of quantum physic. Quantum computers will be able to solve certain problems much quicker than ordinary digital computers.

Chapter 11
Self as Computer

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ABSTRACT

The present chapter considers the computer not as a tool, or as a bicycle-for-the-mind, but simply as self. The authors argue that humans are becoming so enmeshed with the computer, in terms of how we think, act, and communicate, that soon it may no longer be possible to identify where the self ends and the computer begins, and vice-versa. It follows that if such a postulate holds any truth, computing systems must be carefully designed to preserve, and not to harm, human rights. Predicted by some are marvelous benefits for technology, in terms of enhancements to our social, creative, and personal lives. But already clear is that not all of the associated problems lie in the realm of speculation. One example is that the Internet is moving ever further away from the free and open system as foreseen by its original designers, whereby citizens are routinely censored, controlled, and spied upon.

INTRODUCTION

We postulate a technological society so arranged as to benefit all; and name such a society the technopia. Accordingly, we suggest use of atomic networks; which provide for the free, open and frictionless sharing of thoughts, ideas, and most importantly, votes. Introduced are techno-rights, which govern man-machine relationships and guard against—exploitation of the week by the powerful. Overall, developed is an optimistic take on the self-computer, whereby machines serve/aid man and do not enslave him.

We present results of testing a new type of electronic mail, named KeyMail.

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Not very long ago (circa 1950s), room-sized mainframe computers were all we had. And for the vast majority of people, computers were giant electronic 'brains' seen only in science fiction films and in the news. Then in 1976, the personal computer (PC) arrived, in the form of the Apple-1. Now you could buy a brief-case sized computer, take it home; and try it out for yourself! Computers were truly magical; and with the help of your new machine friend, there would be no limit to what you might achieve. In the words of Ted Nelson, personal computers were: Liberation/Dream Machines (Nelson, 1974).

These new 'microprocessor' based machines brought computing power to the people; and they were rightly seen as mind-amplifiers, tools for thought, and creativity boosters. Potentially they were 'information windows' into the combined thoughts of all human kind. Networked computers could even make us more human; by allowing us to know infinitely more about ourselves— individually and collectively. Ted foresaw a new computing age; whereby all reading and writing would move to the screen, and knowledge would be set free.

As it turned out, everyone did get a computer (and later on a smart-phone or tablet), and everything went on-line. And for a time in the mid to late 1990's, the Internet promised to emancipate the individual from established power structures. But the liberation movement fizzled out; and the predicted freedoms evaporated away. Today we see a return to centralized computing; and in the form of massive amounts of personal data held on central servers (a.k.a. the 'cloud'). Unfortunately, centralization is often associated with abuse of power and citizen surveillance; followed by restrictions on individual self-expression. Sadly also, Ted's vision whereby we could all access the deep and parallel structures of knowledge, in fact, never materialized.

This chapter calls for a return to a humanistic vision of computing; with free, open and unrestricted access to the combined wealth of all human knowledge.

HUMANISTIC COMPUTING

As we become ever more involved with, and dependent upon, computers; it may be that our essential nature is being shaped and/or changed as a result. It is prescient therefore to study the nature of an emergent phenomenon; the self as computer (merging of self with computer), and in terms of a deeper, broader and more comprehensive inquiry. Ergo we can learn: who we were, who we are and who we may become.

This chapter concerns the nature of mankind's relationship(s) to/with machines. Probable is that our survival and ultimate destiny as a species, depends on the development of appropriate technologies (and especially computers). Thus careful planning is essential when it comes to our technological future. To get the ball rolling, we formulate a strategy for an ideal human-computer relationship, and postulate a society so arranged as to benefit all; and we call such a society the technopia. A key feature of the technopia is the establishment of natural human rights (techno-rights) with respect to a technological society; combined with appropriate and human-centric information usage; and so to ensure that machines interact harmoniously with humanity (Wiener, 1954).

Wiener urged us to ask the right questions with respect to machines, and this chapter is an attempt to do the same. Our approach is to find human-centric solutions for the problems of an increasingly computer-centric future. But the future is at the same time marvelous and dreadful, known and unknown. The issues are complex because technological issues are intermingled with social, economic, and environmental ones etc. Yet the stakes are so high, that it is beholden on each writer to make his position known.

Paramount, in my view, are three (new) human rights:

- Ownership of one's own thoughts.
- Atomic organization of, and free access to, all knowledge.
- Open (atomic) publication of ideas/votes.

Thought ownership is key, and to ensure that the thinker is rewarded for useful contributions, and not punished or disadvantaged in any way. Knowledge should also be free and open, accessible and flowing everywhere and anywhere without limitation. Unfortunately, current systems often fail to provide for the frictionless creation, publication and use of ideas. Desired are new systems which transcend current computers with respect to the free and open exchange of thoughts, opinions and votes.

Questions are easy to spot for today's systems. For example; are the amalgamated ideas of humanity not the shared heritage of every new born child? Where is the world-library and/or universal knowledge repository? Who builds today's systems, and in what sense are they useful and democratic? Do we have equality of access to ideas—or honest self-expression? If some humans are spied upon, but others are not, then by definition we do not have equality of expression. Are some humans more equal than others? Do we have (in any sense) sufficient access to the deep and parallel structure(s) of all human knowledge? Is technology evolving by itself, and according to an anti-humanistic agenda? Do certain dark agendas shape computer system design/usage. Overall, are we allowing: the wishes of the few to outweigh the needs/wishes/rights of the many?

Finding the answers is challenging. Certain experts proclaim the existence of technological barriers as justification for why humanistic systems cannot ever be built. Others site economic and/or security barriers. Problems do exist, but we must not use the same as an excuse to block the path to authentic and people-centric technologies.

Despite optimism, we live in dark times. Increasingly there is a movement towards centralization of computing resources. Authorities attempt to justify why we cannot ever be allowed to share ideas plus votes openly and/or privately. Are we to accept these self- appointed parties as god-like beings; who judge, rule and punish the rest of us on a whim? Like Beyonce, we ask: 'who run(s) the world?' We might not the like the answer(s), or what it says about human freedom(s) in the year 2014. Conversely, we postulate a new type of atomic network that provides for an open sharing of ideas. A special class of self-centric data is envisaged, comprising massively distributed data 'atoms' which offer boundless mechanisms for the preservation, retrieval and sharing of content (ideas).

George Orwell said: 'if you want a picture of the future, imagine a boot stamping on a human face—forever' (Wiener, 1954). Orwell's nightmarish world is one of newspeak, thought-crimes, memory holes, double-think, and of clouded perception; whereby thoughts are constantly observed, twisted, negated and used to eliminate free-will. Foucault likewise predicated super-panopticon surveillance machines that may be used to curtail human freedoms (Foucault, 1975). Hopefully we can avoid such big-brother scenarios, but we must not throw the responsibility onto the machine (Wiener, 1954).

Another prescient comment comes from Lord Bertrand Russell, who said: 'Machines are worshipped because they are beautiful, and valued because they confer power; they are hated because they are hideous, and loathed because they impose slavery' (Russell, 1963). The quote is apt. Computers are resplendent machines— with high levels of apparent intelligence, independent decision making ability, and perhaps even (on occasion) motivations of their own; but they are also, ultimately, human creations. This is an obvious statement of fact, but less clear is why we should all (collectively) allow computer systems to be designed that (in actual fact) restrict freedoms, limit access to knowledge, and favor minority interests.

My thesis shall be that design of today's computers is unquestionably; design of the whole arena of human life, and ultimately, in a real sense, design of self. Needed is careful planing, to ensure that humans be the masters (not of each other); but of our machine slaves, and it must not turn out to be the other way around!

CENTRAL SYSTEMS

We shall consider, and argue for a new occurrence: the merging of self with computer, a phenomenon which we have named the self-computer (Radley, 2013). Our thesis concerns topics that overlap multiple disciplines including; computer networks, virtual/augmented reality, ubiquitous computing, sociology, psychology, ethics, law, humanism, trans-humanism, and philosophy etc. On second thoughts, perhaps the list of influences is endless, since there are no fields of human endeavor to which the self-computer is unrelated; and upon which technological issues do not (in some way) impinge. Accordingly, there are no solely machine-specific issues (or human-specific ones), because... the problems of technology and humanity are intertwingled (Nelson, 1974).

A primary function of the computer is in helping human beings to think and communicate. Obviously computers help us in so many other ways, for example magnifying our senses and physical abilities; and enabling us to create, model, and sense aspects of the world in a variety of ways that would not otherwise be achievable/possible. However despite the multi-purpose and chameleon-like nature of computers, ultimately it is in terms of their affect(s) on the human mind itself; that computers have the most significant impact(s). Computers (ideally) facilitate, inspire, and shape human thought in the most profound way(s); speeding up and greatly magnifying the precision, scope, and scale of access to knowledge. Furthermore computers can (and should) open up the minds (thoughts and ideas) of vast numbers of people to one another. But do computers really achieve this ambitious feat of bringing humanity closer together?

SOCIAL NETWORKS AND SURVEILLANCE

We start by considering the design of a modern social network. The developers of the Facebook, Tumbler or Twitter networks, which (at the time of writing) have tens of millions of users, are in actual fact, not merely designing a communication system; but rather, in effect, architecting (aspects of) the nature of human interaction itself. Since these networks now represent an ever increasing chunk of all human discourse (and social relations of all kinds); we should, at the very least, be concerned by related powers.

Centralized network social power manifests itself in various disturbing ways, but especially noticeable are issues related to privacy and security. For example, the network owners (often) assume that policing social interactions is their job and/or right. Implicit here is that they are eminently qualified, and (forever) perfectly capable of properly so doing (for the collective good). As a result, these unelected bodies, often go ahead and install surveillance robots on everything we do and say on such platforms. In effect, network owners (often) make certain topics/subject-matters within social discourse illegal. Specific words are disallowed, for example; and (acting as policemen and gatekeepers) they control who may talk to who (and never forget that they know who talks to who—and whats been said!). In particular; (entirely) private social communication is normally disallowed, even though secure (and honest) one-to-one chatting is a natural part of human communication in the real world.

Even more pervasive is government surveillance, which is being performed on a massive scale by organizations such as the National Security Agency (NSA) in the USA. Recent press revaluations indicate that all of our emails, tweets, Facebook comments etc, are being collected for inclusion in an enormous intelligent spying program/database named PRISM. It therefore appears that as a result of going digital, we must now lose all those rights that we once had to privacy in terms of; who we may speak to, what we may say, who knows about it, and when/if social discourse actually happens.

HUMAN RIGHTS

In this chapter, I will argue that the ‘panopticon’ spying on ordinary citizens is, in actual fact, breaking our human rights; and perhaps altering the nature —and definition—of what it is to be a human being. Perhaps system designers need to take another look at what a human being actually is - and especially in terms of human rights.

In terms of moral and ethical law, there are four fundamental human rights, as follows: the right to life, and the right to earn a living through work, the right to choose one's own master (if you do work for others); and also ownership of one's own thoughts. And these rights are the bedrock upon which any (just) society is built; its very foundations, if you like. Interesting is that thoughts are seen (in law) as the private and unassailable property of the individual; that is, they are his/hers to do with as he/she pleases. And the aforementioned four rights lie above all other considerations, and are more important than societal organizational structures like democracy, capitalism or communism. Such 'isms' are, one and all, and in a very real sense; simply mechanisms through which people obtain these basic rights (or are supposed to be afforded the same).

Let us begin with thought-rights. The right to own, and to profit from, one's own thoughts, is a major theme of the current chapter. I argue, accordingly (and in specific senses), that owning one's thoughts, means also owning the right to pass those thoughts onto others (and controlling the methods and conditions of doing so), either openly or in total/partial privacy (if one so desires). Furthermore, I make the assertion that where one does not have such a capability of privacy and free expression—and in relation to thoughts—then one is in some sense a slave. One has lost part of self.

THOUGHT OWNERSHIP

Restriction (or destruction) of thought-ownership breaks a fundamental human right—and you are, in a sense, no longer fully human, wherever and whenever this happens. Or at the very least you are unable to operate as a human-being in some way or on specific occasion(s) and/or by means of a specific communication medium. Put simply, if you do not own your own thoughts, in any social situation or scenario whatsoever, then you are no longer free.

I know that 'social' spying on digital networks is said to be in our best interests, and/or is supposedly being imposed on us to save lives or else to protect us from harm. But even if this were so (certainly it is not so in the vast majority of cases); how can we know that such a situation was/is in fact ever the case, since nobody polices the police, so to speak. Others may say that we have a choice as to whether or not to use these (social network, tweeting and email etc) systems—and even whether or not to use computers. But do we really have such a choice? It is becoming increasingly difficult to operate in a modern society without using computers and networks of all kinds, and especially for email and Internet browsing etc. Certainly not having access to some form of social network, texting and/or live chatting program is restrictive at best, and potentially limits one's freedoms and activities in severe and (often) detrimental ways. In fact, we do not have a choice, and our unelected overlords know it.

Disconnecting oneself form the Internet, and/or avoiding all computers and digital networks, and going 'off-grid', may seem like the activity of a maverick, revolutionary or paranoid schizophrenic. But only by so doing (and avoiding the on-line world altogether) would the average citizen possibly avoid all kinds of spying in relation to aspects of personal activity and interpersonal communication. However every time you spend money on a credit card, apply for a driving license, pay your rent, and/or receive a pay check etc; you are generating information. And all of this data ends up on a database that someone, somewhere, can access on-line. It is as if the vast digital network 'knows' that you are alive, and is, as a result, watching you.

Let us concentrate on thought ownership. George Orwell spoke about the issues surrounding panopticon spying (constant, everywhere and all-pervasive observation) at length (Orwell, 1949).

Many other theorists and writers have followed suit. Each thinker has added his or her own spin onto the debate of the relationship(s) between freedom of expression/action/thought; versus spying, dystopian societies and big-brother. Overall, my assertion is that each of us should own our own thoughts; and in fact that we have a moral and ethical right to them. If we do not, then we are, in some sense, slaves. I put it to you that today's social network, and email operators etc, are breaking our human rights when they spy on our communications, and even when they do so with our own consent and/or knowledge.

Being spied upon blocks honest free-expression, and specifically because you are uncertain what may become of your thoughts, who is reading them, and to what end-uses they may eventually be put. Your own thoughts are being snatched right away from you, as soon as they are communicated to others, and (very often) when sending an email, text or chat message. This is theft, censorship and it is highly immoral—because we can do nothing about it. And we do not know if/when it is happening, and (once again) for what purposes (or ends) our data is being used. But the current situation is even worse than this. By policing the kinds of things that one is able to say on a social network, and the words/opinions that one is allowed or expected to express; such surveillance is restricting not only our human right to free self-expression, but potentially our education, and the ideas that can/may develop in society; and in a most restrictive and severe manner.

Are these actions not thought-theft crimes perpetuated by the powerful against weaker individuals? Whatever happened to respect for other people's opinions? Are we so week-minded that we cannot tolerate dissension?

It could be (or certainly is the case?) that all kinds of useful opinions, ideas and creative inspirations are being checked (blocked); and before they even begin to emerge. This happens because people are afraid of expressing their true opinions; and as a result of (real and/or imagined) surveillance and possible sanction. It appears that the ever-present spying, banning of certain words, and restriction of opinions and feelings, could influence the development of language, and hence thought itself. It is a dangerous path that we are now embarked on.

In the book 1984, George Orwell spoke about the (potentially) corrupting influence of language, and he made several powerful statements that are especially prescient.

From 1984:

- If thought corrupts language, language can also corrupt thought. It's a beautiful thing, the destruction of words.
- Freedom is the freedom to say that two plus two make four. If that is granted, all else follows.

These quotes point to the power of language to influence thought (and vice-versa). In a way language is thought. If you cannot say or express certain words, feelings and opinions— then those sentiments do not exist, never did exist, and will never exist—at least for others. And possibly in a sense, these thoughts do not even exist from the viewpoint of the thinker as well. Such actions obviously open up legal, ethical and moral issues related to network surveillance. I do not have space to even begin to analyze such complex topics in the present chapter. However I can (hopefully), leave space in your mind to entertain the possibility that networks should not sensor all human communication (by default)—and because this may be limiting and/or breaking the human rights of countless millions of individuals. Are such opinions radical? I hope so—because the world is in a mess. It seems that only a radical solution could possibly offer any hope of making a dent in (i.e. impact upon and solve); the major problems now facing the world, and specifically those relating to hunger, wars, environmental disasters and education. Can it be that because we (individually and collectively) no longer own our own thoughts; that we are restricting our capability to govern ourselves, and to solve the major problems facing humanity? I leave it to the reader to answer this one.

Let us get back to the previous example, the social networks. Do not get the impression that I am against all such networks, because I am not. Rather it is my position that these networks, in various forms, and by defining what we can do, who we can talk to, and also the ways in which we do talk; are in actual fact forming a new and artificially constructed—or wholly designed form of self. This new self is being produced by unelected network owners, and others who are close to the biggest computers –according to Jaron Larnier's view (Lanier, 2013). Big questions naturally arise. Do we really want to allow a small number of people (the network owners) to define who we are as a people and also what our lives will be like (and including 'corporate' people too).

Networks are essential to our future as human beings. They are places where humans can meet, come together, interact and exchange thoughts and opinions; sharing ideas, movies, files, and votes etc. Already many of us work, play and engage in commerce on networks. Networks also magnify who we are, in terms of our needs, wishes, desires and potentially the collective actions that are possible [e.g. 'Arab spring']. And it is my opinion that computer networks are simply an extension of real-world social networks (or should be). When it comes to networks, the medium really is the message; and the message is simply: this is what it means to be human—or rather—this is how you can/could retain or demonstrate your humanity and/or—become fully human. Unfortunately certain aspects of your humanity are to be withheld (currently on these networks), and specific thought-rights are to be limited and/or removed (but, don't worry, it's for our own good!). Conversely, I suggest that we must never forget that computer systems—and hence networks—are designed by and for humans. This view may seem obvious—but it is sometimes obscured.

Norbert Weiner said that we should 'not throw the responsibility onto the machine' (Wiener, 1954). Hence do not be 'fooled' into thinking that we have lost control of machines in terms of their basic functions and capabilities. This is not so—machines are (at all times) human made artifacts. The machines cannot yet (completely) design themselves. And even if they could they do not (currently) possess free-will or the 'will to power'.

Perhaps it is natural to think that anything designed by humans would be humanistic, but this is not (necessarily) the case. I think Weiner was referring to the tendency of system designers (and others), to blame the machine (in-authentically) for those cases where a machine limits human rights, and/or does not perform as it should do, or as the user of the technology would wish it to. From this viewpoint, it is as if the technology designs itself, and/ or were somehow alive. Once again I leave it to the reader to make up his/her own mind. As for my own viewpoint, I simply state that I believe that such a view is profoundly wrong, simplistic and anti-humanistic.

Machines (and computers) are designed by humans, and we can make of them whatever we like. They are not fixed in stone and are not our overlords (yet). Rather it is the system designers and owners who are deciding what policies the machines progress/implement. In terms of the social networks, the current systems control how we interact in a variety of ways. They control the language we use and the things we are allowed to say to each other. Unfortunately by limiting, curtailing, restricting and controlling human communications; it is inevitable that current systems are changing the nature of what it means to be human. Is this a frightening and unbelievably depressing state of affairs? Most definitely.

Perhaps we need to go back to the drawing board when it comes to technology; and begin by re-imagining who we wish to be, collectively as a people.

It is vital to realize that the rules and regulations imposed by the designers of each network, will shape the ways in which, and by which, and how; human beings relate, one to another, and in the strongest possible way. The major theme of this chapter is the inseparability of technological issues from matters of general and primary concern—both collectively and individually. In a way technology–is–humanity, and/or humanity–is–technology; because technology is now so enmeshed with who we are, that design of technology is design of humanity and self. In a sense, we are the computer and the computer is us. It seems that a merging of man and machine is inevitable—at least if the human species is to survive.

DEMOCRACY

It is my position that a primary function of technology is to create a utopian future, and to progress the humanistic agenda; complete with democratic values, and human-friendly: policies, values, agendas, laws and societal mechanisms. The focus is on finding ways for people to obtain the fundamental human rights, and more especially in terms of thought-ownership; which is in some ways a precursor to, and facilitator of, all the other human rights. As an example of such a linkage; I put it to you that with current technology we don't even know what are the collective opinions on almost any specific topic or major issue of global concern. If we only knew what society (as a whole) was thinking, perhaps we could implement more humane policies. This happens through wide-ranging aggregation of human thoughts, opinions and votes; and the corresponding collective and democratic wishes of the majority being put into action. These ideas relate to the implementation of, and definition of, democracy itself—and so to the nature of society.

Democracy has multiple meanings and different definitions, but here we refer to the concept in the most simplistic sense imaginable; being the actioning of the collective will of the people. I do not think that we have democracy (on a world-wide basis) at present, no matter what our leaders may say/present. I shall make the argument that for humanity to progress, we must find out what the wishes of the majority actually are, and on an issue-by-issue basis, and then collectively implement the same. Along the way we introduce a number of new principles for a technological society, which we name the technopia.

A technopia is a society so arranged as to benefit all, and it has special laws, rights and technological mechanisms to ensure the same. Especially important are new human rights—techno-rights—that each citizen of the world will be afforded. These rights mirror (and extend) the four fundamental human rights, and are designed to guarantee that each person obtains the same. A special new class of atomic network is prescribed to provide and uphold these techno-rights. In coming sections, we examine the basic nature—and capabilities of—the Atomic Network (Radley, 2013). First however, we develop a design schema for a new class of self-centric data.

SELF-CENTRIC DATA

We apply the concept of self to computer system design; and in particular with respect to the natural actions, modes of communication, and creative output of the individual. Our approach does not make any serious examination of the nature of the self, or else consider the multifaceted philosophical aspects associated with the term. And neither do we make any reference to theories and/or trends in human-computer co-evolution or the new field of technoself studies. Rather we deal with practical aspects of computer system design in terms of efficiency and effectiveness, and with respect to an individual's visual and perceptive skills, creative actions, and communicative needs.

We develop the concept of self-centric data; which is defined as a massively distributed data type which assigns (for the first time) full ownership rights to the creator. Self-centric data is fundamentally different from all other types of data, because it holds within itself boundless mechanisms for the preservation, retrieval and sharing of content. We shall see how these attributes of self-centric data enable systems to be designed which transcend "cloud" (or central server) systems in terms of the scale, security and lifetime of content, whilst fostering unrestricted access to information.

THE PURPOSE OF COMPUTERS

Some time ago, the term computer referred to a person who could do advanced mathematics quickly. Later the term was used for the ENIAC, the "giant brain", which was the first computer that could do advanced calculations. Unfortunately ENIAC occupied an entire gym-sized room! Eventually with the miniaturization brought about by microchips, personal computers and calculators arrived, and the name computer referred to any device that could do advanced functions.

Today there are a great variety of different types of personal computer, from desktops, laptops, mobiles, and tablets to Global Positioning System (GPS) watches etc. And it is clear that computers are beginning to morph into clothing, spectacles and perhaps "stick-on" types. Plus microscopic computers designed to travel in the blood as in the 1966 film Fantastic Voyage are being developed. Even brain embedded computers are possible.

It also seems that computers are multiplying. A quick count finds 11 computers (including PCs, tablets, a smart TV and a smart phone) in my bedroom, and more than 20 in the household. And all have bitmapped displays, keyboards and mouse or touch screen interfaces. We use these devices for storage, transfer and viewing of information. Other activities include entertainment, and person-to-person communication.

Upon reflection, it occurs to me that I actually spend the majority of my time on a computer of one type or another. I sometimes wonder if other people are similarly technology-swamped. And sure enough when I observe friends, it seems that they are just as immersed in technology. For example, have you noticed that everyone is looking at screens much of the time?

Where will it all end in terms of human-computer interactions? I can make no predictions, and perhaps no body could. Certainly it is becoming no longer acceptable to be un-contactable (or to go "off-grid") at almost any time. For instance, friends and family have scolded me (earnestly), for leaving my smart phone at home, or for not being instantly reachable by FaceTime, Skype, text, or live messaging. My point is that something has changed in the last few years, and specifically in how we view ourselves vis-a-vis technology, and especially in a social aspect.

However the topic of the self and its relationship to technology (or technoself) is too large and multi-faceted for the present chapter. Rather we focus here on computer design as it relates to a specific type of digital data. That being personal data, defined as digital information created by the self, or else naturally owned by the self. We include here emails, movies, photos, and documents etc. Hopefully by restricting the analysis to personal data, and related systems / processing, we can illuminate fundamental issues with respect to everyday human-computer interactions.

A key goal is to rise above (or sidestep) the vast complexity and diversity of issues with respect to computer systems in the particular, and visualize the problems that underly the landscape as whole. And unsurprisingly when dealing with personal data, we find that the concept of the individual (or self), is the loadstone upon which everything rests. Unfortunately however, it is not the concept of self that is preeminent in the minds of the system makers. On the contrary, it is normal for digital information (and hence control) to be held centrally, which as we shall see, causes innumerable problems, in both practical and emotional terms, for the individual.

FUNDAMENTAL TRENDS

Two fundamental trends can be identified in computer system design, one distinctly away from the individual, and the other towards him. Norbert Wiener, the inventor of cybernetics, was a supporter of the individual side. In "The Human Use of Human Beings", Wiener encourages us to "ask the right questions" in relation to machines, and to not "throw the problem of responsibility on the machine (Wiener, 1954). Machines (and computers), in Wiener's opinion, are meant to interact harmoniously with humanity. Wiener believed that our scientific creations are not devoid of humanity, but are manifestations of it (or the lack thereof). Remembering the self then, is a core message.

Wiener's thoughts are especially prescient today, because now major powers routinely restrict access to, and use for their own purposes, our personal data (see examples below). Yet our intention is not to discuss the rights and wrongs of such practices, but rather to design efficient computers. Of necessity, we are drawn back to practical issues.

In the 1991 book "Computers as Theatre", Brenda Laurel states that we should think of - and design - a computer interface in terms of a theatrical metaphor (Laurel, 1991). Her idea is that like effective drama, good interface design must engage the user in both thought and emotion. Laurel also says that the user interface (UI) in a way obstructs access, and that it stands in the way between us and what we are trying to do. This is a useful perspective. Perhaps we sometimes forget that the job of the computer is to expand options, not to limit them, and then to get out of the way. A step towards the self is recommended.

In the 2013 book "Who Owns the Future", Jaron Lanier speaks about the major societal effect of digital technologies being to concentrate wealth, reduce growth and challenge the livelihoods of an ever-increasing number of people (Lanier, 2013). According to Lanier, the reason is a faulty information economy that ruins markets, and concentrates power to those corporations with the biggest computers. A giant leap away from the self then.

It may appear that we have given the engineers too much power and say over the design of computers, who then place emphasis on machine-centric issues. In the process, as Wiener warned, they ignore the humanistic perspective. But the truth (at the biggest level) may be far darker. Specifically,it is not in the interests of the"server farm" owners to consider the needs of the self almost in any way at-all. Therefore the move away from self (in the digital world) may have been partly planned, but also partly an accident in the form of engineers who have neither the time, nor inclination, to consider self-issues.

Some experts say the Internet itself is broken. And for efficiency reasons, computer scientists like Van Jacobson now recommend that the Internet be re-designed, specifically towards Content - Centric Data: CCN (Clark et al., 1988). Unfortunately, the problems of the self are ignored here also.

Yet there may be a glimpse of light on the horizon. New self-centric technologies like BitTorrent, BitCoin and similar P2P initiatives could usher in a paradigm shift towards the self. But whomsoever adopts the self as starting point must be prepared to consider what people want to do, and in fact actually do, with computers. Considering personal data as a general purpose (and potentially private) possession, with the right to exist independently is key. We propose that personal data should never be imprisoned inside an App, a network or a database. Is this technological heresy or simply the legitimate self perspective?

Experts like Donald Norman (Norman, 1999) and Howard Rheingold (Rheingold, 1985) have indeed taken a broad-ranging usability and user-centered approach to computer design. They have invited us to think about computers from the perspective of life-enhancement. But it seems that they have not been listened to, because modern systems are (in general) highly specific and fail to address the needs (and especially the rights) of the self at-all. For example, it is often the case that when you create data, that somebody else (in the form of an App) instantly says "that's mine - and you cannot have it back (maybe ever)." It is possible to see such actions as a form of theft. (in a sense, and even when we have agreed to the software usage conditions) Each of us might prefer to know when we are creating data that is owned by us, and when we are doing the reverse. Computer design, it seems, is all about capability, rights and who owns your data.

But not everyone agrees. In "Insanely Simple" Ken Segall (Segal, 2012) summarizes Apple's design mantra as "Simple can be harder than complex. You have to work to get your thinking clean and to make it simple. But it's worth it in the end, because you can move mountains". All very well and good, but for the world's most profitable company (in reality) the mantra is closer to: "Everything on our servers, whether you like it or not, it's worth it in the end, because it will work wonders for our profitability." And companies like Google, Amazon and Microsoft are all following the same environmentally unfriendly road to server farm nirvana. The trouble with this approach is not just the unknown uses (and abuses), that these companies put our data to. Because there is also a danger that they are stealing not just the data, but also (in un-declared ways) the rights that we once had over our personal information, now and in the future.

Especially prescient today are the problems of personal and organizational data security. On an almost daily basis we here reports of governmental and corporate vulnerabilities, break-ins and instances of stolen data. And governments spying on citizens is now common. Debates are raging around many of these issues, which also involve legal points and problems of an ethical nature. Here we take a simplistic view, recommending that a small - but important subset - of these problems can be addressed by looking at personal data and adopting a straight-forward definition of the self and considering the resulting rights and capabilities that necessarily follow.

One example of system designers ignoring the individual perspective, is that many application developers fail to consider that data is "designed" at-all, and thus do not consider it in a wide enough context. For example there are no universal data types and/ or effective data exchange mechanisms between different systems such as email, social networks, and / or devices such as the TV, mobile, computer, telephone system, digital player, entertainment console etc. Non whatsoever!

We surmise that smaller "App" designers are using standard "project based" design methods (and perspectives) such as the Unified Modeling Language (UML). So they focus on task and business specific system requirements. Such an approach characterizes a standard system "user" in a narrow sense, and as a result, they design information silos without thinking of the broader needs of the self. Along the way a very narrow, localized, view of digital content wins, in terms of data lifetimes, security, portability and accessibility. As for the large system designers working for the server farm giants, I leave it to you to judge their motives. But it could be that people may soon tire of the inefficiency of central systems, and vote with their mice, signing up to systems that "ask the right questions" (in Wiener's sense) with respect to self.

A SOLUTION IGNORED

Consideration of "self-centric" data is an ignored solution, specifically to the problems created when taking a centralized approach to computer system design. Put succinctly, few system developers currently addresses the needs of the individual in terms of providing efficient techniques for the open publication, and limitless preservation and/or transfer of data. System developers tend to lock data into information silos. I believe that people are increasingly finding personal data lock-ins and/or personal data spying; untenable and intolerable. One small example of a trend in the direction of self is that Google has in 2013 launched a tool for digital afterlife management, whereby relatives can access a deceased person's gmail account information (Arthur, 2013).

A key factor is that developers fail to consider the user's perspective as an individual who spends a lot of time outside of any one application, network or system; and unfortunately as a result computers offer a very narrow range of functionality. For example, who considers the broader needs of the person at the centre of all the Apps and networks? And who looks after your data in a world of "cloud" storage? What are your rights if the App looses and/or corrupts your data? We can conclude that ownership and no-limits preservation of data is the first aspect of our primary problem.

Technology companies think, and act as if, your data is theirs. They routinely search emails, social network posts and tweets, for example, and throw task "relevant' adverts at you. Also companies like Apple and Amazon seem to think that even once you have paid for data (songs, books) that they can later make changes to it (i.e. either delete data or change the content and copyright notices etc). And this happens even when the data has been transferred to a portable player such as an iPad or Kindle. People are increasingly outraged by such incidents, and rightly so. Another example is a Facebook post. Where once-upon-a-time the Internet was a medium of free expression, now people are routinely reported to the police for relatively minor acts of self expression and/or for voicing opinions. Plus employers and people in authority routinely scan posts also. It seems a bit too much like 1984 (Orwell, 1949). All in all, it is obvious that we now have a severe problem when it comes to avoidance of "big-brother" spying. This is the second aspect of our primary problem.

Perhaps censorship is not always wrong or undesirable, only it would be good to know when it is happening, and/or be able to escape entirely from it at least occasionally, just as you can when you take someone into a private room and talk to them with candor. Surely we are not saying that such conversations are to be possible in the real world but not in the digital one.

A third problem relates to the way that individuals relate to others in the real world. One can give, lend, show or sell real-world objects freely, without fear that they will be intercepted and often without anyone's knowledge. Is this not a fundamental human right and need, to perform certain low-level human-human transaction(s) without being spied upon. Or is such a right only for privileged humans who are closer to the big-computers, as in Lanier's view? Are some humans more equal than others in this respect? (Orwell, 1949). Why should privacy not be a capability offered to all? This is the third aspect of our self-centric problem space, secret individual-individual transactions.

We are now armed with the three primary goals of our new way of thinking about system design. Here we take a humanistic perspective on computers, whereby we think of them not in terms of "Apps", tools for thought, information-appliances, or as a "bicycle for the mind", but simply as self.

SELF AND TECHNO-SELF

Technoself is new interdisciplinary concept which deals with all aspects of human identity in a technological society (Luppicini, 2013). The real-world self is obviously a key concept in technoself studies, and in this view self is changed due to use of new media in relationship to privacy issues, virtual identity boundaries, online fraud, and citizen surveillance etc.

In terms of our basic premise, in this chapter we do not believe that the actions that one is able to perform on digital data should be any different (in principle), from those possible on real world objects. (in terms of personal goods) In a sense therefore our concept of self-centric data differs from technoself in that we do not see a variance in this respect, even though there are obviously many differences in terms of the nature of the objects under consideration. We think that certain human actions on objects and data should be in some respects analogous.

Popular in the 1990s was the concept of the avatar, as in systems such as Second Life, whereby the self is reduced to a mask and achieves anonymity rather than identity. In contrast our concept of self relies on establishing (and revealing) one's true identity. The individual is then free to engage in honest self-expression. We envisage a network of trust, being an invitation only network whereby people join private "friendship" networks. In this part of the network (i.e. BitMail), only approved "trusted friends" can send you messages and/or transfer data to you - and data is utterly private. Additionally a "data-storage' part of the network (as yet unbuilt) would allow publication of data that is made available specifically and/or to everyone. We are (as yet) undecided whether or not this part of the system would allow anonymous publication. If it did not, then this would discourage illegal activity. However if it did allow anonymous publication, then freedom of expression would be upheld. Perhaps Wikipedia-like teams of big-brothers (or editors) are inevitable, and could police infringing content where complaints are made.

Quite a few scholars have spoken about human rights and the Internet, and some at length (Benedek, Veronika & Matthias, 2008). The concept of digital rights describes those human rights that allow individuals to access, use, create, and publish digital content and/or to access and use computers and related devices. The idea is related to the protection and realization of existing rights, such as the right to privacy or freedom of expression. We have no interest here (due to space limitations) in getting involved in any particular arguments, either for or against digital rights. The question of what to do about illegal network activity and/or legitimate (law enforcing) management of data remains. Even how to discover illegal activity is problematic where you attempt to uphold the self's privacy. (i.e. who polices the police) Perhaps security issues (for public data), are best solved by supplying identity details (network host etc) when asked so that authorities can investigate illegal behavior physically and on the data channel itself.

We are not attempting to formulate a new area of techno-studies. Rather we take a practical viewpoint, whereby if you have a right in the real world and/or you can perform some action with objects (in terms of personal goods) in reality, then it stands to good reason that you should be able to so do in the digital world. We offer no defense, logical or ethical, for this viewpoint. We simply make the (unproven) claim that when you adopt the resulting self- centric data principles (see below) that you then suddenly discover that many of the problems that individuals experience with computers (in the biggest sense) disappear. And you also find that interactions with computers become more efficient in the process.

Now let us leave behind all philosophical and ethical arguments, made, alluded to, or ignored, and examine the theoretical and practical results of applying our new self-centric philosophy to some basic computer tasks.

In the real world individuals are (in general) free to create an object, and then to sell, lend, or exchange it. Ownership and existence are key rights in this respect (Capability 1 & 2 of self-centric data - ownership and storage/retrieval). Secondly when one owns an object one can typically store it forever (Capability 3 of self-centric data - object persistence). Also one may wish to show an object or lend it to others in secret or else publicly (Capability 4 of self-centric data - transferring items to others publicly and/or in secret).

These attributes of self-centric data might seem to be obvious, but as with other fundamental issues, when you think about the subtleties, all simplicity evaporates. Ownership, for example, becomes complex when considering the rights-of-use issues around lending an item or changing ownership of copyright on it and/or when someone makes a copy.

A key goal is to guarantee that these four fundamental capabilities are maintained in digital data, forever and without precedent. In table 1 below we show the 4 capabilities and the desired features of each, which have been identified from their real world counterparts (objects). Interestingly self-centric data can hold within itself a "mission-impossible" style auto-destruct date, that causes the data to delete all traces of itself from the network.

ATOMIC NETWORKS

As a partial solution to some of the issues discussed above, we have developed the idea of an atomic network. An atomic network is the polar opposite of a centralized or cloud network. It effectively provides a 'save' and 'load' function for the Internet, and provides for an indestructible data type that cannot be controlled and lives forever. Let us examine how such a theoretical network might work.

Let us assume that network members are scattered across the Internet, that is they are located on different IP (Internet Protocol) addresses and some may be behind Network Address Translation devices (NATs). Furthermore, each network member has a special client program on his personal computer or mobile device. Next we provide the following system actions; save and load, based on a unique data unit identifier. When the user chooses a file (data unit), and saves it to the network, it is automatically given a unique identifier, an owner identifier and a member-specific key and/or password if it is private.

Now what the client program does next (upon save) is interesting (and unique), it "atomizes" the data unit to the network. The item is split into many thousands of tiny pieces (atoms) which are then disseminated across the network as a whole. There are many, many copies of each piece (data atom) which are saved on many remote computers

Table 1. Capabilities / Features of Self-Centric Data

Ownership	Storage / Retrieval	Persistence	Transfer	Feature
Private / public according to audience settings	Massively distributed data model - huge redundancy	Data "atoms" held in the swarm - multiple copies	Swarm network of helpers	Audience
Encrypted by key + date algorithm and / or password.	Distribution provides added security.	-	Highly secure - no intact copies of full data unit.	Security
-	Robust storage + efficient retrieval	Indestructible	Torrent-like	Efficiency
No Central Servers	Atomized to the network	Massively distributed -100 backup copies (atoms)	Torrent-like	Location
Encryption + password	Key-based + id / atom protection	-	Key-based + id / atom protection	Privacy
Changeable lifetime	Immortal / Perishable	Immortal / Perishable	Short / Fast	Time

hard drives, for later retrieval at an unspecified time. Data atoms are encrypted according to the key for the data unit as whole. Next when the owner (or key / password holder) chooses to load (or retrieve) the data unit from the network, then the owner's client knows how to request from the network all of the constituent atoms, re-assemble them and so to reproduce the data unit. Note that network members agree to reserving part of their computer disc for other people's data "atoms". You now have a robust way of backing-up and sharing items using the link identifiers for the data unit. When another network member's client requests such a link, a "torrent" of constituent data "atoms" is sent to that client (from all across the network), until such time as the data unit has been fully reconstructed. Every network member's computer is now a data-atom server! And a sufficient "stock" of identical copies of each data atom (perhaps 100's) is automatically maintained according to continuous network maintenance tasks.

One now asks the question, what has been achieved with such an atom network? Firstly data is effectively immortal and indestructible, and relies on the unbreakable redundancy provided by massive distribution and replication of hundreds of identical atoms across many separate network locations. And the robustness of the network increases with number of network members (computers to store atoms). Other key advantages include no longer having central servers; and this is environmentally friendly and brings security advantages. Additionally data save/loading speeds are much faster (i.e. no central server upload times and torrent-like data atom transfers).

KEYMAIL

KeyMail is a new type of electronic mail. KeyMail employs end-to-end multi-encryption and is a private "friendship" network and is not compatible with email. KeyMail employs a new protocol for electronic mail, being one that enables users to share large files quickly, securely and potentially without any size limitations. KeyMail is not designed to replace email. Rather the concept for sending a KeyMail is to transfer large amounts of data privately and efficiently. Many people wish to share large files, but email programs limit the size of attachments to around 20 MB. KeyMail provides a four point solution, whereby large files can be shared rapidly and in a secure manner. No data is held on central servers, and files are end-to-end encrypted.

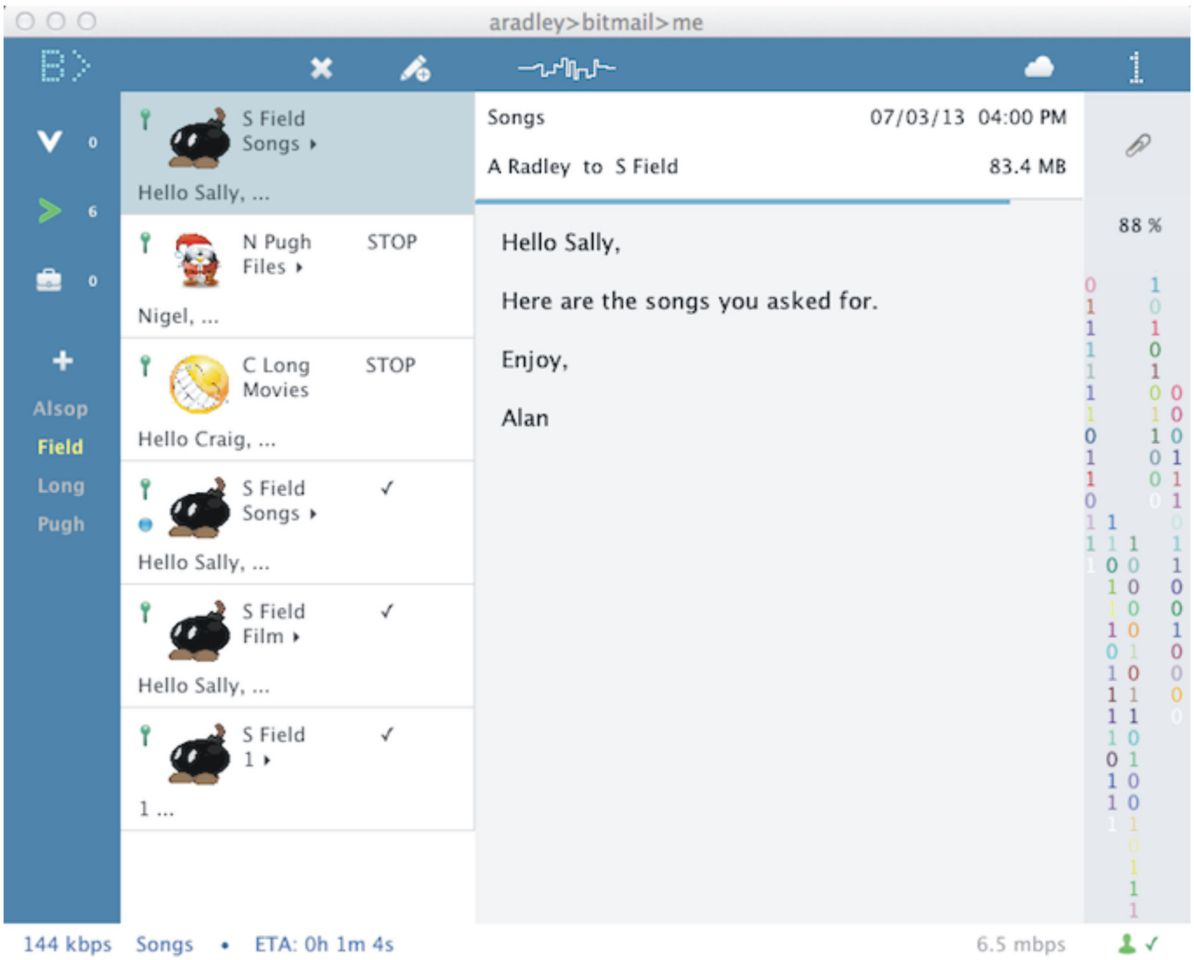
Additionally there are no upload delays, and no SPAM. KeyMail can take a variable period of time to arrive at the destination depending upon the size of the file transfer. The largest file we have transferred with KeyMail across the Internet is 20 GB, which took 2 hours to fully arrive at a transfer rate of 300-600 kb/s. KeyMail has several inherent advantages over email, including faster speeds (no upload delays), and it potentially offers transfer of items of an unlimited size, plus it enables the sending and receiving of multiple files simultaneously. (latter capability is not possible with email) Files can be sent directly from one USB Key-Drive to another, without generating any copies—not even on the sender / receiver computers. KeyMail runs on Microsoft Windows or Apple Macintosh computers. Put simply, KeyMail provides freedom from spying plus unbreakable hacking protection, and all without generating any digital footprints.

With ordinary email the message is copied onto innumerable Internet computers, stored onto a cloud server, and then backed-up. As a result, your information is unprotected and open to theft / copying. KeyMail avoids the troubling scenario of having your private data stored anywhere and everywhere—and potentially forever!

KeyMail Security Features:

- Secret protocol
- Multi-layer encryption

Figures 1. KeyMail Client running on Apple Macintosh Computer



- Live P2P message transport
- Packet-scrambling (distributed)
- Private network /cypher matching
- No message copies anywhere
- Message self-destruct /live texting

CONCLUSION

Any work purporting to identify a golden solution to all of the worlds problems—or even a tiny portion of them—is bound to be labelled as optimistic at best, and more likely as deluded, unrealistic, or simply as a work of pure fiction. And especially precipitous is the path followed by anyone who considers technological solutions as some kind of super-positive solve-all. In his 2005 book The Singularity is Near Ray Kurzweil puts forward the view that the law of accelerating returns predicts an exponential increase in technologies like computers, genetics, nanotechnology, robotics and artificial intelligence. He says that this will lead to a technological singularity in the year 2045, when progress outstrips human ability to understand it. At this point, he predicts that machine intelligence will be more powerful than all human intelligence combined (Kurzwel, 2005). Ray foresees only positive benefits for technology, and he might be labelled as a techno-optimist.

However the lessons of history are just the opposite; and that the introduction of any new technology does normally have major unexpected (and often negative) consequences/influences. What can be said with certainty is that effective technology design is far more difficult than at first sight it may appear; and it is essential to see innovations from the broadest possible 'humanistic' perspective. Perhaps we can follow the key example of the humanities. We have laws and legal presidents (based on human rights); and it seems that likewise we now need technological rights—or techno-rights—to govern computer systems. Certainly we cannot allow technology to continue to develop without top-level planning; because already clear is that vast numbers of human beings are being trodden underfoot in terms of basic rights; including aspects of thought ownership and access to the combined wealth of all mankind.

In this chapter we have viewed computers as potentially beneficial to society, but as not necessarily so. Machines have always held a janus-like prospect. They magnify human potential with magical and transformative powers, but on the other hand they sometimes bring anti-social, destructive and/or dehumanizing forces into society. Perhaps the current chapter raises more questions than it answers. We ask why should it be be so—that computers bring negative elements into society, and if the negative aspects must always follow any technological revolution and/or improvements. We have considered if our new system of techno-rights could possibly help, by fostering the human use of human beings. Other questions arise, as to the specific ways in which machines may beneficially impact society, and also the ways in which they may sometimes have/bring detrimental effect(s). Someone needs to consider the how, why, when, where and who; and in relation to technological changes; and using examples from history, fiction and also in terms of basic theories.

One may think that many of the problems with respect to technology have been well-examined, and are, to some extent, well-understood at least in terms of outcomes and especially in terms of the anti-humanistic nature of technology. That is to some extent true. However findings are often scattered about in various works of fiction, non-fiction, in papers and now increasingly on social media and in the form of websites and blogs etc. And when it comes to solutions, the lesson(s) of history are difficult to divine. In particular, it would seem that technological revolutions are hard to predict, even harder to manage, and almost impossible to control. Clear is that one technology tends to sweep aside and/or encompass previous technologies. Furthermore the social implications, which at first tend to appear bright and optimistic; in reality turn out to be darker than we would otherwise collectively have wished for.

And the dangers in relation to technology are real. David Thoreau says that men must not: 'become tools of their tools'. Another interesting (if somewhat mystifying) feature of the current zeitgeist, relates to the manner in which many people uncritically accept all technological developments as somehow natural, just and inevitable and/or unstoppable. Perhaps we (as a people) do not even believe that we have the power (or ability) to shape and control our own creations. One example, is that no organizations or regulatory bodies are responsible for the overall strategic direction of all computing inventions on a worldwide basis, and in particular from a humanistic perspective. Perhaps this is about to change, as Sir Tim Berners-Lee has recently called for the creation of an on-line Magna-Carta or Bill of Rights for the Internet (Berners-Lee, 2014) and others including Edward Snowden and Julian Assange have brought attention to the dangers of citizen surveillance.

Today it would seem that we are no longer mere spectators and detached users of machines, but rather it appears that we are now immersed inside of a new global technological entity. Whatsoever 'it' is; has been much debated, for William Gibson it was cyberspace [9], for Sir Tim Berners-Lee the World Wide Web (Berners-Lee, 2014) others called it the Internet, the information super-highway, or the Global Village, still others the World Brain, and not least, George Orwell called one version of it Big Brother (Orwell, 1949).

I would argue that 'it' is simply self; and furthermore it is a self that we ourselves can design, form, shape and use in whatever ways may suit our collective future needs/wishes.

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KEY TERM AND DEFINITIONS

Data Atomization: Refers to the storage of self-contained data units (documents, file etc) on a massively distributed network, and in such a manner that each data unit is split onto a large number of tiny segments (or atoms), the same being atoms which are replicated across the network for later retrieval. There are many copies (perhaps 1000's) of each atom to foster accessibility, redundancy and data immortality.

Data Immortality: Is defined as a data type which is inherently indestructible (or which strives to attain such a status), and/or to data which has an exceptionally long life time (or "lives" effectively fore-ever and so is not susceptible to localized corruption or loss.

Distributed Data: Refers to a special kind of computer network where data units (self-contained pieces of information) is/are stored on more than one node (or physical location).

Human Enhancement Technologies: Are techniques that can be used (not only) for treating illness and disability, but also for enhancing human characteristics and capacities.

Open Publication: Is where anyone can publish anything to anyone, and is defined as the capability of a person (e.g. the user of a computer network) to publish content without censorship.

Self-Centric Data: Is defined as a massively distributed data type which assigns (for the first time) full ownership rights to the creator.

Technoself: Refers to the idea that human identity is shaped /changed by the adoption of new technologies and the relationship between humans and technology.

Chapter 12

Microblogging as an Assisted Learning Tool in Problem-Based Learning (PBL) in Bahrain:

The Edmodo Case

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ABSTRACT

This chapter is part of a series of studies related to the use of social media tools in higher education. In particular, the authors investigate the students' level of familiarity, engagement, and frequency of use of social media technologies. They analyze the experiences of using the Edmodo tool to support PBL, and they relate participants' opinions regarding the use of the tool. The data was collected using two questionnaires and a focus group interview at the end of the course. The main findings of this study are comparable and somehow familiar to their previous study (Paliktzoglou & Suhonen, 2014). Moreover, with regards to the adoption of Edmodo as a learning tool to support PBL, although literature argues that cultural differences play an important role in the acceptance of learning tools (i.e., Cheung, Chiu, & Lee, 2011), the results indicate that Edmodo has a positive reception as learning tool in blended learning to support PBL.

INTRODUCTION AND AIMS

Social media tools are used in many higher education institutions for educational purposes in numerous new and innovative ways. However, because this method is new, especially in a *PBL* context, there is a lack of research on the topic. This study forms part of a series of studies related to the use of social media tools in higher education. In order to investigate and gain additional insight into this situation, we carefully studied the experiences of students during a blended learning course at Bahrain Polytechnic. The aims of this study are to assess students' level of familiarity, engagement

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and frequency of use with social media. We also wanted to discover Web Media students' opinions regarding their experience of using the Edmodo microblogging tool in a *Problem-based Learning* (PBL) context. Finally, we wanted to compare the results of this study to our previous study (Paliktzoglou et. al., in press) which was conducted in an online learning course among Computer Science students in Finland and where the main findings were that the students' engagement with social media is low and that Edmodo, as a learning tool used in a online course, had a positive impact on the students.

The participants in this study were a cohort of Web Media students from the Content Management course at Bahrain Polytechnic. During the course the students used Edmodo as a supporting tool in developing a fictional eMagazine for their *PBL* teamwork assignment. Following the *PBL* structure four teams of four to five students worked together to solve problems and apply concepts learned during the course. The microblogging tool, Edmodo, was used to promote and extend the team interactions online and outside the physical classroom space. The motivation for this study stems from the researcher's opinion that there is a lack of empirical studies on the specific use of Edmodo as a microblogging instructional tool, particularly in higher education. The study aimed to answer the following research questions:

1. What is the Web Media students' engagement with social media tools in higher education in Bahrain?
2. In which degree do the students accept microblogging, and more specifically Edmodo, in a blended learning course to facilitate *PBL*?

In the study we collected data from two questionnaires and a focus group interview at the end of the course. The first questionnaire evaluates the students' level of familiarity, engagement and frequency of use of social media and the second one assesses the adoption of Edmodo as an assisted learning tool in a *PBL* context. We also discuss the experiences and challenges faced by the authors in designing a teaching and learning project which integrates the use of microblogging, and more specifically Edmodo, in a *PBL* context. Finally, we will outline the potential implications and recommendations of this study for future implementations.

BACKGROUND

Learning Framework: Social Media as Learning Tools

The integration of technology in the daily lives of millions of people around the world has resulted in the rapid growth of social media tools over recent years. As such, the social media phenomenon has attracted researchers who wish to study both the positive and negative aspects of using social media tools in various settings. Social media tools offer new and various different ways of communication, using computers and other mobile devices. Users can communicate privately or in a more public way, such as a comment posted for public viewing. However, the fundamental idea behind social media is not novel. In the late 1990s several sites, with functions similar to today's social media tools, had already appeared. From the very beginning of the internet, communicating with others through interfaces such as chat rooms, Internet forums, message boards, web communities and blogs was introduced (Albion, 2008).

Similar to other communication tools, social media tools have rules, conventions and practices which users have to adhere to in order to be accepted as legitimate users in these online communities. As argued by Jacobs (2008) social media tools also have some potential pitfalls to negotiate, such as the unintended consequences of publicly posting sensitive personal information, confusion over privacy settings and contact with people one may not know.

According to Safran, Guetl, and Helic (2007) social media tools are part of a wider online phenomena, also in the field of education and learning, which enables self-expression, communication and more versatile user interaction online. Additionally Chatti, Jarke and Frosch-Wilke (2007) propose that in the era of culture centralized collaboration, one-size-fits-all, top-down, static and knowledge push models of traditional learning initiatives need to be changed to a more open, dynamic, emergent, social, personalized and knowledge pull model for learning. In recent research it has been argued that social media concepts open new windows for more efficient learning and have the potential to overcome many of the drawbacks of traditional learning models (Chatti et al., 2007; Maloney, 2007). Moreover, Ozkan and McKenzie (2008) argue that a 21st century approach to teaching necessitates the engagement of educators with students trough social media technologies. Finally, it is noteworthy to point out that social media tools have the potential to foster the adoption of new learning models based on networking, collaboration, intelligent search and social knowledge creation (Greenhow, Robelia, & Hughes, 2009).

Problem-Based Learning (PBL) and Social Media Tools

Finkle and Torp (1995) define Problem Based Learning as:

A curriculum development and instructional system that simultaneously develops both problem solving strategies and disciplinary knowledge bases and skills by placing students in the active role of problem solvers confronted with an ill-structured problem that mirrors real-world problems.

In other words *PBL* can be described as a student-centered pedagogy which aims to provide knowledge using a problem solving approach. The problem solving approach is composed of students pursuing solutions by asking questions, debating ideas, making, collecting and analyzing data, proposing solutions, drawing conclusions, and communicating their findings to others: the essence of the *PBL* approach. In previous research it was identified that *PBL* promoted critical thinking, collaboration, communication and problem solving and could, at the same time, edify students with skills (Chang, & Lee, 2010; Chung, & Chow, 2004; Hogue, & Kapralos, 2011). Previous research has also shown that technology can be used to support *PBL* pedagogy, making the learning process more relevant and meaningful to the students (Barron et al., 1998; Edelson, Gordin, & Pea, 1999; Solomon, 2003). As such the potential of technology-supported *PBL* seems significant, since it can be used to enrich interactions between students and reduce the time constraints of the traditional classroom.

Integrating the strengths of social media tools, such as Edmodo, in a *PBL* context seems a proficient way to effectively facilitate this teaching approach. Students using social media are able to share information, negotiate and promote ideas and most importantly work cooperatively. Furthermore, through the use of social media the instructor can record the learning process, track which tasks have been completed and ascertain what else needs to be done - thus assuring the successful completion of the learning process.

Albion (2008) argues that the use of social media promotes an interactive, rather than a static relationship, with the information produced. One original example, in which the strengths of social media tools and *PBL* are combined, is a study conducted by ITESM (Monterrey Superior Education Technological Institute). The study shows that the adoption of *PBL* and social media tools effected changes to the curriculum. The study revealed that students' acceptance of the approach was particularly high and an increase in quality of work and motivation was also recorded (Alonso, Alcalá, & López, 2007). Likewise, in keeping with the nature of the *PBL* approach the instructor's role was reinvented, he was now identifiable as a facilitator responsible for the creation of an environment which enhances independent learning. Despite the fact that literature on the topic is limited, there is sufficient evidence to indicate the potential of using social media tools to support *PBL*. Combining the *PBL* approach and social media can create a student driven environment that has several benefits that could ideally enhance independent learning.

MICROBLOGGING AS AN EDUCATIONAL TOOL

Educational Impact of Microblogging

In recent years there has been an increase in research related to the use of microblogging in learning scenarios and its potential has clearly been outlined (Borau, Ullrich, Feng, & Shen, 2009; Ebner & Schiefner, 2008; Gaonkar, Li, Choudhury, Cox, & Schmidt, 2008; Ramsden, 2008). Additionally, McFedries (2007) states that: *A microblog can be seen as a weblog that is restricted to 140 characters per post but is enhanced with social networking facilities.*

As such microblogging is in many ways similar to blogging, with the main difference between the two being that in microblogging (as its name implies) a limited number of text characters and a smaller size of audio and video files is used. Microblogging promotes cooperation, interaction, the exchange of ideas, sharing of resources and reflection on learning among both students and the instructor (Ebner & Maurer, 2008). Additionally Hsu and Ching (2011) argue that with the use of microblogging a solid learning environment can be created where knowledge and community building are promoted in combination with "learning by doing" activities. Moreover, microblogging can promote critical, analytical, creative, intuitive, analogical and associational thinking (Duffy & Bruns, 2006). Nevertheless, using social media in education brings to light important constraints and considerations for educators. Educators must adapt to communicating within a set limit of 140 character increments, managing a constant stream of comments or unethical behaviour by students and potential distraction in a face-to-face classroom (Corbeil & Corbeil, 2011). However, Ebner and Schiefner (2008, p.159) argue that "learning is a cognitive and social process that develops through conversation, and as such is an essential part through all learning processes and microblogging can extend our possibilities". Gao, Luo, and Zhang (2012) suggest that microblogging has the potential to encourage participation, engagement, reflective thinking as well as collaborative learning in different learning settings. Microblogging is a simple way for the audience to ask questions, have discussions, share resources and create shared comments on learning materials (Ebner, 2009). A study by Wright (2010) shows that microblogging promotes the documenting of ongoing processes and just-in-time thoughts and as such students were able to share and reflect upon their teaching experiences. Micro blogging can thus be used to sustain engagement in learning.

Challenges of Using Microblogging

As with any new social media tool introduced in education, microblogging has several challenges which have been presented in previous studies. One of the major challenges was the participants' unfamiliarity with microblogging. As argued by Agherdien (2011) many learners were not familiar with Twitter and found it difficult or even intimidating to use. This challenge falls in the domain of users' resistance to adopt or learn new technology. The unwillingness to learn or use the technology can potentially limit the scope of interactivity afforded by microblogging (Lowe, & Laffey, 2011).

However Rinaldo, Tapp, and Laverie (2011) suggest that convincing students of Twitter's benefits in a creative way and/or establishing rewards to encourage its use could be probable solutions to the challenge. Furthermore, previous research has outlined that a possible challenge to the adoption of microblogging as a learning tool is information overload (Ebner, Lienhardt, Rohs, & Meyer, 2010; Holotescu, & Grosseck, 2009; Rinaldo et al., 2011). The amount of information posted online can sometimes be distracting, even to the extent that some students may feel that it is a waste of time reading posts containing less useful information.

Regardless of the growth in adoption of microblogging in various educational contexts, there is a lack in empirical studies on the topic. This research study aims to discuss experiences and challenges whilst also providing key recommendations for future and similar implementation in an institute of higher education.

Edmodo Microblogging Tool

Edmodo is described on its official site www.edmodo.com as:

…a secure, social learning platform for teachers, students, schools and districts. We provide a safe and easy way for your class to connect and collaborate, share content and access homework, grades and school notices. Our goal is to help educators harness the power of social media to customize the classroom for each and every learner.

Edmodo is a free online microblogging platform that focuses on learning and offers a safe and easy way to connect, collaborate and share ideas, files, events and assignments among instructors and students. Edmodo uses the microblogging model, but it has been especially designed for educational purposes. Basically Edmodo, as a micro blogging social learning platform, is accessible from any mobile device or smart phone. We evaluated a variety of microblogging platforms (including Twitter, Jaiku, Cirip.ro Postcros and Tumbl) and we selected Edmodo for the extensive functionality that it provides which includes the incorporation and use of other social media tools.

Edmodo has an easy to use straightforward interface and features which uses the microblogging model and allows instructors and students to access the tool anytime, anywhere. Instructors can post messages and notes, discuss classroom topics, give assignments and grade class work, share content and materials and network and exchange ideas with their students and other instructors. Finally, Edmodo offers a class calendar and polls feature, a specific feature to store and share files, and the ability to integrate (RSS) streams.

Edmodo supports the use of multiple simultaneous discussions, where the instructor can create collaborative “groups”. Moreover, Edmodo simultaneously provides autonomy and a secure environment where no one without access may view or participate in the discussion learning space unless otherwise designated by the instructor. Additionally, students within their greater group have the ability to create their own groups, the so called “small groups” in order to facilitate a more specific task. The accessibility feature of Edmodo, in combination with the user friendly interface, makes it a potentially effective and promising solution to support group work and PBL. The above mentioned features are the stepping stones to active participation between students and instructors and in so doing Edmodo has the potential to create an effective learning environment.

Edmodo as an Educational Tool

As we have previously discussed vast amounts of research, which focuses on micro blogging in education, has been carried out. Much attention has been afforded to Twitter and the domain of higher education whilst Edmodo has not received as much consideration. However, there have been a few studies related to the use of Edmodo in secondary education which have showed that Edmodo

Figure 1.Edmodo.com

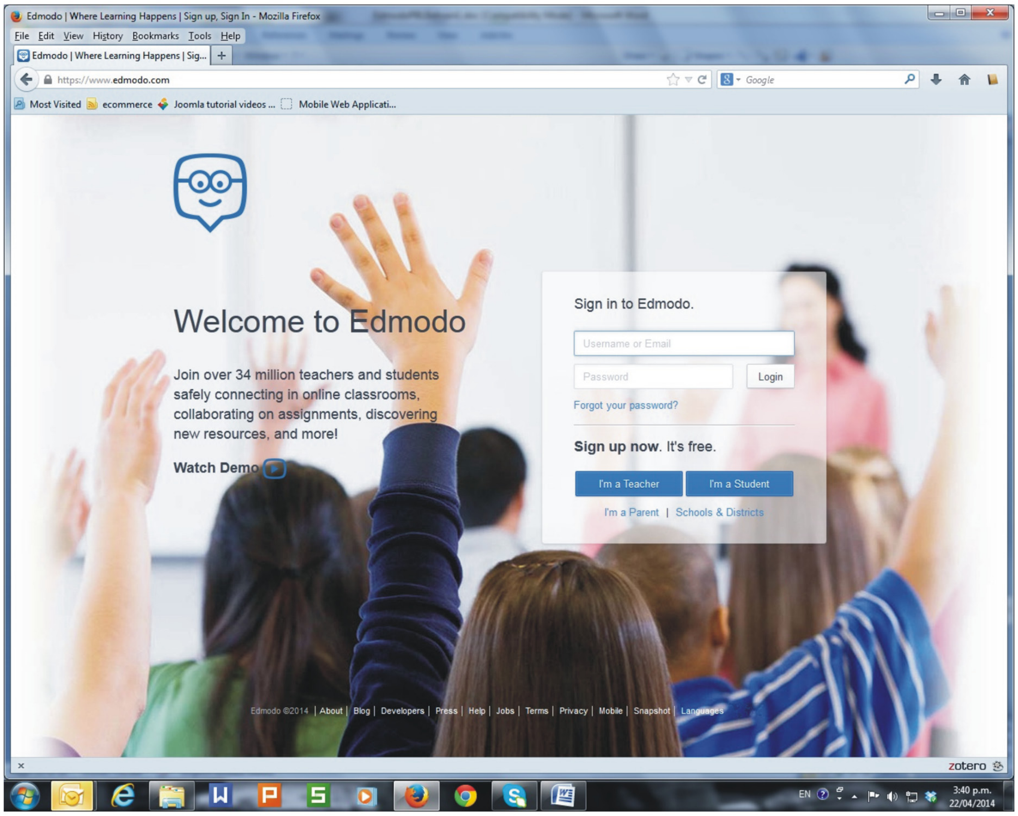
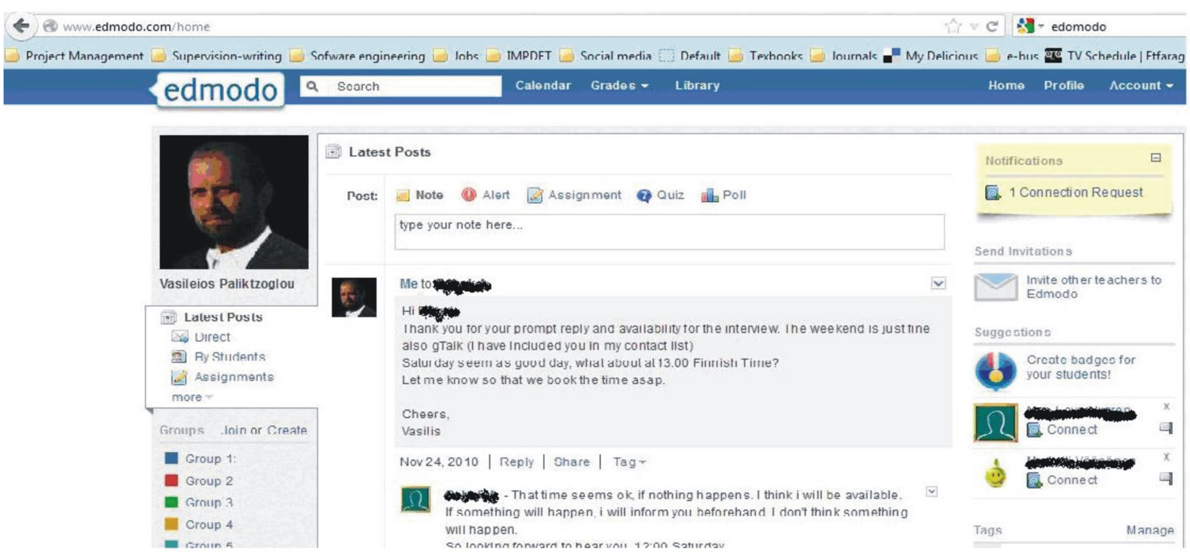


Figure 2. Main features of Edmodo



promotes collaboration between students (Picardo, 2008). Furthermore, Edmodo supports students to formulate and deliver answers and respond to one another in turn. Additionally, a study by Jarc (2010) showed that students' progress can be easily tracked using a discussion thread and that this encourages dialogue and collaboration as it is almost like having an interview with the students. Jarc (2010) argues that Edmodo provides a safe collaborative environment and reduces the amount of paper used in the classroom. The above mentioned studies indicate that Edmodo can easily be adopted in the context of secondary education. However, very little research relates to Edmodo's potential in higher education settings and more specifically PBL context.

RESEARCH DESIGN

The Role of EDMODO in the Study

In this study, Edmodo was introduced as a platform to support *PBL* group work to a cohort of Web Media students participating in the Content Management course at Bahrain Polytechnic. In this course students used Edmodo for their *PBL* teamwork assignment. The aim of the assignment was to develop a fictional eMagazine, and the purpose of Edmodo was to support the process. After completing the first questionnaire, students were introduced to Edmodo and, through a set of practical tasks; they were instructed on how to use the tool. Consequently the students, in groups of four to five, started working with Edmodo as a supporting tool in their *PBL* teamwork assignment. Moreover, all the lecturing material (in the form of articles, books, podcast and RSS) beyond the general instructions relating to the working of the course was given in Moodle. The rest of the course material was provided in Edmodo. It is worth mentioning that the instructor (in his role as facilitator) was constantly supporting, stimulating and facilitating collaboration on a day to day basis. Part of the learning strategy was to motivate students to collaborate, share resources and discuss their work in Edmodo. As part of the collaboration process students were instructed to post at least 3 posts per week related to their topic, and then reply to posts from colleagues. In this way students were encouraged to become active participants and participation was rewarded as part of the course marks.

The research data were collected from two questionnaires: one released at the beginning and one at the end of the course as well as a focus group at the end of the course. At the end of the given questionnaires there was a clear explanation about the nature of the research and the participants were asked for their official approval to proceed with the assurance that all data would be treated confidentially. The first questionnaire was used to ascertain students' familiarity with social media tools and it formed part of the first week's "tasks to do". The students, which were all enrolled in the course, took an average of seven to ten minutes to complete the questionnaire. None of the students received any information relating to Edmodo before hand as we sought to discover how much, if any, prior knowledge they possessed. The first questionnaire was split into two parts: the first part related to the demographic information of the participants (name, age, level of studies) and the second part sought to assess the students' level of familiarity and engagement as well as the frequency with which they made use of social media. The questions were prepared according to the Likert scale where the students could rate each item on a 1 to 5 response scale, but also with the option of "Yes" or "No**".** The second (post-module) questionnaire formed part of the last week's "tasks to do". The students took on average five to eleven minutes to complete the questionnaire. The second questionnaire also consisted of two parts: the first part once again related to the demographic information of the participants (their name, age, level of studies) whilst the second part focused on the engagement during the course with Edmodo. As was the case with the first questionnaire, the questions were planned using a Likert 1 to 5 response scale. The second questionnaire also included open ended questions where students were able to comment or offer suggestions to help improve the use of Edmodo in the future. At the end of the both questionnaires there was a clear explanation as to the nature of the research and the participants were also requested to grant their official approval to proceed with the study. They were once again assured that all data would be treated confidentially.

Finally, following the step-by-step guide, we conducted a focus group at the end of the course (Einsiedel, Brown, & Ross, 1996). During this focus group students had the opportunity to provide feedback about their experience using Edmodo in a *PBL* context.

Results

The dataset, n=23, 17 female (74%) and 6 male (26%), consisted of undergraduate Bahraini students studying at Bahrain Polytechnic. The majority of the students (17) were aged between 20 and 30, none over 30 and 6 under 20.

First-Questionnaire-Social Media Familiarity and Context of Use

In the first part of the questionnaire we wanted to assess the familiarity of the students with various social media tools: Blog, Wiki, Podcast (Audio & Video), Tag cloud, Social Bookmarking, Social Networks, Chat, Micro-blogging, Media sharing, Virtual worlds, Mashups, and m-Learning. In addition we asked how frequently these tools were being used by students. The results for familiarity and frequency respectively are given in Figures 3 and 4. Of all the tools, students were most familiar with Chat, social networks and microblogging as they used these most frequently. They were less familiar (but aware of the application) with mashups, social bookmarking and tag cloud technologies. Prior to the start of the study most students were not familiar with Edmodo, even though their questionnaire answers indicated that microblogging is one of the social media tools with which they are most familiar.

The third part of the first questionnaire wanted to ascertain whether the students had used social media tools for personal learning and studying, as part of course work or for personal use. In the context of use part, the same tools as in the previous section were assessed. The results are presented in Figure 5. The highest frequencies were encountered for Wiki and media sharing as a tool for studying and learning, while social networks, chats and media sharing were most frequently used for personal purposes. The students reported that they did not have much experience in the use of social tools as part of course work. The tools most frequently used in course work were blogs and wikis.

Second Questionnaire - Edmodo Experience

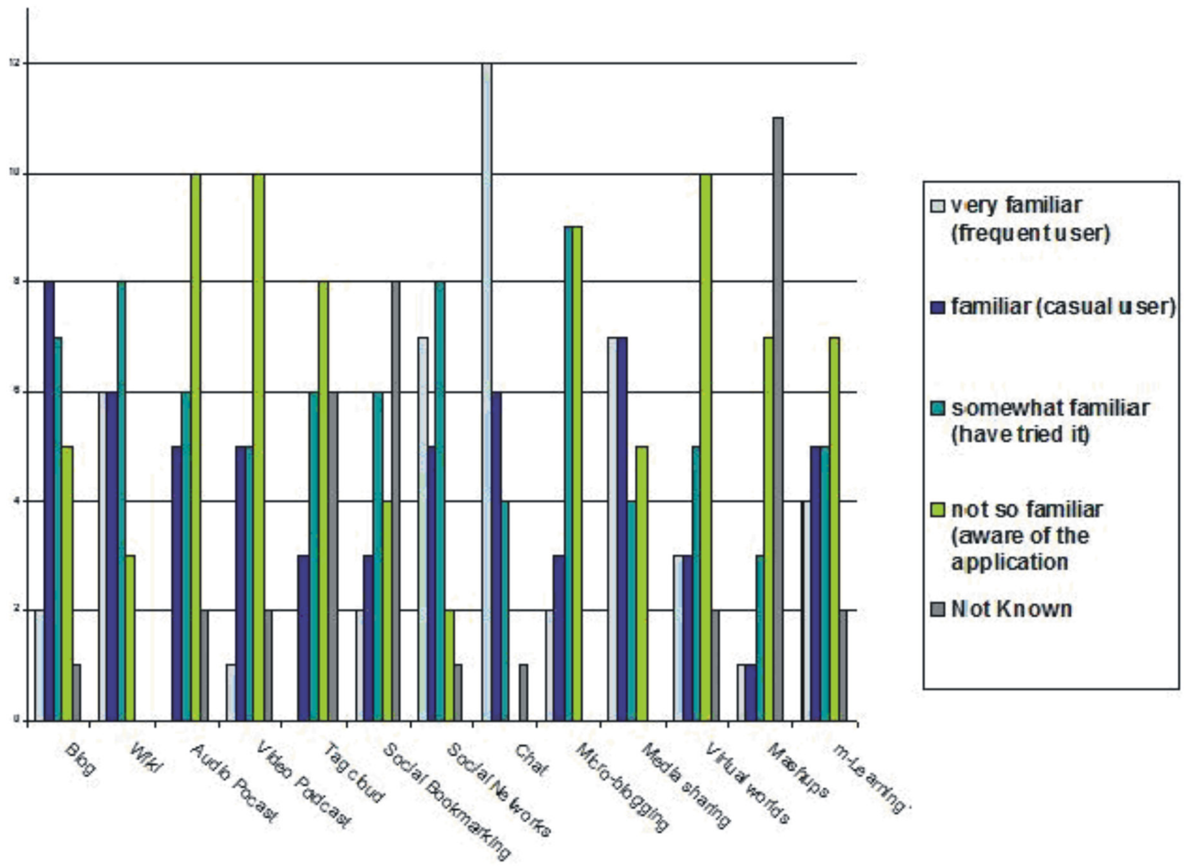
The participants filled out the Edmodo experience questionnaire after they had worked with the Edmodo tool for the duration of the course.

Participation and Collaboration

The results illustrate the positive impact of Edmodo as a learning tool in *Problem Based Learning (PBL).* The students were producing content in Edmodo with the higher frequency "Daily" and "Weekly" respectively. They were reading content with the highest frequency "Daily" and "Weekly" as seen in Figure 6.

Students mentioned that the instructor did influence their use of the tools with higher frequency ("agree", 52%). It was outlined that the structure of the learning activities in the course with the highest frequency ("agree", 57%) motivated the participants' use of Edmodo. The participants mentioned that Edmodo added value to their

Figure 3. Users' Familiarity with Social media tools



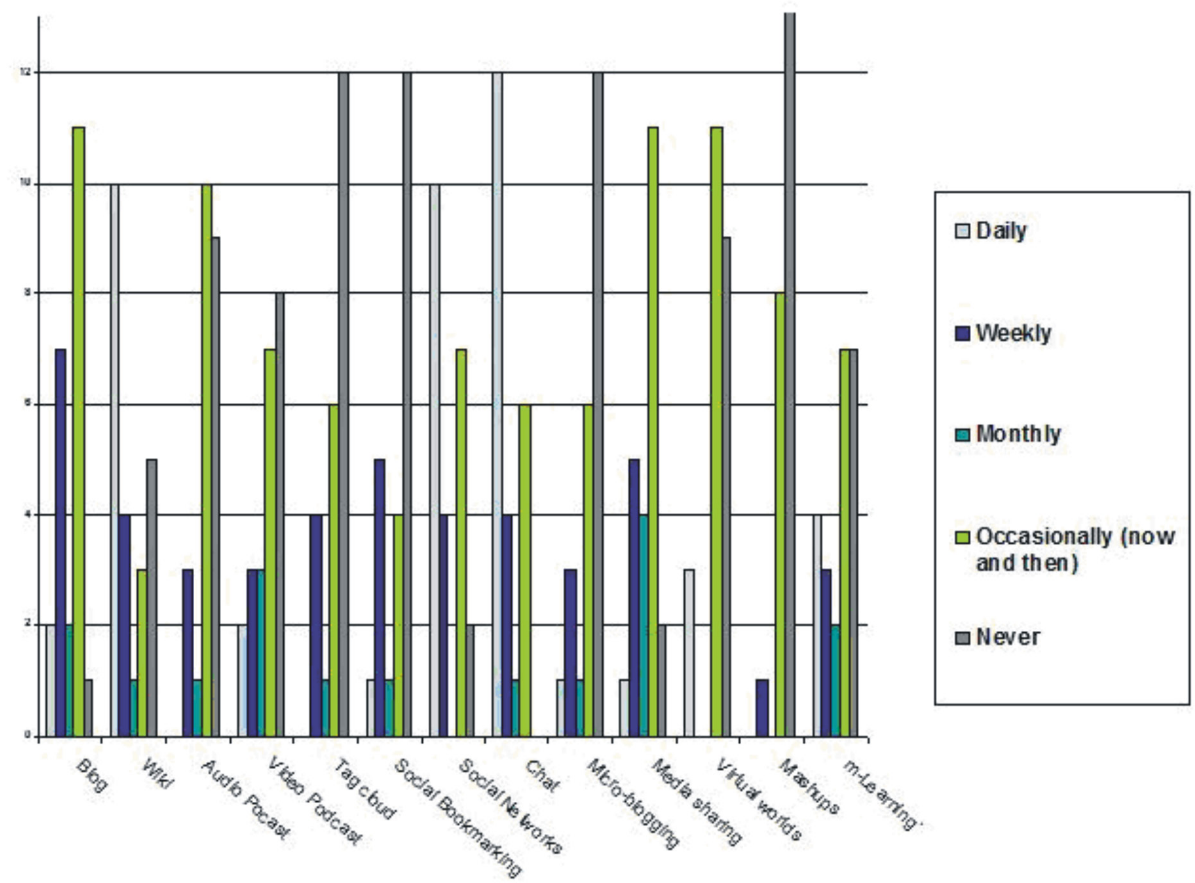
overall learning experience in the course with higher frequency ("agree", 57%). Additionally the participants replied that Edmodo added value to the intellectual value of the course with higher frequency ("agree", 43%).

Reflection and Processing of Course Content

Students mentioned that the "module structure" with the highest (57%) frequency motivated them to use Edmodo. Moreover, the students ("agree"52%) and ("agree"57%) with the higher frequency that the tools facilitated and captured their thoughts on what they were, respectively. As such it was recorded that the participants ("agree"70%) facilitated their personal reflection and supported them to connect concepts with cases and examples ("agree"35%) with higher frequency as seen in Figure 8.

In addition, it was reported that Edmodo supported the participants to work with others in the course, building on ideas or resources together with higher frequency ("completely agree", 61%). The students mentioned that Edmodo supported them to discuss course concepts with others in the course ("completely agree",48%) and supported and created a sense of comfort and community ("agree",52%) and they were able to get more information or support from the instructor ("completely agree",52%).

Figure 4. Frequency of use of Social media tools



Expectations and Recommendation

The students reported that the course met their expectations ("agree", 48%) with the higher frequency and they were very positive in recommending the use of this approach in other courses with ("completely agree", 48%) the higher frequency. Finally, most of the students when asked to comment or suggest improvement in the use of Edmodo, mentioned that they found learning with this tool interesting. However, it was mentioned that prolonged use of the tool (for the duration of the whole semester) can cause the students to become overloaded with information. So much so that eventually they could not easily reach due to the taxonomy of Edmodo.

Focus Group

Following the Einsiedel et al. step-by-step guide to conducting a focus group we conducted a focus group at the end of the course (Einsiedel et al., 1996). The preliminary questions addressed during the focus group are outlined below:

1. What did you like about Edmodo?
2. Please describe any problems that you may have faced using Edmodo.

Figure 5. Context of use of Social media tool

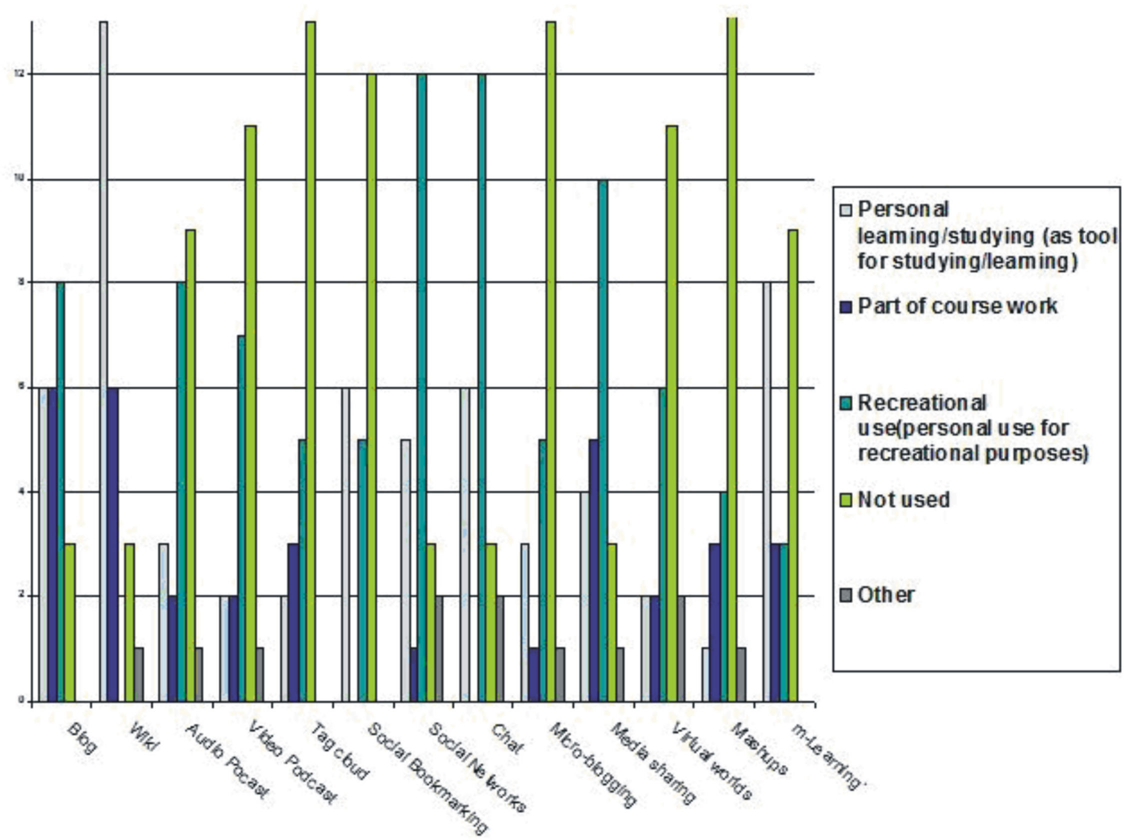


Figure 6. Use of Edmodo during the course

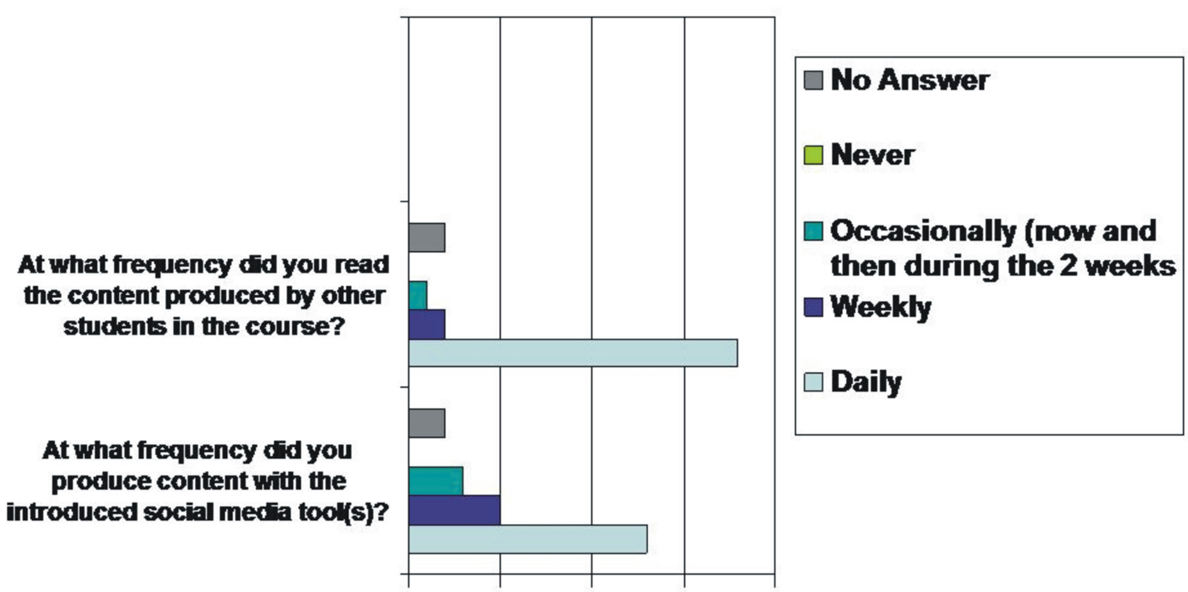


Figure 7. Participation and collaboration

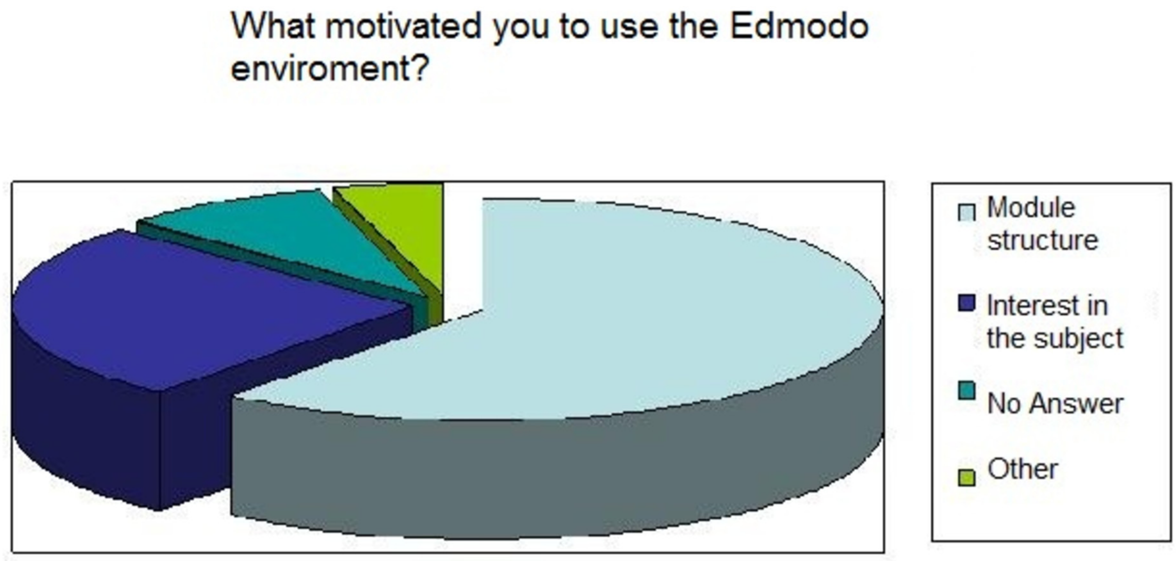
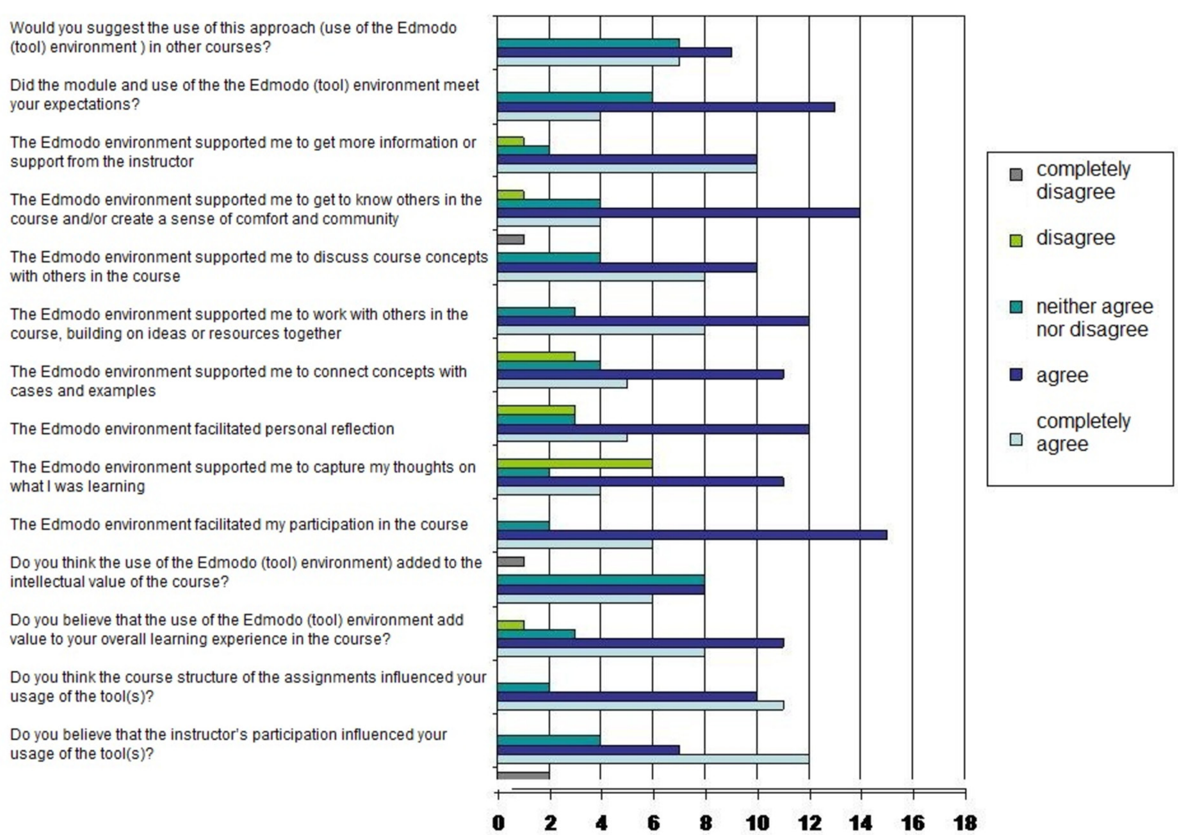


Figure 8. Reflection and processing of course content



3. What features do you think should have been added to Edmodo? Explain the benefits or added value of such features.
4. What is your opinion/perception on the use of Edmodo for educational purposes?
5. Do you think that students/teachers could benefit by using Edmodo? If so, explain how.

Before conducting the focus group, the nature of the research was explained to the participants. It was clearly stated that all data would be treated confidentially. The focus group was transcribed to assure correctness of information. Information of a personal nature was not required and the participants could voluntarily cease their involvement in the study at any time.

Collaboration and Feedback

The students' feedback outlined several positive collaborative learning opportunities.

Students commented that "Edmodo is a very useful tool that connects students together" and that "It's simply an educational Facebook." However, students also outlined the difficulty of working collaboratively stating that "It is difficult to work in groups" and that "It would be more beneficial if each group member participated via Edmodo." Nevertheless, the focus was on their practice rather than on the use of Edmodo itself.

Motivation and Familiarization

The students mentioned that the process of adopting Edmodo as a learning tool happened quickly. Although, the exact time span needed for students to be comfortable with its use varied. Students commented that "It was easy to use, it is like Facebook" and that "It took me some time to get use to the way Edmodo operates."

Technical Issues

In using Edmodo the participants faced some browser-specific problems; however this is not uncommon for any browser related tool. The reported problems stem from user frustrations with some of the additional functionalities in Edmodo such as using widgets to access other social media tools or just from the lack of them.

Positive and Negative Aspects of Edmodo

One of the negative aspects mentioned by students was that the navigation in Edmodo was rather complex and could sometimes be confusing. They remarked that "when I log in I didn't know where to go to and how to navigate" and "the taxonomy was difficult, it was difficult to find older posts." On the other hand the participants mentioned that Edmodo was useful and suggested that it was a very good approach for the tutor-researcher to adopt in the future. One interesting suggestion for a further feature in Edmodo was "I think it would be useful for Edmodo if it had a Blackberry application."

Views on Educational Impact

Students stated that Edmodo allowed them to feel connected to the tutors and other students in the class. The participants specifically mentioned that "Using Edmodo as a group work tool was ideal" and that "Edmodo offers a good environment for working on PBL assignments" as well as that "It is much easier to plan using Edmodo." From an educational point of view it must be stated that using other social media tools within Edmodo was rather useful. Additionally, some of the students highlighted that both educators and students were able to use Edmodo to add to and build upon one another's contribution.

Instructor's Remarks

Working with Edmodo was interactive and enjoyable though a significant amount of time and effort is required on the part of the course instructor to moderate Edmodo, especially when there are more than three groups working on diverse subjects. While using groups is indeed useful and promotes collaboration and the exchange of ideas, we have certain reservations as to how much effort the instructors will need to put into the facilitation of big cohorts/groups where there can be more than 30 contributors. The fact that there are no clear instructions as to the taxonomy in Edmodo could cause problems in following the flow of both course teaching and learning. On the other hand, as students and instructors become more experienced, less instructor input is anticipated, and the above mentioned issues could become less pertinent. Additionally, as argued in the literature, cultural differences play an important role in the acceptance of Edmodo. Students in our case were not skeptical when using Edmodo as a leaching tool (Cheung et al., 2011). On the contrary, it was observed that the reception was more than welcome. Moreover we would suggest the following improvements in order that Edmodo increases its usefulness, especially taking into consideration the *PBL* contexts:

1. Create a dedicated add-on feature to support the *PBL* learning process. This could be implemented by improving Edmodo's taxonomy and relating all the material (links, sources, conversations) to the outlined "problem" of the course.
2. Provide a common "space" for all the *PBL* groups in Edmodo, where all the students and the instructors could communicate and share ideas. At present the groups work in isolation.
3. Add an embedded chat feature that will provide a synchronous communication among students and the instructors. At present there is not such feature available in Edmodo.

Having implemented the features suggested above, the authors argue that Edmodo will become more widespread in the higher education domain and that this will lead to a better reception of the tool, especially considering the *PBL* context.

DISCUSSION

The motivation for this study was inspired by the lack of empirical studies on the specific use of Edmodo as an instructional tool in blended learning courses within a *Problem Based Learning (PBL)* context, particularly in higher education. There has been increasing research on the use of Twitter in learning scenarios (Gao et al., 2012). However, there is still much to investigate on the use of Edmodo as an instructional tool in *Problem Based Learning (PBL)*. The learning curve for the integration of Edmodo in the student participants' course is not steep and our experience was that there were no particular technical drawbacks. From our findings it is evident that Edmodo, as an instructional tool in *Problem Based Learning (PBL),* promotes collaboration among students. The tool supports students' confidence to work collaboratively by receiving useful feedback from fellow students as well as their instructor through forum posts. The reception of Edmodo was positive indicating that it can be used as an online tool for study or personal recreation in a *PBL* context. From the educational point of view it is noteworthy to highlight the fact that in using Edmodo, both educators and students are able to contribute and build upon one another's input. The participants collaborated, using Edmodo to create and read content on a daily basis. As such Edmodo had a high acceptance rate and students mentioned that it is a great tool for learning. Our findings propose that the structure of the module helped in the adoption of Edmodo. Moreover, students also suggested that Edmodo be used in other *PBL* courses. Our study is comparable to studies conducted by Alonso et al. (2007), where it was argued that the nature of *PBL* facilitates the role transformation of *instructor* into *facilitator* who is mainly responsible for creating an atmosphere that enhances independent learning. The main findings of this study, especially with regards to familiarity with social media tools, are comparable and somehow familiar to our previous study (Paliktzoglou et. al., in press) conducted in an online learning course among Computer Science students in Finland. Moreover, with regards to the adoption of Edmodo as a learning tool to support *PBL*, although literature argues that cultural differences play an important role in the acceptance of learning tools (Cheung et al., 2011), our results indicate that Edmodo had a positive reception as learning tool in blended learning to support *PBL*. In addition our findings also point out that the integration of some crucial educational features (such as collaborative writing, conference calls and chat) would add to the adoption of the platform in higher education. As such we would recommend that some of the above mentioned points might prove useful to future educators when considering the integration of Edmodo in blended *Problem Based Learning (PBL)* courses in higher education.

CONCLUSION

This study provides experimental evidence that students' engagement with social media tools can be enhanced by using microblogging, and most specifically Edmodo, as educational tool in blended learning course to support *PBL*. Furthermore, from findings drawn from students' perceptions, engagement and experiences it is evident that the students and the instructor were actively communicating and collaborating in Edmodo. Moreover, students positively recommended the use of Edmodo in other blended learning courses with *PBL* curriculum. It is noteworthy to mention that one specific limitation of our experiment was that the participants were restricted to the specific setting of Web Media students from Bahrain Polytechnic. In addition we suggest that similar studies be conducted with a broader set of participants in order to compare them to this setting. Our results indicate that social media tools, and more specifically Edmodo, can support social-constructivist models of pedagogy and more specifically blended learning courses using *PBL*. Finally, due to the continuing growth in the use of social media tools in higher education, it is hoped that this study will motivate further controlled studies with Edmodo in blended learning courses using the *PBL* context in order to evaluate how emerging technologies can be more efficiently utilized and adopted in higher education. As we mentioned earlier, this study is part of a series of studies related to the use of social media tools in higher education. Further work will include an article in which the Finnish and Bahrain experiences will be compared.

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KEY TERMS AND DEFINTIONS

Blended Learning: A hybrid approach to teaching and learning, where the traditional face to face approach is mixed with web based one.

Edmodo: Educational microblogging tool.

Engagement: Understands concepts and incorporate then in our daily life.

Familiarity: Knowledge of something.

Microblogging: Posting short and frequent microblogs.

Problem Based Learning: Inquiry based teaching method based on problem solving strategies.

Social Media: Web 2.0 web sites and applications.

Chapter 13
Ubiquitous Learning Supporting Systems:
A Challenge for Computing Software Designers

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ABSTRACT

Ubiquitous learning features intuitive ways of identifying appropriate learning collaborators and right learning contents and services at the right place and at the right time. Consequently, there are many aspects that must be considered in designing computing applications that support this kind of learning. In this chapter, ubiquitous learning is introduced and characterized, the challenges that must be faced by those in charge of designing and developing such applications are reviewed, and the state of the art of this recently initiated line of research at the Informatics and Information System Research Institute of the National University of Santiago del Estero are presented. The developments achieved to date as well as the future guidelines are also shown.

INTRODUCTION

The emergence on the web of new paradigms together with their corresponding applications in the educational field and the great development in the communicational technologies allow altogether to make a rich diversity of educational resources available for students, create new and varied training environments, personalize learning and facilitate that a set of training activities be performed from everywhere on every device. Such advancements have brought about the rise of the so called ubiquitous learning (u-learning) which is a new educational paradigm that occurs within a ubiquitous computing environment and let the learning of the right content occur at the proper place, at the right time and in the right way (Shih & Tseng, 2009)

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The networked mobile technology system supporting u-learning is made up of a complex set of multiple ways of mobility, diverse mobile technologies, diversity of transporters, a variety of students, a multiplicity of learning contexts, teachers with different levels of experience in u-learning and several approaches to content design and learning methods. Additionally, the development of u-learning environment requires the user needs being taken into account (i.e. different ways of operating, thinking, knowing that involve physical and cognitive capacities and limitations) so that they can utilize such an environment easily and fruitfully. These questions are mentioned in many papers published. Tackling them is posed as a challenge for those designing and developing u-learning supporting computing applications.

This chapter aims to introduce ubiquitous learning, its theoretical and technological foundations highlighting the differences as to other computer assisted learning models; review the questions made by other authors when designing u-learning environments; and to present the research line on "U-learning supporting Web systems" that is being developed at the Informatics and Information Systems Research Institute of the National University of Santiago del Estero since 2012 by defining its theoretical background, the developments achieved to date as well as the next lines of action.

THE UBIQUITOUS LEARNING

In this section the ubiquitous learning is defined and characterized, its theoretical and technological foundations introduced and the main differences as to the other computer assisted learning models highlighted.

Definition

Traditionally, learning has been seen as a process by which the learner comes into contact and acquires knowledge or skills from an authorized source. This definition is not longer enough to describe the way in which knowledge conditions convergence in the information society. The more advanced learning theories state that learners do not absorb personally significant knowledge passively but they rather create it actively out of their experience of the world. As asserted by Cope & Kalantzis (2009) nowadays, learning, through knowledge creation, goes beyond the design of comprehension within the limits of our head since from the very moment we use web technology to make sense of the world around us using blogs, wikis, mash-ups, podcasts, social software, virtual environments, free code and access media, and many other practices online already existing or emerging, the constructs of our own developing comprehension become information available publicly. Consequently, learning process and products are merging rapidly into a ubiquitous knowledge compromise. Ubiquitous learning represents a new educational paradigm mostly due to the new digital media. Particularly, it is the result of the convergence of e-learning and the ubiquitous computing (Shih & Tseng, 2009)

In relation to the definition of ubiquitous learning; in Saadiah et al. (2010) an interesting analysis of the definitions purposed by various authors is made. From this the one provided by Sakamura & Koshizuka (2005) asserts " … we learn anything, at anytime and at anyplace using ubiquitous informatics technology and infrastructure".

However, Saadiah et al. (2010) state that the terms "anywhere and anytime learning" and "learning with ubiquitous computing technology" raise confusion between researchers. Therefore, they introduce the following definition: "U-learning is a learning paradigm which takes place in a ubiquitous computing environment that enables learning the right thing at the right place and time in the right way". This definition avoids using the term "anything, anywhere and anytime". This is due to the challenge of an information-rich world in providing what is right, at the proper moment and in the right way and not only to make information available at anytime. The main objective of doing so is to help out the students in getting the exact information that they are looking for at the moment.

Characteristics

Although u-learning has attracted the attention of researchers, the criteria or characteristics for u-learning are still unclear (Hwang, 2006). In Chen et al. (2002) six characteristics of m-learning have been identified and since then they have been adapted by various researchers to become part of the u-learning characteristics. These characteristics are urgency of learning need; initiative of knowledge acquisition; mobility of learning setting; interactivity of learning process; situating of instructional activity; and integration of instructional content.

The first attempt in proposing the u-learning characteristics was by Curtis (2002). Compared to Chen, Curtis listed characteristics that are based on three unique key affordances to handheld computing. These characteristics include: permanency, accessibility; and immediacy.

Ogata & Yano (2004) expanded these characteristics by considering learners' mobility within embedded-computing environments. They manage to identify another two major u-learning characteristics, namely interactivity and situating of instructional activities.

In later Works, Hwang et al. (2008) found that it is more appropriate to apply the expression "context-aware" when defining u-learning. In reference to the definition, they proposed several significant characteristics of u-learning which include seamless services, context-aware services, and adaptive services.

Finally, Chiu et al. (2008) considered that using context-aware technologies and ubiquitous computing technologies in learning environments foster students' motivation and performance. Hence, they summarized the main u-learning characteristics as follows: urgency of learning need, initiative of knowledge acquisition, interactivity of learning process, situation of instructional activity, context-awareness, actively provides personalized services, self-regulated learning, seamless learning, adapt subject contents, and learning community.

The various characteristics that have been presented by researchers and discarding those that overlap can be summarized as follows:

- **Permanency:** Students never lose their work unless they were erased deliberatively. Additionally, all the learning processes are recorded continuously every day.
- **Accessibility:** Students have access to their documents, data or video from everywhere. This information is provided on the basis of their request.
- **Immediacy:** Wherever the students are, they can get all the information immediately. Thus, the students may solve problems quickly. Conversely, the student can record the questions and search for the answer later.
- **Interactivity:** Students interact unconsciously with computers and integrate devices; moreover as a benefit from the multiple communicational tools, students interact with experts, teachers, peers, etc. The levels of interactivity achieved using ubiquitous informatics are very high. Two levels of interactivity must be differentiated: on the one hand that occurs between the learner and the device and on the other hand the possibility of communication and collaboration with teachers, experts, and peers. The most basic interaction occurs with the service that is facilitated by the ubiquitous computing which involves a new way of communication with the machines, and even "the communication" (data exchange) among machines without manned intervention.

- **Situation of Instructional Activity:** Learning is integrated into daily life. The problems encountered as well as the knowledge required are introduced in their natural and authentic forms. This helps the students observe the characteristics of the problem situations that make certain actions pertinent. Situated activities aim to reactivate memory by evocating the learning process and the real experience lived that contributes significantly to reinforce new knowledge. In words of Jacquinot et al. (2007): "these interactions improve learning because of the ability to adapt learning interaction to the learner's situation.
- **Adaptability:** Students can obtain right information at the proper place in the right way. Adaptive teaching is based on the idea of fitting teaching methods to the personal characteristics of the students; an individualized teaching method will help learning to occur more rapidly, more efficiently and with a high level of comprehension. Adaptive teaching is quite beneficial to students with especial educative needs or very specific was of knowledge. In this context, ubiquitous information seems to show itself as a new possibility.

The former three characteristics are common to every educative model that includes computer use and operation, especially if they are connected to the Internet. These are very basic characteristics that the environment must warrant in order to develop a ubiquitous learning model.

Background

The ubiquitous learning results and develops from the following pedagogical theories (Zhou et al. (2012). Firstly, the *Behaviorist Theory of Learning,* where the individual learning behavior are seen as "stimulus-response" processes of adapting to the external environments in which if stimulation is controlled, the learning processes can be controlled and predicted and it is therefore possible to control and predict learning results.

Secondly, *Cognitive Learning Theory* which is focused on the viewpoint that students no longer receive external stimulation passively. They are the main body of information processing at the time of actively selecting the external stimuli.

Constructivist Leaning Theory is also underlying the u-learning. According to this theory, knowledge not only results from teaching in classrooms but it is also constructed by students on the basis of their background knowledge system.

Lastly, there is the *Situated Cognition Learning Theory*; learning nature resides on the interactions and collaborations among individual and others in a participative way in environments, practices, and communities.

The ubiquitous learning provides technological support to the theories mentioned above; at the same time, these learning theories constructed theoretical basis for u-learning.

In recent times a new learning theory for the digital era developed by Siemens (2004) & Stephen Downes has arisen on the basis of the analysis of the limitations shown by behaviorism, cognitivism, and constructivism to explain the effect that technology has had on the way we live, communicate, and learn nowadays. This is the *Connectivist Theory*. Connectivism means the integration of the principles explored by the Chaos Theory, Neuronal Networks, complexity and self-organization. Learning is a process that occurs within a wide range of environments that not necessarily are under the control of the individual. This is the reason why knowledge (seen as applicable knowledge) may reside outside the human being; for example, within an organization or a database and is focused on the specialized connection in chunks of information that allows us to increase more and more our present state of knowledge. This theory is guided by the understanding that decisions are made on the basis of the accelerated transformation of the bases. New information is acquired continuously that the previous one becomes obsolete. The ability to discern between important and trivial information is vital as much as the capacity to recognize when this new information alters the decisions made out of previous information. Undoubtedly all this makes up an important theoretical basis for u-learning.

From a technological standpoint ubiquitous learning has its bases in *ubiquitous computing*. The term "ubiquitous computing" has to do with the generalized presence of computers in our lives. Ubiquitous Computing is defined as a computational environment that is knitted in the daily life woof and becomes invisible (Weiser, 1993). This leads human-computer interaction towards a different dimension where the user is surrounded by a complete and intelligent environment made up of devices and sensors that communicate with each other and functions supplying a set of consolidate services. It follows that in ubiquitous computing, software agents, services and devices must integrate perfectly and cooperate to backing human objectives such as needs foresight, negotiation for the service, acting on behalf of the user, and service delivery anywhere and anytime.

This new form of computing shows certain features that make it distinctive (Cope & Kalantzis, 2009):

- **It is Situated:** Ubiquitous computing places information processing, communications, and recording and playback devices every in our lives.
- **It is Interactive:** It allows a person to connect with machine and that the machine answers them back on the basis of the functions programmed on it.
- **It is Participative:** It generates ubiquitous means that in turn generate the culture of participation. It is about a culture where the distinction between writers and readers, creators and consumers is increasingly blurred (Jenkins, 2006).
- **It is Particularly Agnostic:** It gives room to a new sense of space. Things like where we work, where we buy, where we learn, where we live or where we have fun used to be useful to define construed, institutionalized, unbelievable solid spaces. Ubiquitous computing makes the limits between such spaces be at least porous though it is possible that in the long term it questions the relevance of what has short time ago been considered unbreakable spatial, institutional and vital borders.
- **It is Temporally Agnostic:** It also creates new sense of time. It fuses the "now" and the "when". Being able to save easily and cheap makes asynchronous communication easier in such a way that there is no need for a lesson, a movie or a work shift to start at a given time. "Now" can be before or after. What is important is not to take into account the others' schedules but to program ours.
- **It is Cognitively Integrated:** Ubiquitous computing demands new ways of mental getting around, new logics of social navigation, new uses of the computer considered as an appendix of our thought. Our thought is built individualistically through a path weaved using icons and hyper-textual links. It is sought instead of following instructions. One's own routes of reading are created; things are not read as the author thought it should be done. These activities make thought be shaped by the computer.
- **It is Intuitive:** As any other habit, ubiquitous informatics is a very intuitive part of our life and world experiences, a kind of second nature at least from the very moment we learn to operate devices. Adults that having overcome the digital gap have become fluent speakers of a second language (the language of the ubiquitous informatics), and children that have grown up as "digital natives" speak the ubiqui-

tous computing language as it has always been there. This computing has become a so ubiquitous thing that it is hard for both native and second language speakers even to notice its presence. It is just the way we live today.

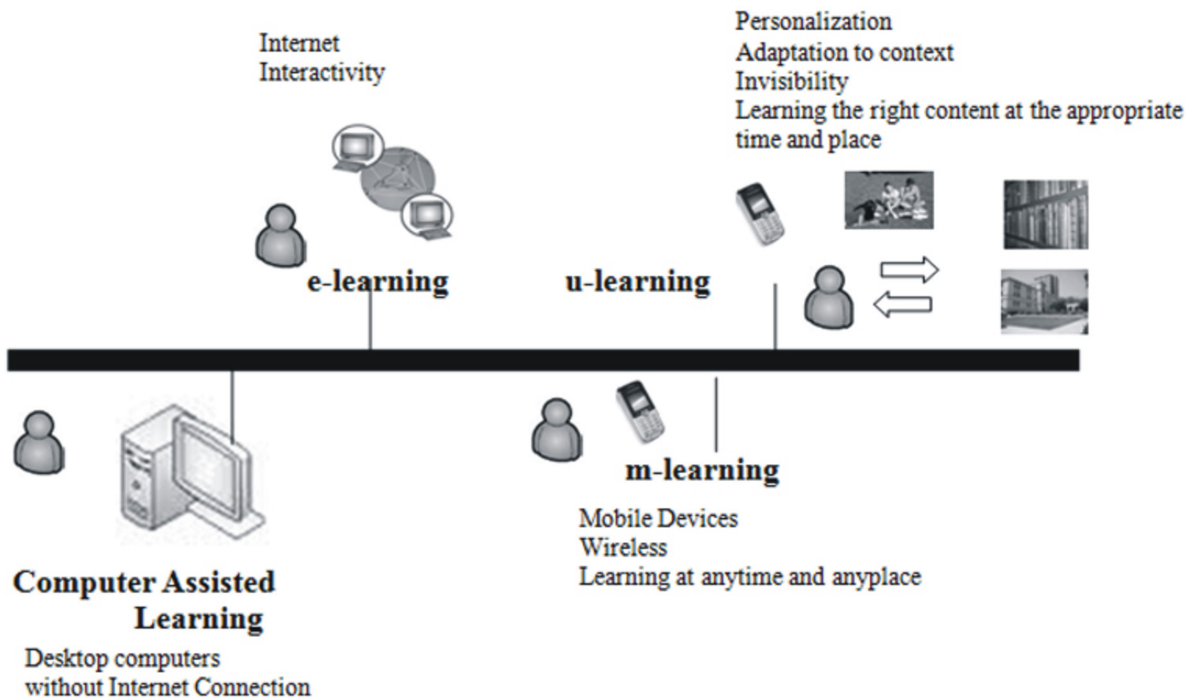
- **It is Invisible:** The user is exposed to a few sets of services available to them and is ignorant of the implementation of the complex systems supporting those services (Satyanarayanan, 2001).

Ubiquitous Learning as to Other Learning Paradigms

U-learning is a new learning paradigm considered as an evolution from the former ones that went from the conventional learning to the electronic learning (e-learning), from this to the mobile learning (m-learning) and now the change goes to u-learning. Later on and on the basis of the works by Ogata et al. (2005), Saadiah et al. (2010) and Liu & Hwan (2009) these paradigms are compared by listing the most outstanding individual characteristics in order to provide a better comprehension of the ubiquitous learning. Its evolution is synthesized in Figure 1.

- **Computer Assisted Learning:** In this learning paradigm, desktop computers are used and consequently they are not integrated into the environment surrounding the student which makes it impossible both context information retrieving and mobile feasibility.
- **Electronic Learning (E-Learning):** It refers to online education using conventional computers connected to the web, so interacting with the web is its main characteristic. This is an interactive learning with subject contents available online and automatic feedback provided the students' learning activities. In this learning the Internet is the fundamental requirement since it allows for the access to study materials and monitoring of learners' activities. It is a holistic learning with synchronous and asynchronous access. Self-directed by the student and oriented on the basis of their online behaviors. There are individual, in peer group, and inter- peer group leaning activities. Evaluation modes are based on values, synchronous or asynchronous judgments of the students themselves, their peers, or teachers and through an artificial grading of the learning system. Only does the passive participation of the student take place in this learning context. Every kind of pedagogical theories and tutoring strategies are applied in this learning paradigm.
- **Mobile Learning (M-Learning):** The fundamental *characteristic* of this learning is its learner´s increased capacity to move physically within their learning environment. This mobility is due to the use of such devices as PDA, tablets, smart phones, and so on. These mobile devices can be connected to the Internet using wireless technologies and allow for the learning in anyplace at anytime. However, information about the learner learning context cannot be retrieved in this learning paradigm. Like the last one, it is a holistic learning with synchronous and asynchronous access though in this case, it is situated in the real environment what allows for a timely access to learning information. There exists an active participation of the student and there are individual, group, and inter-group learning activities but using situated information that permits declarative knowledge such as real-world learning objects observation and classification be acquired. Learning contexts belong to real world but the learning context is passive. The learning strategies are project-based

Figure 1.



and authentic learning and scaffolding (Liu & Hwan, 2009).

- **Ubiquitous Learning (U-Learning):** This a special kind of distance education that is defined as an environment compatible with computers integrated to and invisible to daily life. Therefore, they support a dynamic learning by communicating the devices integrated to the student's environment. The communication among the devices and the sensors integrated to the environment allow learning to learn while the students are in movement integrating themselves in this way to their learning environment. It is mainly applied to the procedural knowledge learning using authentic context information what makes it appropriate to carry out activities aiming to achieve the skills and capacities needed for performing complex experiments. It allows for personalizing not only on the basis of the learner learning style and their background knowledge but with the context aspects and information such as location, time, various devices, etc. It increases the chances for designing innovative educational activities that can be carried out within and outside a physical space (indoors and outdoors) thanks to the possibility for sensing the context. If facilitates access and evaluation since instantaneous feedback and advices are given. U-learning is appropriate for assessing real-world learning activities. The specially used strategies are the project-based learning, authentic learning, scaffolding and cognitive learning (Liu & Hwan, 2009).

UBIQUITOUS LEARNING CHALLENGES

Out of reviewing works by various authors tackling the ubiquitous leaning theme, what follows is a list of the main challenges that those designing and developing computerized environments that give support to this kind of learning must face.

Challenges for the Educational Environment

Cope and Kalantzis (2009) suggest seven changes to be made in the educational environment in order to

Implement a practice that is congruent to the ubiquitous learning. As follows:

1. Blurring the institutional, spatial and temporal boundaries of traditional education. In ubiquitous learning, the educative fact may occur anywhere and anytime in contrast to what happens in the traditional education where students must stay in the same place at the same time, study the same topics and have to follow the same pace. Other relevant aspect to highlight is that education continues "during the entire lifecycle"
2. **Re-Arranging Balance:** In the traditional classroom, a certain kind of discipline (i.e. listening to the teacher, reading the authority embodied by the textbook) and a particular relation with knowledge (i.e. the facts and theories that must be known, the bibliography that must be studied, and the history from which examples should be extracted) underlie. Today, equilibriums have changed in many life fields. Ubiquitous computing has brought about with it huge transformations and have generated a "new relational order". Students change from passive knowledge receivers into collaborators assisting teachers in knowledge design. There are many sources of knowledge that frequently come into problematic disagreement one to another. There are many knowledge sites and modalities that have to be uncovered by one in order to make sense of the world. There may be certain widely accepted knowledge corpuses so that their authority is unquestionable but this is applied only in certain specific and local circumstances: we can do it only in a given space and time.
3. **Learning to Recognize Differences among Students and to Use Them as Productive Resource:** In the ubiquitous learning not all the students have to be on the same page; they may be on different pages in accordance with their needs. Every learner may connect the general and authorized with particular specifications related to their vital experiences and interests. All the learners may be knowledge and culture creators. Learners can also work in group building up collaborative knowledge. In this context, teachers have to compromise themselves as members and co-designers of such cosmopolitan learning communities, always by their learners, together with them in their learning journeys.
4. **Widening the Range and Combination of Representational Modes:** The ubiquitous computing records and transmits meaning in multimodal way: oral, written, visual, and sonorous. Unlike the previous recording technologies, these representational modes still remain reduced to the same processing make: a sum of ones and zeros. Educators have no more to save than to understand the different grammars of the multiple signifying modes that have made the digital possible, as much deep as the traditional alphabet or the symbolic forms.
5. **Developing Conceptualizing Capacities:** The ubiquitous computing world is full of complex technical and social architectures that we should be able to read both as readers and participants because which this learning

demands higher order levels of abstraction and metacognitive strategies.

6. **Connecting the Own Thought with the Distributed Cognition:** In the era of ubiquitous computing, knowledge is within one's reach because it resides in the device hold in their hands. Educators have to think on new ways of evaluating learners' abilities since in this new environment knowing how to know is more important than just knowing.
7. **Building Collaborative Knowledge Cultures:** The ubiquitous computing makes it easier social reflexivity that can lead to "communities of practice". Within a ubiquitous learning context, teachers tend to take advantage of peers knowledge building and of the collective intelligence power. Additionally, students are involved with people that in other context (past) would have been considered as an intrusive, individuals foreign to the learning process: parents and other relatives, friends with whom share interests, experts. Social-network-based digital spaces are the best indicated for a kind of job joining simplicity and transparence, and that value contribution diversity.

Challenges in the Design of Computer-Assisted Learning Systems

Hwang (2006) enunciates a set of characteristics that must be met by software environments giving support to ubiquitous learning and represent a challenge for designers as well. The author points out that this type of software must:

- *Be context-sensitive*, that is, that the student's situation or the real environment situation in which the student is situated must be able to be sensed.
- *Provide support to personalization* of a right way, place, and moment on the basis of the student's personal and environmental situation as well as of their profile and "portfolio".
- *Make a seaming less learning possible* anyplace, anytime, that is, the student must be able to learn uninterruptedly while going from one place to another.
- *Be able to adapt the content of every theme* in order to adjust them to the functions of the various mobile devices.

This author also defines a set of situational parameters that need to be considered at the time of performing evaluating activities and tutorship in a ubiquitous learning environment, namely:

- **Personal Situation Sensed by the System:** It includes student´s location and time of arrival, temperature, sweat level, heart beatings, blood pressure, etc.
- **Environmental Situation Detected by the System:** Includes sensor's ID and location, temperature, humidity, air components, and other environmental parameters surrounding the sensor, and the objects getting close to the sensor.
- **Feedback from the Mobile Learning Device´s Sensor:** It includes the values detected for the elements (e.g. water temperature and acidity, air pollution, a tree shape and color) and their pictures.
- **Personal Data Obtained from Databases:** It includes the learner's learning profile and portfolio as well as their predefined programming, the time they are expected to start a learning activity, the acceptable longest and shortest time for a learning activity, the learning place, the ways to achieve learning o sequences of a course, drawbacks and prohibitions of a running learning activity, etc.
- **Environmental Data Retrieved from Databases:** It includes detailed information of the learning site such as the learning activities sequencing displayed on the site,

the site management limitations or rules, the site utilization records, the equipment placed in the site, the ones using the site or being its owners, etc.

Challenges in Context Modeling and Representation

Due to the relevance of context representation in the ubiquitous learning systems, this section provides a detailed tackle of the topic is done.

Schilit & Theimer first present the term "context sensitive" to refer to the location, the identities of the people nearby, the objects and the changes in these objects. Brown et al. (1997) adds information about the time of the day, season, temperature, etc. to this definition. Schmidt et al. (1999) defines context as "knowledge about the information technology user and device state including environment, situation, and in a lesser extent the location.". These authors design the general structure of the context out of six factors: the user, the social environment, the activity, the conditions, the infrastructure, and the position. At this point worth being highlighted the inclusion of the "infrastructure" and "device" contexts as additional elements incorporated into the list of consolidate descriptors (position, social network, environmental parameters) (Bernardos Barbolla, 2008). According to Want et al. (1995) context can be defined by: 1) the of the user´s symbolic description of position; 2) their identity and that of surrounding them; 3) the identities and the state of the objects near the user; and 4) physical parameters such as weather, temperature, light level, meteorological conditions.

Other authors like Dey (1998) add the user's emotional state and focus of attention to the context data. The same author as well criticizes these definitions saying that some of them are too specific (Dey, 2000). Consequently the context is defined as "whatever information that can be used to characterize an entity´s situation. Such an entity is a person, a place, an object considered to be relevant as to the user-application interaction that is likely to include the user and the application itself". This definition makes context definition for a given application easier for an application developer. Whether a piece of information can be used to characterize the user situation in an interaction, it is the context that is considered to be the information.

On the other hand, Schilit et al. (1994) pose a definition for context from a user-centered approach saying that the three more important aspects of context are: where are you? who are you with? and what resources are close to you? They assure that context is more than just knowledge of user location since there are other things that are of interest to them that can too be mobile and that change constantly. Thus, they affirm that the elements of interest are the relationship between the user and the various things in the situation.

Considering the diversity of definitions, it becomes interesting the review on the different approaches to capture and use the context in ubiquitous computing environments made by Prekop & Burnett (2003). It is presented en Table 1.

When learning, context comprises two fundamental environments, namely the *learning context* and the *mobile/ubiquitous context.* As to the former, many authors have given different interpretations of it though seemingly coincide in that learning context refers to environment, situations, tools, materials, people (in relation to social networks), and learning activities. Being more specific, learning context is characterized by the students, the learning objects, and the learning route where the set of learning activities is performed in the light of a particular pedagogical approach.

The context in ubiquitous environments is summarized mainly in the space and temporal aspects of the user situation. On the basis of the changes and properties of this two attributes, the users of these systems will get information from the various personalized services available to them.

Table 1. Approaches to use and capture context in ubiquitous systems

Approache	Approaches Features	Works
Focused on physical location	Use GPS coordinates to identify user physical location.	(Brown et al.,1997), (Burrell & Gay, 2003) and (Pascoe, 1998)
Focused on demarcated physical location	Mark physical space with a mobile WWW infrastructure. URLs are associated with physical places or objects - for example, exhibits in a museum. When a user with an enabled device is moving through physical space, the Web pages associated with the physical locations or objects are shown on the device.	(Kindberg et al.,2000) and (Smailagic et al., 2001)
Focused on external dimension of user context	Includes location and a variety of different sensors, such as light, sound, movement, touch, temperature, air pressure, etc.., to understand the physical context of the user. This approach allows building context-aware applications with a richer understanding of user actions within the computing environment.	(Kovacs et al., 1999), (Kidd et al., 1999), (Coen, 1998) and (Mozer, 1999)
Focused on internal dimension of user context	Expands the previous approach towards more cognitive domains, such as information retrieval, decision making, monitoring situations, product design, etc. For this includes internal dimension of users context (goals, tasks, work environment, business processes, personal events, communication, physical and emotional state, etc.)	(Budzik & Hammond, 2000), (Finkelstein et al., 2001), (Lawrence, 2000) and (Hong & Landay, 2001)
Hybrids	They take into account internal and external factors.	(Burnett & Chapman, 2001) and (Prekop & Burnett, 2003)

The context is a rich-in-information source requiring advanced models of representation; it is needed for defining, manipulating and storing contextual information in a way that can be processed by a machine. The context may have multiple alternative representations. The key point is to find the most appropriate representation for the application development becomes easier. Context modeling is the step previous to design and implementation of any ubiquitous system. According to Held et al. (2002) and Strang and Linnhoff-Popien (2004) context representation must be:

- *Structured* so that information can be filtered effectively
- *Interchangeable (and interpretable)* before the different system components.
- *Able to compose/decompose itself* and keep itself in distributed form.
- *Uniform*, to facilitate interpretation during the mediation process of service and contents adaptations in both intermediate stages and final devices meeting the established user preferences.
- *Extendable* to be able to include future attributes
- *Appropriate* to handle information quality parameters
- *Standardized* in order to become interchangeable among different system entities.

There exist many representations of the context model (Strang & Linnhoff-Popien, 2004): key-value, marking schemes, graphics, object-oriented, logics-based, ontology-based, layered, and so on. Other challenge consists of choosing the most appropriate representation able to meet most of the expectations.

Shortly, it can be said that finding the way to develop the computational and managerial abilities of the ubiquitous devices to orientate students' learning and improve the development of their cognitive structures and thought models in addition to promote knowledge creation and solve their problems are the key issues to be solved at the time the informatics environments supporting ubiquitous learning be designed.

OUR CONTRIBUTIONS TO THE UBIQUITOUS LEARNING SUPPORTING SYSTEMS FIELD

In order to face the aforementioned challenges, the research line on "*Web information systems supporting Ubiquitous learning"* is being developed at the *Informatics and Information Systems Research Institute of the National University of Santiago del Estero*. This line is developed within the frame of the research projects entitled "*Personalized Web information system based on ontologies to support ubiquitous Learning",* approved by the Scientific and Technological Researches Secretary of the National University of Santiago del Estero for the period 2012-2015; and the "*Multi-agent Adaptive Systems supporting Ubiquitous and Collaborative Learning"* research project approved by the Scientific and Technological Promotion National Agency and the National University of Santiago del Estero, for the period 2014-2016.

This research line has the objective to address theoretical and methodological contributions that can be made in the development of web information systems to support learning, through the application of ubiquitous computing techniques and methods, ontology, and personalization techniques. Therefore we are working on the following hypothesis: It is possible to improve the interoperability and usability of web information systems, to support ubiquitous learning, in university contexts incorporating ontology and implementing personalization techniques.

Objectives

Out of the enunciated hypothesis the following specific objectives were posed:

1. To design models of ubiquitous learning environments adjusted to the university context from a systemic approach.
2. To analyze, design, construct, evaluate and/or re-use ontologies for web information systems supporting ubiquitous learning in university contexts.
3. To design, construct and evaluate ontology-based user models to personalizing web information systems supporting the ubiquitous learning in university contexts.
4. To design, construct, and evaluate the technology agent-based modules of content personalization, navigation and user interfaces for web information systems supporting ubiquitous learning in university contexts.
5. To integrate modules of content personalization, navigation and user interfaces in web information systems supporting ubiquitous learning in university contexts.

Developments Achieved

In attention to the objectives posed in the previous sections, what follows is a brief presentation of the developments achieved within the frame of research projects already mentioned:

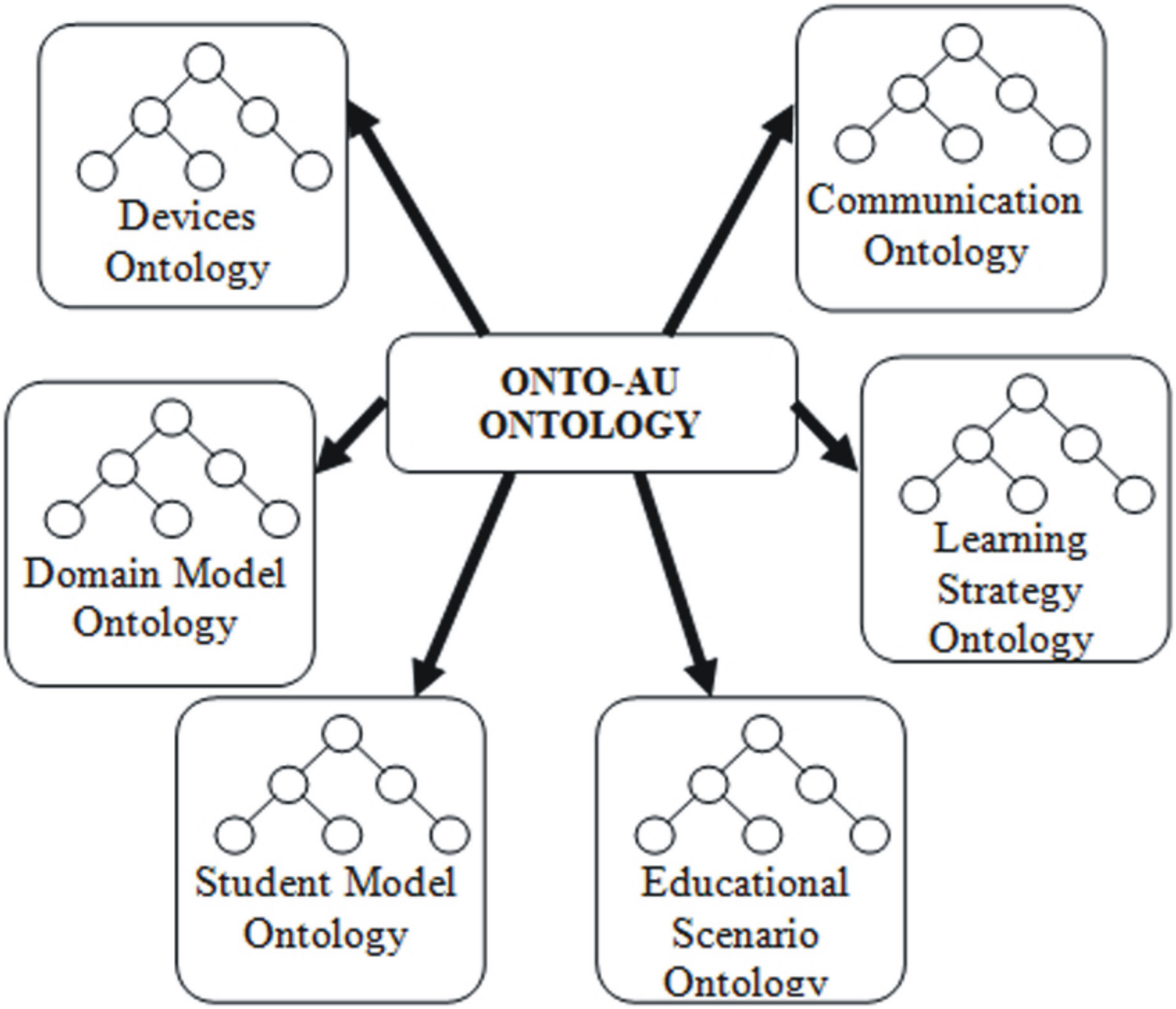
- **ONTO-UL, an Ontology Supporting Ubiquitous Learning (Álvarez et al., 2012):** Facing the need of representing and integrating information related to the various aspects involved in ubiquitous learning, the ontology ONTO-UL is proposed and shown in Figure 2 where the different elements of the environment are represented conceptually. It attempts to give students support through personalized services in a wide range of working contexts. ONTO-UL is made up of several ontologies, each one responding to a specific objective as follows: devices ontology, communication ontology, domain ontology, student model ontology, educational setting ontology, and teaching strategy ontology. The set of ontologies conforming the ONTO-UL becomes consequently a fundamental tool to personalize the various services that a web service offers to support the ubiquitous learning; provides an appropriate frame to offer a learning service adjusted to context changes, mobility, and connectivity as well as to the own individual characteristics of each student.

- **Student's Ontology for Computer Networks Teaching Ubiquitous System (González & Durán, 2013):** One of the ontologies forming ONTO-UL is that of the user (student) profile designed and developed for university u-learning systems. To achieve it, it was necessary to select previously the characteristics of the students and the environment that are relevant to carry out personalizing tasks in such systems. The ontology was constructed using the Protege-OWL software and evaluated to ckeck its quality. It was thus possible to identify both advantages and drawbacks of ontologies utilization to create the required model. Figure 3 shows the classes and subclasses of this ontology.

- **Generic Model of a Multi-Agent System Supporting Ubiquitous Learning (Durán et al., 2014a):** Aiming at facing the complexity of those informatics applications able to support the ubiquitous learning a model-based design approach was considered to tackle the task. Consequently, a generic model of informatics applications supporting ubiquitous learning was developed. This looks at three general models: the architecture of the application, learning context (where the student, the domain,, and the learning strategies are modeled), and ubiquitous learning (where the available technology and the environment are modeled). To manage all these models and the ONTO-UL ontology the architecture of a web system was developed as conformed by a set of software agents in charge of maintaining the needed ontologies and personalizing the various services of the ubiquitous learning environment. This can be seen in Figure 4.

- **Model-Based Approach to Represent Context in Ubiquitous Learning Applications (Álvarez et al., 2013):** A context meta-model is proposed for ubiquitous learning applications. This meta-model (Figure 5) is made up of a "Learning context model" including, in turn, a Student Model (describing the most relevant characteristics of the student in order for personalization); a Domain Model (containing the classes that allow for specifying the organization, the representation and structure of learning objects on themes of the application domain); a Learning Strategy Model (describing the different actions that can be used to make mostly significant learning possible in the context of ubiquitous learning); a Ubiquitous context Model containing a Devices Model (describing the different types of devices such as PDA, sensors and mobile phones equipped with various hardware and software that can be used by the students of a u-learning environment), a Communication Model (describing the different types of communication between the u-learning system and the user), and an Environment Model (describing the various ones in which ubiquitous learning may be achieved); and a Functional Model that allows to relate both previous models and model the system tasks and capacities.

Figure 2. ONTO-UL Ontology Model (Álvarez et al., 2012)



- **Instantiation of the Services Model (Durán et al., 2013):** On the basis of the generic model introduced by Alvarez et al. (2013), a new version was generated by adding the Services Model that describes the categories and types of services. The category represents the service class offered by the application. The type represents a group of services with characteristics in common within a category of services. Then the instantiation of this model was performed for designing an application supportive of ubiquitous learning for university students enrolled in a course on "Computers Network". The model instantiated is presented in Figure 6.

- **Ontological Models-Based Architecture for Ubiquitous Learning Applications (Durán et al., 2014b):** Architecture to develop informatic ubiquitous learning applications is proposed. On the basis of this architecture the development of appli-

Figure 3. Class Hierarchy of the ONTO-UL

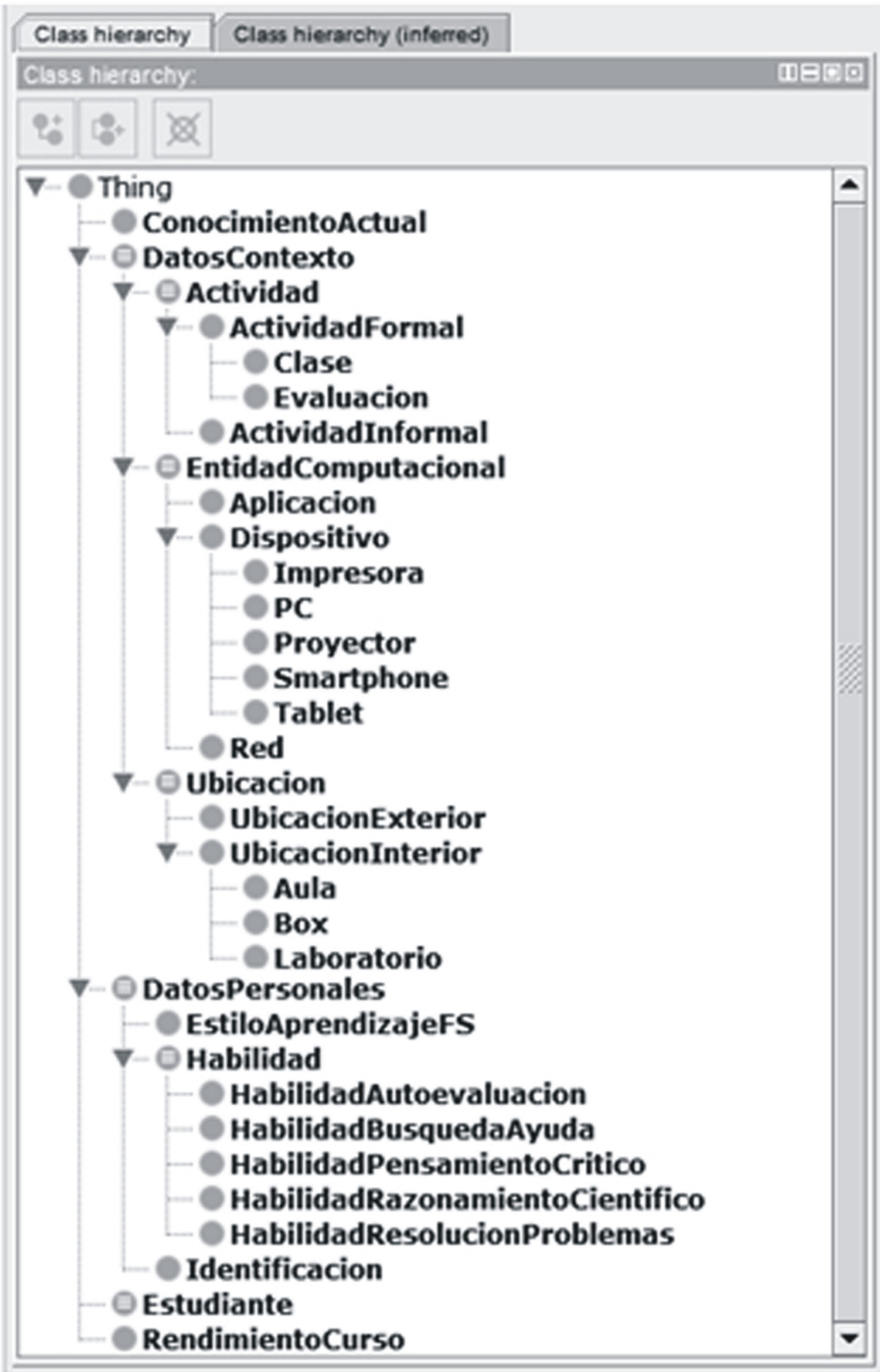
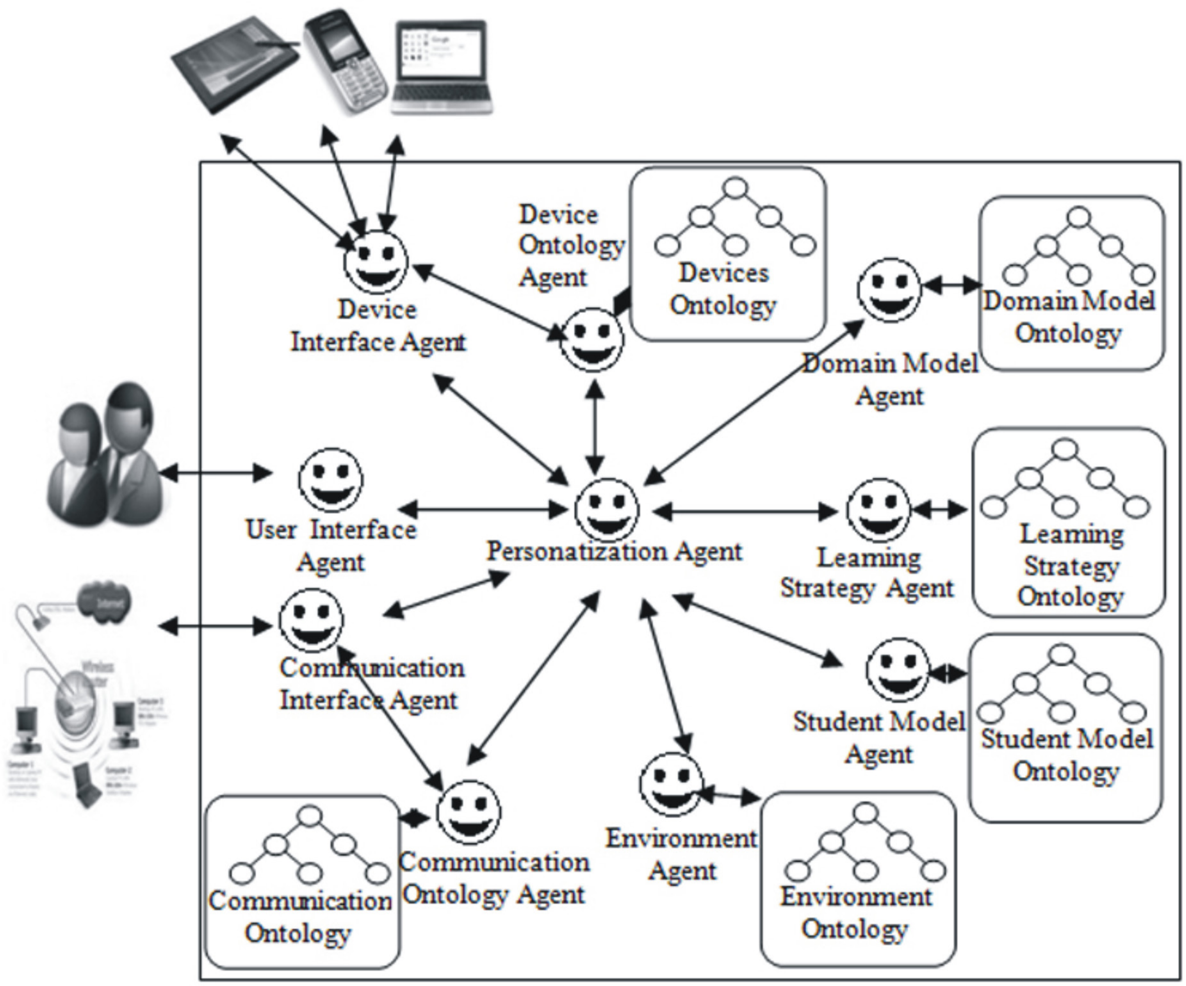
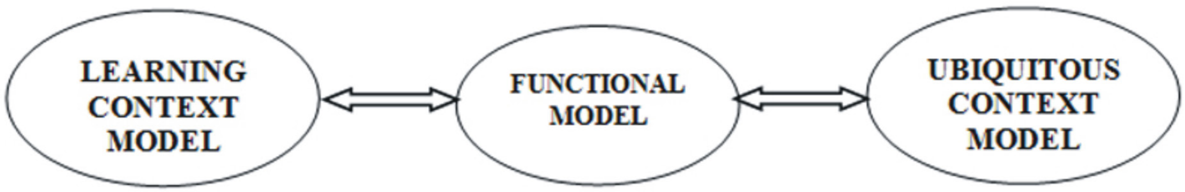


Figure 4. The Architecture of the Multi-Agent System (Durán et al., 2014a)



cations that operate in dynamic environments of ubiquitous computing and adapt to context changes will be possible. This architecture offers, in addition, an ontological method-based approach to application development that facilitates the dynamic and automatic adaptation of the services available to the student. The architecture proposed embraces four dimensions (Figure 7): the models, the ontologies, the software components, and the outer world. The first and the second ones include the representation by means of CIM-type models (computer independent model) and its later transformation to PIM-type model (Platform independent models). The CIM-type models represent the application domain and for this case the use of ontologies is proposed in addition to the Use Case Diagrams, Activity Diagrams, etc. that are usually used in Software Engineering. For the PIM-type models the OWL-type ontology management language will be used together with other models proposed by Software engineering. The third dimension of this architecture comprises the various

Figure 5. Context Meta-model for Ubiquitous Learning Applications (Álvarez et al., 2013)



software modules making up the ubiquitous learning application –PSM (Platform-Specific Models). The fourth reflects the system environment (i.e. student, system administrator, mobile devices by which the student can connect to the system and the outer data resources the system accesses to such as Learning Objects repositories) that must be considered in all the previous models.

CONCLUSION AND FUTURE WORKS

In spite of the fact that ubiquitous learning environments have caught researchers' attention in the informatics and educations fields, the criteria to establish a complete and functional u-learning environment are not yet clear. In this chapter an attempt has been made to define the main questions that should be tackled at the time of designing and constructing this kind of environments, and show the advancements that in this direction have

Figure 6. The Services Model instantiated (Durán et al., 2013)

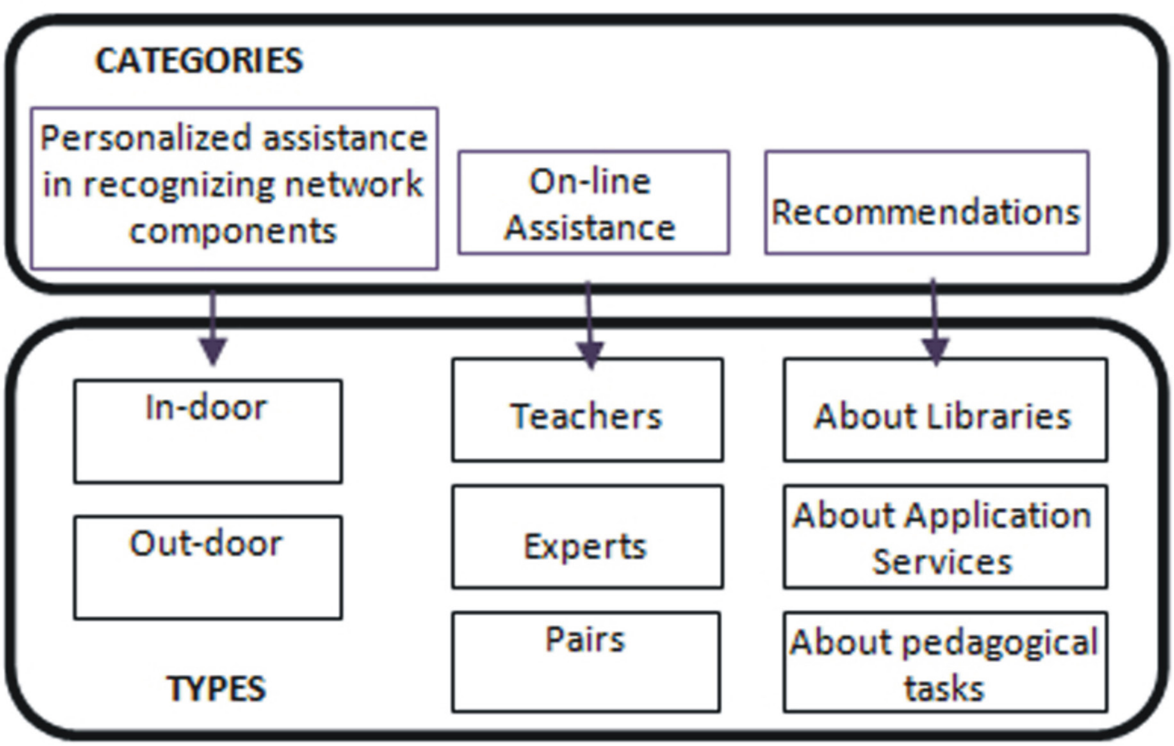
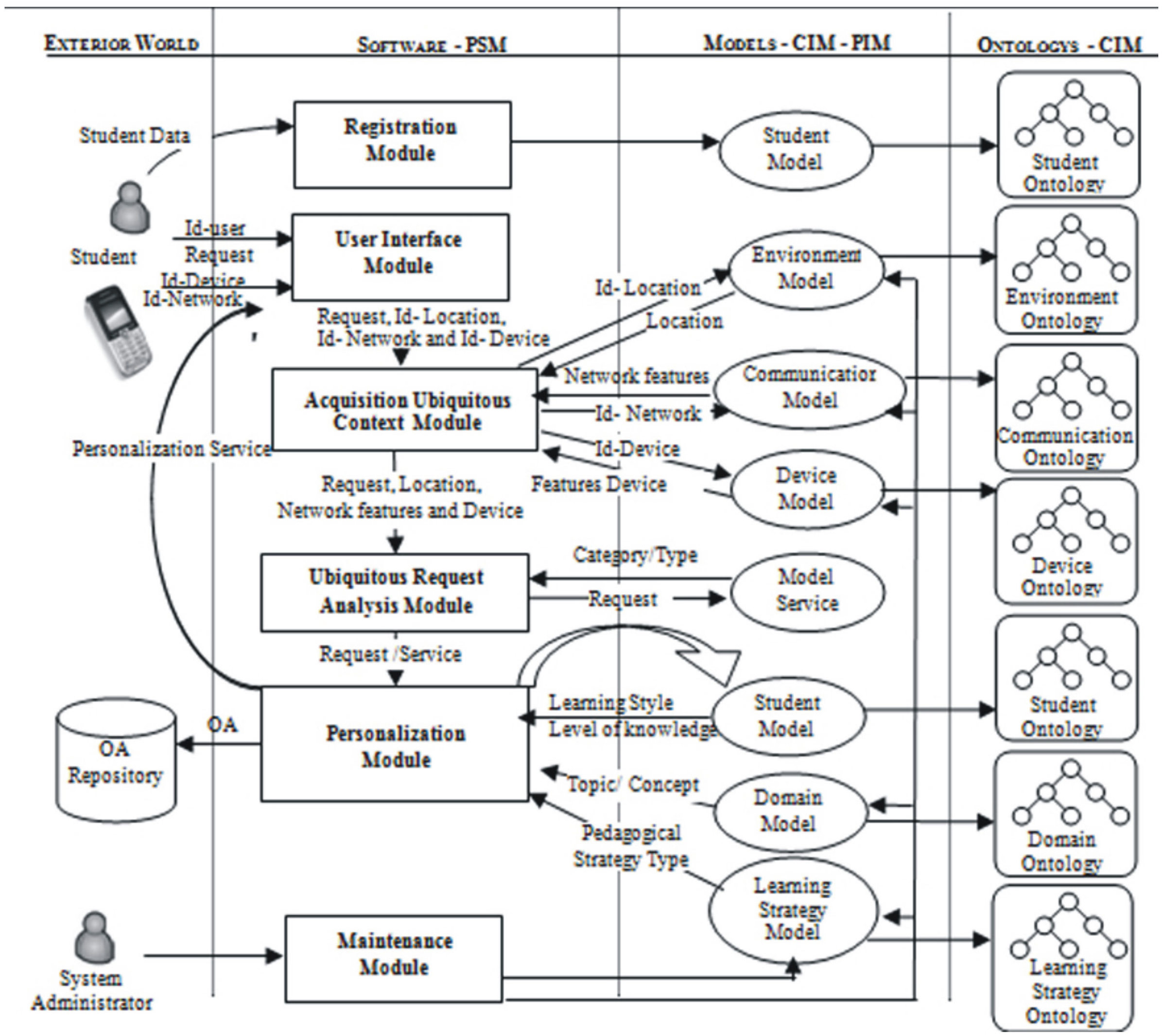


Figure 7. The Ontological Models-based Architecture for Ubiquitous Learning Application (Durán et al., 2014b)



been achieved from the "web systems supporting ubiquitous learning" research line that is presently run in the Research Institute of Informatics at the Exact Sciences and Technologies Faculty of the NUSE.

From this line, several models have been proposed to represent various aspects of a u-learning environment such as learning contents and strategies, devices, and communication networks that can be used by the student as well as individual and environmental parameters so that the system can provide the student personalized support. In addition, the real-world observation and the solving-problem abilities of the students can be trained and evaluated in a context-sensitive environment.

Nowadays, work is being done in the instantiation of the models for the different u-learning applications in the university level.

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KEY TERMS AND DEFINITIONS

Computer Application Design: Activities aimed at enabling software design using Software Engineering methods, techniques, and tools.

Intelligent Agents: Are software entities that execute a series of operations to meet other software or user needs. To build them Artificial Intelligence techniques are applied.

Learning Context: Is any information that characterizes the student, activity, educational content, learning strategies and the environment surrounding the student.

Ontology: Is a domain concept representation, their properties and relationships.

Systems to Support Ubiquitous Learning: Are information systems oriented to treat the interaction between student and smart devices, adapting educational content to characteristics student, to time and to place. They are generate to fill a need for ubiquitous learning.

Ubiquitous Computing: Computing environment consists of sensors and mobile and smart devices, embedded in the physical world, interacting with people naturally and invisibly.

Ubiquitous Learning: Is the learning at right time and right place, personalized and dynamic that uses devices integrated into student's environment.

Chapter 14
Data Mining Applications in Computer–Supported Collaborative Learning

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ABSTRACT

Our own data mining techniques allow us to discover non-explicit knowledge from a large amount of data. Currently, Computer-Supported Collaborative Learning systems generate a wealth of data, derived from the stored interactions and product of collaborative work of students and teachers. Manual processing of these interactions is both costly and tedious, and practically impossible to do in real time. Because of this, there are now trends of research that attempt to achieve automatic processing using data-mining techniques. This chapter describes the phases and tasks involved in the entire process of knowledge discovery and also presents some research applying data mining to process the contributions of students and teachers in collaborative-learning environments.

INTRODUCTION

In the last decade the use of computers to automate different processes has come to be a major event. This situation caused a significant increase in the amount of digitally stored data. It is even possible to affirm that the variety of used data types has also increased. This new reality is easily evident in areas such as e-commerce, virtual education and mobile communication, just to name a few of the areas that have evolved considerably in recent years. This increased availability of digital data is positive for any organization, either public or private, since in addition to being a sort of back up or organizational memory they represent an invaluable source of knowledge for people who occupy decision-making positions in these organizations.

Currently it is observed that although most of the data sources are digital, the largest number of data processing for this issue, including analysis and interpretation, is performed manually. Organizations that use some kind of software to perform this task are rare. Examples abound. Until not long ago TV channels in our country transmitted campaigns aimed at combating dengue, responding to a policy designed by the Ministry of Health

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of the Nation. It may be asked how they came to that decision. It is possible to imagine that all the provinces affected by the disease provided its capital with data regarding the sick and contagious, and that decisions at national level were taken through meetings of provincial Ministers of Health together with their counterpart at the national level. Thus, by successive meetings the current data were analyzed and interpreted (perhaps using some statistical software), other epidemics suffered in the country and in neighboring countries were noted, and as a result of dialogue and negotiation, decisions were "manually" taken that led to the implementation of measures such as communication campaigns. Of course this approach is not wrong, but is more expensive, slower and has a strong sense of subjectivity of the participants. Furthermore, when both the quantity and variety of data type are numerous, proceeding in this way is impossible if knowledge of quality and timeliness are required for proper decision-making, simply because it exceeds our human capacities for analysis and interpretation. This is where Informatics provides specific techniques and methods to overcome these difficulties, encompassed in the Process of Discovery in Databases (aka data mining).

The education community has also suffered the impact of the changes and technological advances. In the last decade the adoption of the Internet as a way to reach students has inevitably changed the way in which knowledge and information are transmitted and shared by teachers and students. This reality has been instrumental in the emergence of new tools applicable to virtual education or *e-learning*. One of these approaches is the Computer Supported Collaborative Learning, which allows groups of students to work together in pursuit of a goal, sharing resources, skills and knowledge, having dialogues, collaborating and coordinating its activities through the use of the computer, in a way completely independent of the time and place variables. In collaborative environments numerous interactions between actors occur, but as it was said in previous paragraph, the difficulty arises when analyzing these data to generate useful information aimed at improving the teaching and learning process. Therefore, data mining is a promising option in the field.

This chapter is organized as follows. In section 2 constituent phases of the Process of Knowledge Discovery in Databases are introduced, and descriptive and prescriptive task types are described, to which the process can be oriented. In Section 3 some research in the area of CSCL is presented, applying data mining techniques. Finally, some conclusions are set forth in section 4.

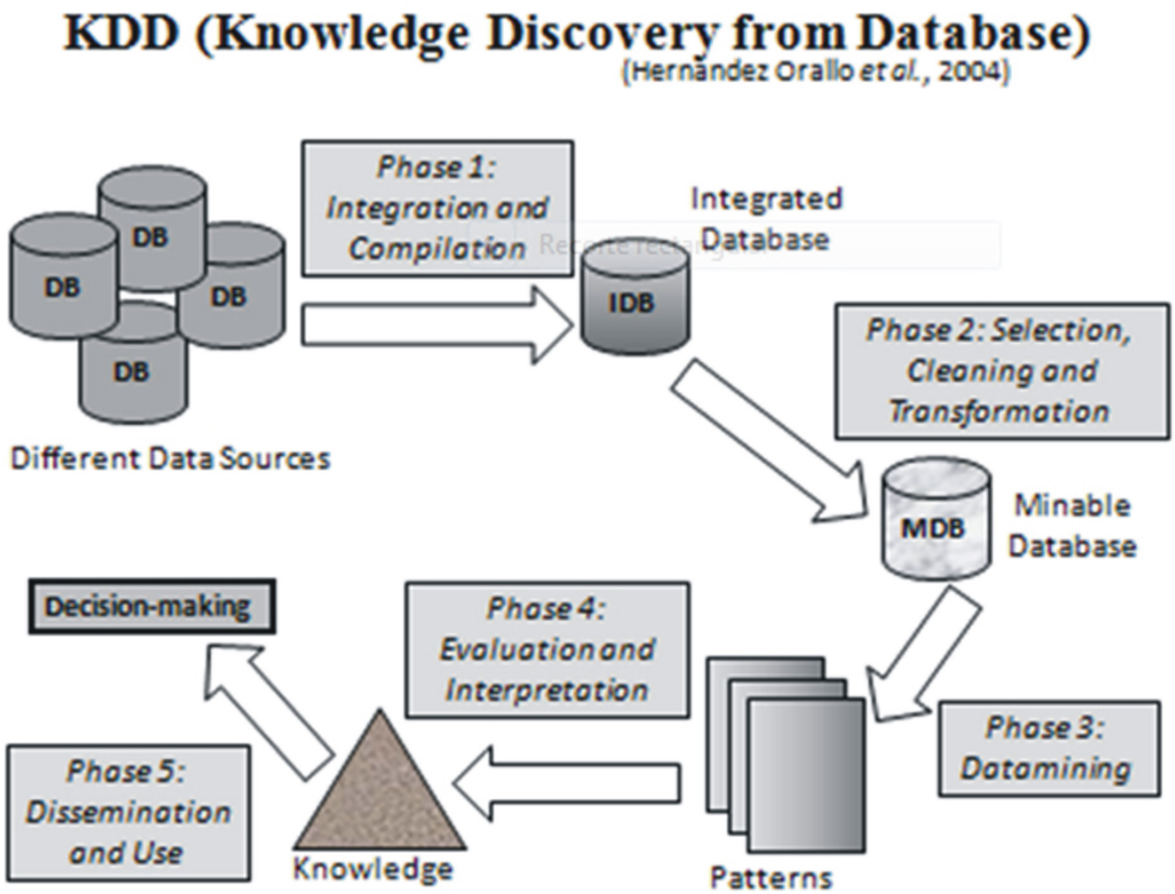
THE KNOWLEDGE DISCOVERY PROCESS

Constant progress in computer science and associated technologies, together with the growing expansion of their use in various aspects of life has turned the storage of large amounts of data into a frequent situation. Manually scan this accumulation of data in real-time could be tedious and expensive, and usually a humanly impossible task to carry out.

The Process of Knowledge Discovery in Databases *(KDD)* emerged as one of the possibilities to meet the need of a methodology for intelligent data analysis aimed at extracting useful knowledge (Riquelme, Ruíz, Gilbert, 2006). KDD is understood as the process of identifying, in large volumes of data, significant patterns that are valid, novel, potentially useful and understandable for a user (Hernández-Orallo, Ramirez-Quintana, & Ferri, 2006). The KDD process consists of five phases: Integration and compilation; Selection, Cleaning and Transformation; Data mining; Evaluation and Interpretation; Dissemination and Use (Han & Kamber, 2001; Hernández Orallo, Ramirez Quintana & Ferri 2006; Witten & Frank, 1999).

The phase of *Integration and Compilation* aims to gather the data required for the next phase of the KDD process. At this stage it is useful to

Figure 1. KDD Process Phases



answer these questions: What internal/external data sources will be extracted, how data should be organized, how they are kept up to date? Will it require more than one minable view? (Hernández Orallo, Ramirez-Quintana, Ferri, 2006). Often, gathering the necessary data is not an easy task, and it may even become necessary to build a data warehouse. A warehouse is a set of historical data, from internal or external sources, integrated and organized for the implementation of tools oriented at generating useful knowledge for decision making (Hernández Orallo, Ramirez-Quintana, Ferri, 2006). The problems that arise when integrating different data sources are usually the following: two or more different objects are unified, two or more identical objects are left apart and data is missing. These problems should be detected and resolved. To make such detection, it is useful to construct summary tables of attributes, histograms or scatter plots (Fig. 2, 3 and 4, respectively). The possibility of creating these elements is usually available in most software products applied for data mining tasks. The product of this phase is the integrated data Base (IDB).

Missing data are easy to detect in an IDB since they equate to blank attributes or empty fields. Given missing data, strategies to follow are: ignore, delete (column filtering), filter (removing the affected tuple), or replace (placing the *average* on numerical data and the *mode* on nominal data

Figure 2. Summary table of attributes

ExampleSet (32561 examples, 0 special attributes, 15 regular attributes)

Role	Name	Type	Statistics	Range	Missings
regular	Age	integer	avg = 38.582 +/- 13.640	[17.000 ; 90.000]	0
regular	Capital_gain	integer	avg = 1077.649 +/- 7385.292	[0.000 ; 99999.000]	0
regular	Capital_loss	integer	avg = 87.304 +/- 402.960	[0.000 ; 4356.000]	0
regular	Class	binominal	mode = <=50K (24720), least = >50K (7841)	<=50K (24720), >50K (7841)	0
regular	Education	polynominal	mode = HS-grad (10501), least = Preschool (51)	Bachelors (5355), HS-grad (10501), 11th (1175), M	0
regular	Eduction_num	integer	avg = 10.081 +/- 2.573	[1.000 ; 16.000]	0
regular	Hours_per_week	integer	avg = 40.437 +/- 12.347	[1.000 ; 99.000]	0
regular	Marital_status	polynominal	mode = Married-civ-spouse (14976), least = Marr	Never-married (10683), Married-civ-spouse (14976)	0
regular	Native_country	polynominal	mode = United-States (29170), least = Holand-N	United-States (29170), Cuba (95), Jamaica (81), In	583
regular	Occupation	polynominal	mode = Prof-specialty (4140), least = Armed-Forc	Adm-clerical (3770), Exec-managerial (4066), Hanc	1843
regular	Relationship	polynominal	mode = Husband (13193), least = Other-relative	Not-in-family (8305), Husband (13193), Wife (1568)	0
regular	Rice	polynominal	mode = White (27816), least = Other (271)	White (27816), Black (3124), Asian-Pac-Islander (1	0
regular	Sex	binominal	mode = Male (21790), least = Female (10771)	Male (21790), Female (10771)	0
regular	Work_Class	polynominal	mode = Private (22696), least = Never-worked (7	State-gov (1298), Self-emp-not-inc (2541), Private (:	1836

or allocating an *estimated value*). When missing data are completed or deleted, information is lost because we no longer know what was missing. Therefore it is generally recommended to create a Boolean attribute that indicates if the previous attribute was missing or not, or assign the value "missing" if the attribute is nominal.

Erroneous data are also easy to spot in an IDB if the possible values of the different attributes are known. Erroneous attribute values can be recognized through the summary table and histograms. Given incorrect information, strategies to follow are: ignore them, delete them (column filtering), filter them (removing the affected tuples), or replace (allocating a default). It is important to be clear that a wrong item is not synonymous with missing data, nor wrong data equivalent to abnormal or atypical data (possible value but rare occurrence).

Figure 3. Histogram of data

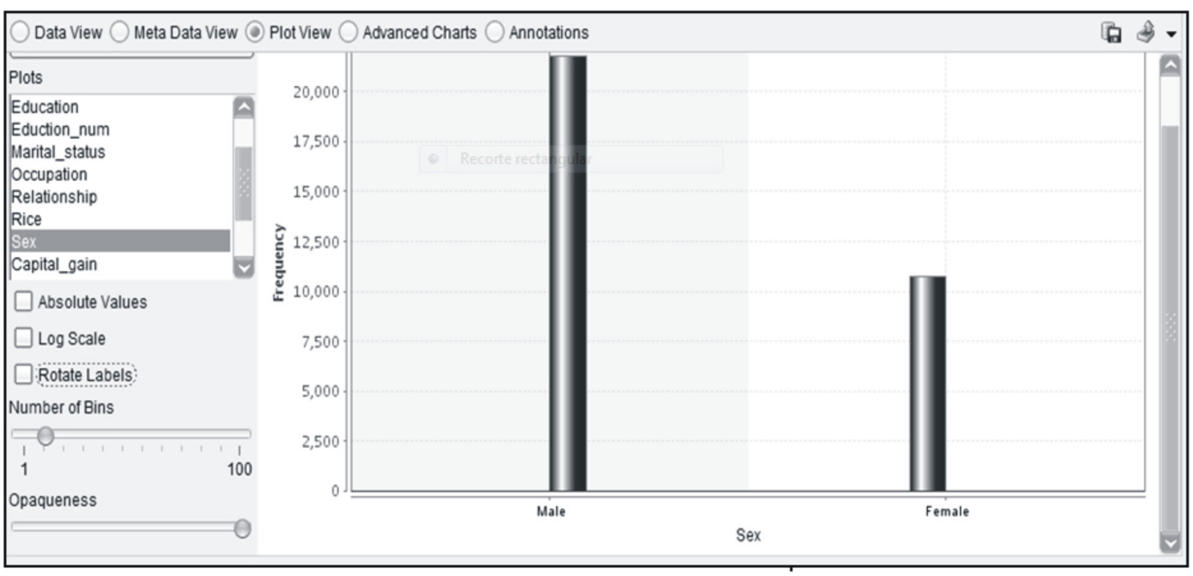
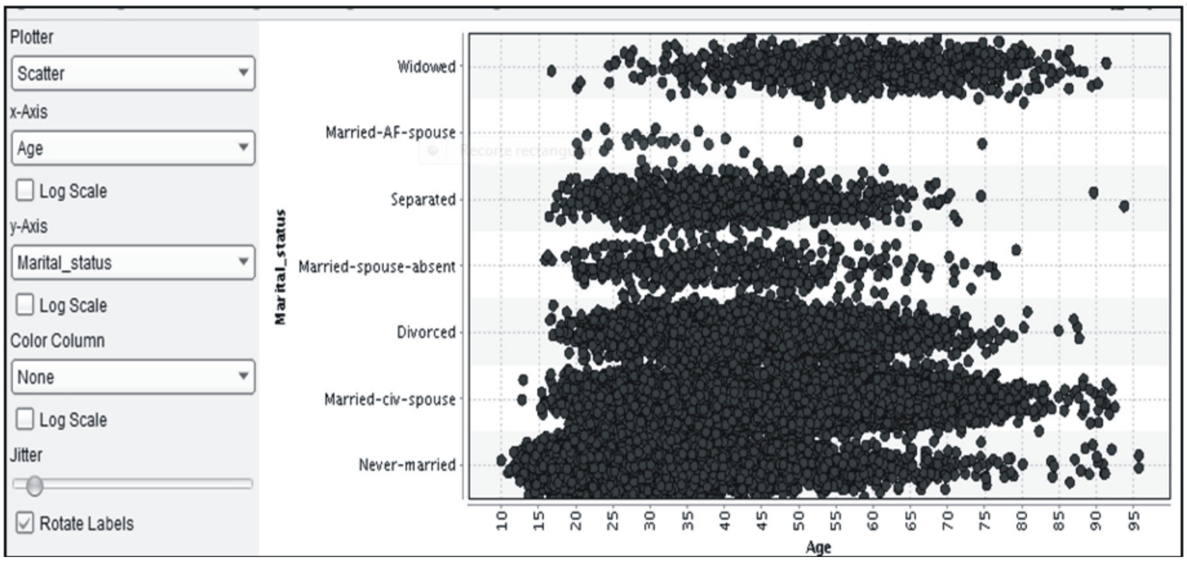


Figure 4. Scatter Plot



The phase *Selection, Cleaning and Transformation* aims to arrange the data in a suitable format for the next phase of the KDD process. It is common that while incorporating internal and/or external sources, a set of data having different formats, different degrees of integration, different primary keys, etc. is obtained. Furthermore, it is necessary to select and prepare the subset of data to mine, since surely many of the collected data are irrelevant or unnecessary for the intended mining task. There is a well-known principle in the area that affirms that quality of discovered knowledge depends not only on used data mining algorithm, but also on the quality of the mined data (Han & Kamber, 2001). Hence the importance of this phase.

The *Selection* involves deciding what data will be required of all the collected and integrated data, the *Cleaning* is performed as necessary to remove some data, while the *Transformation* appears when you need to modify some data, or even create new ones based on existing ones. Typical actions of transformation are: transform an attribute into another, derive a new attribute from known attributes, change the data type of a given attribute, and change the range of possible values of an attribute. Note that the type and amount of actions to be performed in this phase of the process and also the execution order depend on the problem and the characteristics of the data. The resulting product is the Minable Database (MDB).

Consider the following case type to illustrate the actions comprised in this phase. There is an IDB with the attributes of name, last name, age, sex, marital status and number of children, and it is intended to apply the KDD to discover any link between the distribution of gender, age and marital status with respect to children. First it could be decided that the attributes name and surname are unnecessary for the minable base, so these attributes are eliminated from the IDB. On the other hand, since the number of children is important assuming certain predefined ranges (1 – small family, 2 or 3 – standard family, 4 or more, large family), it was decided to transform the attribute number of children into a code according to these ranges. So, once you have made these changes, the MDB would be constituted.

The phase *Data Mining* is the most characteristic in the KDD process, so it is common that this phase is known as *datamining*. This phase can be defined on the basis of a set of primitives, specially designed to facilitate the discovery of efficient and fruitful knowledge. Such primitives include (Witten & Frank, 1999) the specification of the sections of the database or dataset in which you want to work; the kind of knowledge to be discovered; the existing knowledge that could be useful to guide the KDD process; the measures of interest to carry out the evaluation of patterns in the data; and finally, the ways in which the discovered knowledge could be visualized. This phase is implemented by performing predictive or descriptive type tasks to be described in the next subsection.

The phase *Evaluation and Interpretation* involves, first, assessing the quality of the patterns obtained by the carried out data mining tasks, and secondly, doing some kind of reformulation of the results in order to make the discovered knowledge easier to understand and use by the user to whom they are ultimately intended. Performing such an assessment depends on the work done, thus this will be developed in the next subsection.

The last phase of the process is *Dissemination and Use*. The model built by KDD can be incorporated into an existing application for manual or automatic execution. Discovered new knowledge must be disseminated in the organization for use by end users. In addition, it is necessary to monitor the evolution of the model since discovered patterns can cease to be valid with the passage of time. Because of this, the model should be periodically reevaluated, retrained and perhaps reformulated.

KDD process is *iterative* because it is suitable to explore alternative models until you find one that is more useful to solve the problem. In addition, once the model is built, and based on the results obtained it could be decided to change parameters or use other techniques, and this can lead to the need to go back even to the first phases.

Descriptive and Predictive Tasks

Each task has its own requirements and the information obtained with each one of them can differ greatly. Using predictive tasks is intended to establish future or unknown values for a variable, based on known variables. The descriptive task, however, allows patterns to be identified in the data. Within the predictive tasks are included the *classification* and *regression*, while *clustering*, *correlations* and *association rules* correspond to the descriptive tasks.

With the *classification* each new instance of the database is classified as belonging to one of the predefined classes, denoted by a particular attribute. Each possible value of this attribute identifies the different classes. The value of the class depends on the value of the other attributes of the tuple. When evaluating classifiers the aim is to determine the quality of the patterns found, regarding their predictive accuracy. Usually *Precision* and *Recall* measures are calculated. To do this it is necessary to know the values of: TP = True Positive (correctly classified instances), FP = False Positives (incorrectly classified instances), and FN = False Negatives (unclassified instances which should have been classified). The formulas applied to calculate the listed measures are the following: *Precision* = TP/(TP+FP) and *Recall* = TP/(TP+FN).

Consider the following example. An insurance company has a BD where each client is classified as *risky* or *not risky*, based on their attributes of age, gender and income level. Thus, each new client that the company incorporates is classified as belonging to one of these two classes. It is known that in over twenty new instances of customers in the database, seventeen of them were classified correctly and two more incorrectly as *not risk*y and only one was classified as *risky* when it was *not risky*. Therefore, the calculated measures for this classifier are as follows: Precision = 17/(17+2) = 17/19 = 0.89 and Recall = 17/(17+1) = 17/18 = 0.94. These are very good results.

The *regression* by means of a function assigns a real number value to each instance. Unlike classification, regression assigns a numerical value to each instance. To assess a regression the quality of the model is estimated by comparing the predictions (h (x)) with the objective function (f(x)), calculating the *Mean Square Error* measure: MSE = 1/n * SUM $(h(x) - f(x))^2$, being *n* the number of items included. Consider the following example: a construction company has a database containing details of all performed constructions. Using a linear regression function on instances contained in the database, it would be possible to predict the total duration of future buildings of the same type. Another case could be a computer consultant who has a database containing details of all their developed projects. Using a function of linear regression on the instances contained in the database, it might be feasible to predict the cost of software projects of the same type. The prediction made by calculating the mean square error could be evaluated in both cases.

Clustering lies in discovering groups or segments from data. These groups are comprised of similar instances contained in the database. The principle of grouping or clustering is to maximize intra-group similarities and maximize inter-group differences. By clustering it is possible to discover groups (clusters) in the data, and then generate labels and talk about classes. Segmentation is difficult to assess because there is not any class nor is there any previously known numeric value usable for testing. Generally the following measures are calculated: *Cohesion* (distance to the centroid of the group from each instance of it) and *Average Distance Between Groups* (distance between the centroids of the different groups). A centroid is defined by the majority value in each of the attributes assumed by the contained tuples in each cluster. A library that makes sales over the internet could discover groupings to recognize buying preferences of their customers. Having this knowledge will allow, for example, in any situation where a customer is interested in a book, to identify to which group he/she belongs and suggest books purchased by other clients of that group. From the discovered segments or clusters the referred measures could be calculated in order to assess the quality of the performed clustering of customers.

The *correlation* examines the degree of similarity of the values assumed by two numerical variables in order to discover if there existed a similar behavior. To evaluate the correlation the *r* coefficient is used When $r = 1$, the variables are correlated, if $r = -1$ then the variables are negatively correlated, and if $r = 0$ then the variables are not correlated. Let us suppose that an insurance company wants to launch a new insurance sale. To define potential customers they might be interested in discovering if their insured income level is correlated with the amount of insurance policies the client has contracted. Calculating the *r* coefficient the insurer could design an appropriate policy for sale.

With the *rules of association*, it is possible to identify relationships between non-explicit attributes, but taking into account that this does not imply causality. The common formulation of an association rule is "IF the attribute *X* takes the value *a,* THEN the attribute *Y* takes the value *b*". It is always intended to create rules that can be applied to as many instances as possible, and that these had relatively high accuracy in those instances. The measures to assess the quality of the discovered rules are: *Coverage* (number of instances to which the rule is applied correctly) and *Confidence* (Proportion of instances that the rule predicts correctly). Suppose the virtual library *Amazon* applies association rules to discover which books are often purchased together. For example, they discover the association rule that says: IF book1 = Probability THEN book2 = Statistics. Let us assume that 60% of the times someone buys a book of Probability also buy one of Statistics, and that this occurs with 3 out of 10 clients. Based on this assumption, the coverage of the rule is 60% and its confidence is 30%.

APPLICATIONS OF DATA MINING IN CSCL

There has been some research in the area of CSCL using data mining techniques to achieve different goals. The following briefly describes these techniques, introducing them according to the alphabetical order of the authors.

- Anaya and Boticario analyze the interactions stored on forums to characterize student collaboration considering four variables: activity, initiative, regularity and tendency to teamwork (Anaya & Boticario, 2008). The authors defined several indicators to assess these variables. They applied *clustering* techniques and used for that the Weka software. The experimentation allowed them to identify three distinct behavior segments which they labeled as: high, medium and low collaborative groups. Analyzing the centroids of the clusters, they also found that the number of interactions sent by the students and the number of responses received by the students for contributions that initiate a dialogue on the forum are the two most important indicators with which to classify the behavior of a group.
- Bovo *et al.* used *clustering* for grouping students with similar behaviors (Bovo, Sánchez, Héguy & Duthen, 2013). The authors identified active students and passive recipient students. The experiment was performed by processing the stored interactions using Moodle. Bovo and colleagues defined several indicators of collaboration that were processed using the Weka software. The result suggests that there are no substantial differences in the number of accesses, number of downloaded material, time spent on-line, number of lessons read, number of forum topics read and grade obtained between active students and passive recipient students. However, different behaviors were observed for the following variables: number of created topics in forums and number of questions asked in forums.
- Cobo *et al.* applied *clustering* techniques to detect similar patterns of behavior on forums (Cobo, García, Santamaría, Morán, Melenchón & Monzo, 2011). The study allowed them to identify three clusters that respectively bring together the students who read and write, the students who only read, and finally, the students who do not read or write.
- Costaguta *et al* presented a multi-agent model, applied in the area of CSCL, featuring a conflict detector agent in each collaborative group, and a training agent for each student (Costaguta, García, Amandi, 2011). Specifically, detector agents analyze and evaluate the process of collaboration, identifying problems caused by inadequate manifestation of collaborative skills in the students of each group, while personal agents try to improve group dynamics training students in those collaboration skills where they have shown problems. The experimentation showed a high degree of efficiency in the functioning of this model. The experiment was conducted using a semi-structured interface based on opening sentences. The set of opening sentences was defined on a one to one relation with the attributes of collaboration that students could come to express. To process interactions *Bayesian networks* were created. These networks enabled the detection of training needs of collaborative skills in students, and they showed good performance capability.
- Duran and Amandi proposed a method to automatically detect patterns of collaborative behavior. Such patterns are discovered *applying association rules* (Durán &

Amandi, 2009). The authors propose to create and maintain a Profile of Collaboration within a dynamic and collaborative student model. Experimentation was not conducted with actual students, but through simulation of behaviors in different contexts.

- Ozan *et al.* analyzed the interactions registered in working sessions of collaborative groups to discover, by *rules of association*, the link between team roles played by students of the Group and the skills of collaboration expressed through such contributions (Ozán, Costaguta, & Missio, 2012). The authors worked with the Weka software.
- Padilha *et al.* developed a model which has two agents, one in charge of processing interactions and calculate certain indicators, and another agent dedicated to generate different reports on the performance of the group and the individuals (Padilha, Almeida & Alves, 2004). The authors define both qualitative and quantitative variables. They apply a text categorization task to classify student contributions. For this type they define five categories (each associated with a qualitative variable) and also propose some twenty keywords by category in order to perform the *classification* of the interactions. Padilha and colleagues generated activity reports with different levels of abstraction, allowing comparison of the performance between groups, the performance of a member of the student group with the rest of the members thereof, and also to see a history of the behavior of a given student. These reports are of graphic type in the first two cases and tabular in the last one.
- Perera *et al.* [10] collected interaction data of students who collaboratively worked in an online learning environment that allowed them to create wikis, manage different tasks, and manage a repository containing different versions of software created by the group (Perera, Koprinska, Yacef & Zaiane, 2009). The data which were stored and then processed using data mining techniques were the events that took place each time a wiki was created or modified, a task was created or modified in the administrator, or a file (or directory) was discharged or modified in the shared repository. The authors used the Weka software and applied *clustering* techniques at team level and individual level. In terms of group interactions they sought to identify groups with different behaviors regarding possible events and could thus identify best groups and worst groups, and were able to classify them at the level of students into four segments which were labeled as administrators, developers, passive and other. They also conducted an analysis of sequential patterns in order to identify patterns of behavior at the level of sequence of use of resources in the repository, sequence of individual actions within the group, and sequence of tasks performed on wikis and task administration. The authors identify behavior patterns in effective and ineffective groups.
- Santana Mansilla *et al.* propose a classification of e-tutor collaboration skills and develop *clasifiers* that allow recognition of the contained categories in the proposals on free text classification (Santana-Mansilla, Costaguta & Missio, 2013). Construcción. The research addresses how to perform the processing of interactions of teachers who use free text. The experimentation carried out allowed them to demonstrate that text mining techniques are appropriate for the analysis of this type of contributions. The authors constructed different classifiers (responding to different algorithms) and

compared the result obtained therefrom. Santana and colleagues modified the Gate tool to suit the syntax, semantics and grammar of Spanish language.

CONCLUSION

The use of CSCL environments in the area of virtual education is clearly growing. It is also clear that these systems allow the management of multiple courses, where students interact and generate a high amount of contributions through dialogue and collaborative work. These data should be analyzed in order to improve the teaching and learning processes. However, to expect that such an analysis is carried out manually and in real time is an unattainable goal for any human being. That is why Data Mining, with the ability to extract non-explicit knowledge from a large amount of data, promises to be the solution to this problem. In this article there have been some developments that augur well.

Most of the student interactions found in research is processed in online collaborative environments, in order to find similar patterns of behavior, both at group level and at student level. Only in one of the analyzed works the focus was centered on the behavior or interactions expressed by teachers. Most of the experiences in the past involved the use of *clustering* techniques, whereas the use of other techniques such as *text categorization*, *analysis of sequential patterns*, or *rules of Association*, were less frequently observed.

The integration of techniques of data mining within on-line learning environments, in particular with the environments of CSCL, is incipient. It is expected that the amount of research or experiences that link the CSCL with the mining of data will increase in the coming years.

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KEY TERMS AND DEFINITIONS

Computer Supported Collaborative Learning: Is an emerging branch of the learning sciences concerned with studying how people can learn together with the help of computers. In others words, it is a pedagogical approach wherein learning takes place via social interaction using a computer or through the Internet, for example. This kind of learning is characterized by the sharing and construction of knowledge among participants using technology as their primary means of communication or as a common resource.

Data Mining: Is a process of analyzing data from different perspectives and summarizing it into useful information. The information that can be used to increase revenue, cuts costs, or both. Data mining software is one of a number of analytical tools for analyzing data. It allows users to analyze data from many different dimensions or angles, categorize it, and summarize the relationships identified. Technically, data mining is the process of finding correlations or patterns among dozens of fields in large relational databases.

Knowledge Discovery in Databases: Is a process of discovering useful knowledge from a collection of data. This widely used data mining technique is a process that includes data preparation and selection, data cleansing, incorporating prior knowledge on data sets and interpreting accurate solutions from the observed results.

Machine Learning: Is a subfield of computer science and artificial intelligence that deals with the construction and study of systems that can learn from data, rather than follow only explicitly programmed instructions. Machine learning is employed in a range of computing tasks where designing and programming explicit rule-based algorithms is infeasible for a variety of reasons.

Software Engineering: Is the study and application of engineering to the design, development, and maintenance of software. In short, the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software.

Chapter 15
Model for Effective Collaborative Learning in Virtual Worlds with Intelligent Agents

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ABSTRACT

The predecessors of virtual worlds are the multiplayer online role playing games; they appeared in the mid-nineties and have been studied since then. Virtual worlds are part of the shared spaces technologies and are applied to strengthen the weaknesses of teamwork, allowing identifying a direct relationship with the intellectual capital. Theoretical models have attributes that differentiate them from other digital media and allow getting more effective team collaboration. A feature of virtual worlds that allows such collaboration is that unlike 3D games, virtual world's user actions lie on their interests, which vary from meeting people to manage business. Based on the information about virtual worlds, intellectual capital, collaborative knowledge management, intelligent agents, and MPLM3D platform, this work proposes a model through which to demonstrate how the interaction with intelligent agents allow to achieve an effective collaborative learning into a controlled distributed computer environment using the platform Second Life.

INTRODUCTION

The diffusion and global recognition of virtual worlds starts in 2007 with the popularity of Second Life in the blog "Medical Library Tech Trends 2007" as part of technology trends, and the first was precisely Second Life (Lara, P., & Martinez, J., 2004). Virtual worlds are part of the broad field of "shared space" technologies with Augmented Reality, Telepresence and Virtual Reality, all discrete spaces represented and executed by computers which are accessed exclusively through the Internet. On virtual worlds people interact through their avatars, the process of knowledge is managed by the users themselves through their avatars, through new ways to transmit and

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share information on a global scale, in an apparent local environment, generating collaboration networks and information ecosystem. Virtual worlds like Second Life have limitations to its mass use because of the significant hardware and software resources that requires to those wishing to use them, however there are many promising applications of these virtual worlds, including distance education. The research have reviewed the state of the art of Virtual Worlds, Intellectual Capital, Collaborative Knowledge Management, Intelligent Agents and MPLM3D Platform and proposes a model that shows how the capabilities of virtual worlds allow getting an effective collaborative learning by experimenting with agent avatar interaction in Second Life, which can answer frequently asked questions from the participants avatars.

STATE OF THE ART

The state of the art includes the field of 3D virtual worlds involving intelligent agents and collaborative learning with emphasis on the environment and interactivity. Its content draws on two sources, the first ones are the experiences in the virtual world Second Life and the second one is the intellectual capital and collaborative knowledge management.

Intellectual Capital

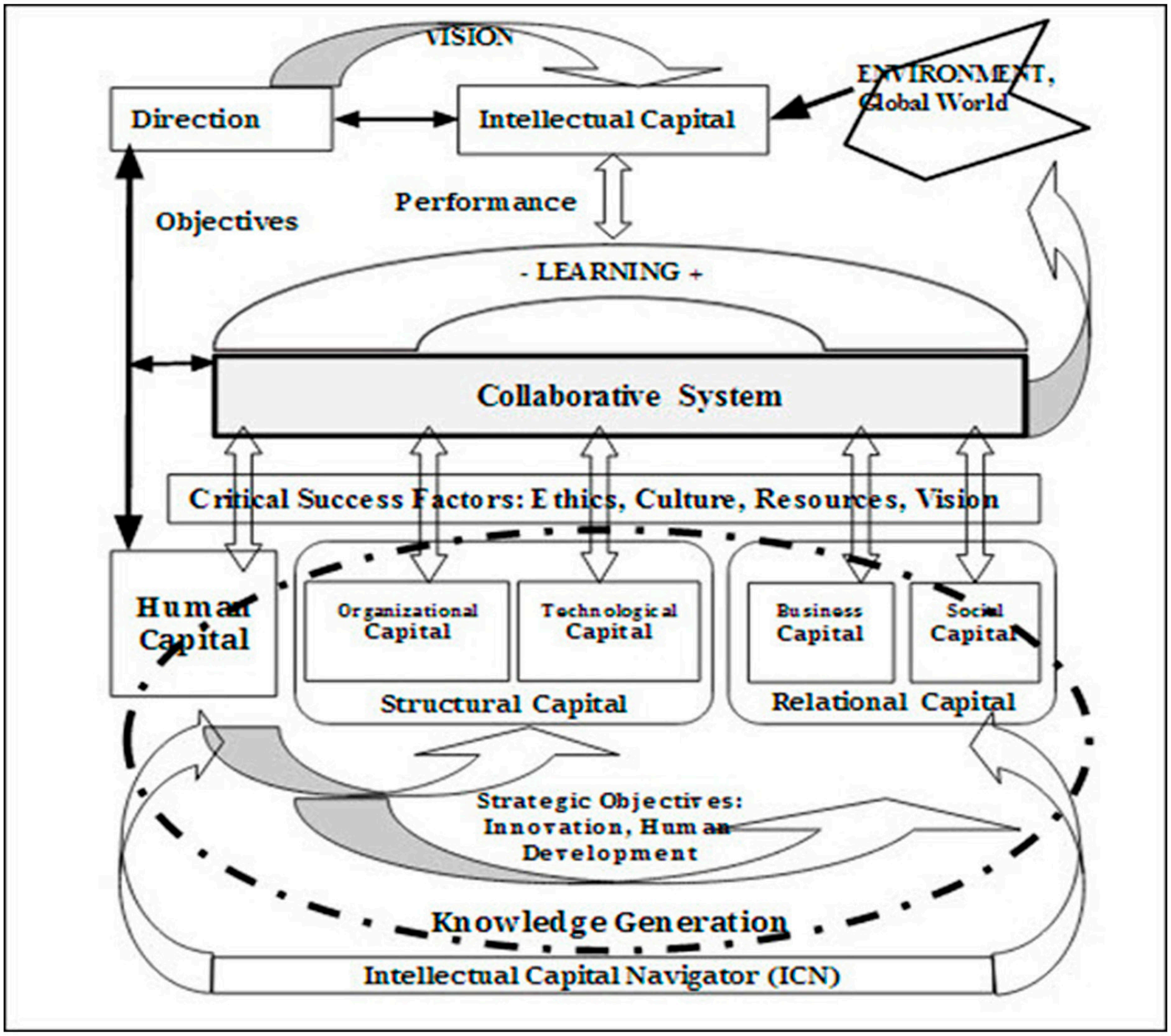
Intellectual capital, according to Benavides Benavides, E. (2012), "is everything that cannot be touched but it can make money for the company." "Intellectual capital is the search for effective use of knowledge," "represents the collective intangible assets that can be identified and measured" "is the set of company assets, although not reflected in the financial statements that generate or will generate value for it in the future, as a result of aspects related to human capital and with structural capital as the innovation ability, customer relations, quality of processes, products and services, cultural capital and communications that allow to a company to take a better advantage of the opportunities than others, resulting in the generation of future benefits."

"Intellectual capital is the product of the interplay of Human Capital (knowledge workers, the ability to learn and adapt, etc.), Structural Capital (trademarks, patents, copyrights, product names and other assets intangible internal processes and research and development, etc.) and Relational Capital (business relationships with customers, suppliers, distributors, investors and other stakeholders: government and society in general), which is reflected on the ability of the human talent to add value not only to tangible assets but also to intangible assets of an organization which generate or will generate future value on which the organization can consolidate a sustainable competitive advantage over time." Benavides, E. (2012).

Furthermore the research analyzes the model DirCCI, "Collaborative Management of Intellectual Capital" in which, from the perspective of intellectual capital, a way of integrating collaborative business rules is presented. Bernuy A. (2007)

Bernuy Bernuy A. (2007) presents: (1) the direction as an entity; (2) the indicators of intellectual capital as a result of learning; (3) the environment that always releases changes or delivers rules of play, (4) a collaborative system as the main component that instructs, shares and supports the decisions. This new system is based on agents and the processes of transformation from human resources to structural capital and relational capital. Then is when the organization creates knowledge and the most important elements are the innovation, competitive skills and human development. Transformation processes are studied in other research called "intellectual Capital navigator". Bontis N. (1998). The transformation is based on rules called "workflow" Bernuy A. (2007).

Figure 1. DirCCI Model. Collaborative Management of Intellectual Capital from the reference Bernuy A (2007)



Virtual Worlds

We can use different approaches to achieve the definition of virtual worlds. From a technical perspective, Zapata said that a virtual world is a "discrete space, populated by a set of independent actors, which can be represented by a software program running on a computer" (Montoya and Zapata, 2005). It is a computer-generated space in three dimensions, but it is not a continuous space as we experience in the physical world but discrete, consisting of virtual territories logically intertwined. The actors are independent because they determine their participation is autonomous without being subject to the other participant.

From a semantic perspective, López-Barajas indicates that it is right to refer to virtual worlds as Multi User Virtual Environments (MUVEs), which are accessed through the Internet and where the interaction and communication is facilitated with themselves through an isometric polygons environment", with them the illusion of three-dimensional space (López –Barajas, 2009) is constructed. A virtual world is strictly not a world but rather an environment, which in this case is generated by the computer using a web-based polygon structure properly integrated that produce the illusion of three dimensions that are accessed via the Internet.

These virtual environments simulated by computer may try to represent fantastic and unrealistic scenarios in some cases, while in others it can represent any kind of real world environment, including simulating real, such as gravity or the physical properties of objects physical behaviors, among others. People interact in these virtual environments using virtual representations of them called avatars, which in turn can be fantastic or similar to their physiognomies in the real world (Barreiro and Casado, 2009).

Zapata presents a philosophical perspective whereby MUVEs design seeks to implement methods of distributed artificial intelligence, through a collection of autonomous agents that want to solve a given problem." The main idea of philosophy is to maintain a consistent world in which every action is justified by an effect, either on the environment of the actor who performs, or other pertinent actors" (Zapata and Montoya, 2005).

As seen in the definitions presented, virtual worlds are understood as computer-simulated environments in which avatars or software agents interact. However, they can also be considered as a new class of information system, one that combines the structural aspects of traditional systems modeling and simulation, with support systems for emerging knowledge processes that require knowledge of other disciplines as engineering design, computer graphics and computer simulation. (Chaturvedi, Dolk and Drnevich, 2011). To consider virtual worlds and applications developed within them as information systems opens up new opportunities to leverage the contributions of the methodologies of the discipline of information systems.

The three-dimensional virtual worlds can be classified broadly into two groups according to (Zapata, S., & Montoya, D., 2005). Online games and metaverses. Online games appeared in the nineties. There are the first person games like Quake, which are designed for small groups of a few dozen users to play together. Then we have massively multiplayer online video games (MMOG) that are designed to scale from hundreds to thousands of players simultaneously, like EVE Online and World of Warcraft.

Metaverses or meta-universes are virtual spaces considerably larger and very different from online games. They present a single persistent world, i.e. continues to exist and evolve even when users are offline, in which users can roam around without predefined objectives different regions. No goals to achieve, no lives to care, no levels to overcome, such as online games. Also, metaverses require greater technological capabilities, for example on the server use. In addition, metaverses allow any user to create content without needing to be an expert and also retain ownership of such content. This is a feature that allows metaverses submit a thriving economy where users sell and buy virtual content.(Zapata, S., & Montoya, D., 2005).

The predecessors of virtual worlds were MMORPGs (massively multiplayer online role-playing games), such as Ever Quest or World of Warcraft" Barreiro, A. (2009). The difference between virtual environments and 3D games "is that there are no rules, there is no objective or phases to overcome. The actions to be taken are set by users according to their interests: meet people, do business, promote their products, modeling virtual environments, etc." Barreiro, A. (2009). This research considers that as an opportunity to create new application environments.

In conclusion authors define virtual worlds as computer-simulated environments that users can inhabit and in which they interact with others, either themselves or through agents or graphic representations called avatar. Chaturvedi, D.R. (2011).

Second Life is an online virtual world owned by Linden Labs, where users can build their own environment, interact with each other and even start up business models. It has its own currency convertible to real currency Barreiro, A. (2009).. It is currently the market leader in virtual worlds, and has been used from the beginning for meetings or teaching classes and lectures, especially from developing their voice module. "Universities around the world rushed to open their virtual installations in this environment, although usually more for advertising than with a true vocation to use it as a virtual teaching tool." Barreiro, A. (2009). The users membership of Second Life, one of the most recognized metaverse, has increased more than twenty times between 2006 and 2009 to reach 15 million. Bélisle, J.F. & Bodur, H. O. (2010).

There is a daily concurrency of resident, which demonstrate the permanence of inhabitants of the virtual world. The Maximum Daily Concurrency seems to be reaching 57, 000 to 61,000 at peak times during the last 3 months; Minimum Daily Concurrency seems to have dropped habit down to 28, 000 to 31,000 during low peak hours during the last 3 months and Median Daily Concurrency seems to be around 45,000 to 49,000 during the last 3 months. Even with fluctuations it shows its persistence in time.

Collaborative Knowledge Management

Collaborative knowledge management requires "to create synergy in organizations, in order to capture the knowledge in the people; the user needs to implement the effective collaboration between them." Bernuy, A. & Lombardo, M. (2005b). Intelligent Agents and Multi Agent Systems (MAS) are aligned to distributed systems that enable interoperability, communication, security, migration, and proper management of the environment and the necessary dialogues in virtual worlds. The "Intelligent Distributed Control Systems based on Agents (SCDIA) allows the collaboration of: 1) Measurement Agent: collects the information needed to get the status of the process, 2) Controller Agent: take actions based on the state of the system, 3) Coordinator Agent: modify control agent decisions and sets new goals and services and coordinates the agent community, 4) Actuator Agent: implements the decisions taken by the controller agent, coordinator agent, and / or specialized agents, and 5) Specialized Agents: they perform special tasks of the community of agents.

On the other hand the "Multi-User Virtual Environments" (MUVEs) such as Second Life can be a great tool to educate people and to do research so that people learn. The use of automated conversational agents with artificial intelligence capabilities can develop more interaction with people from identifying their human and emotional profiles. "They can be used to tutor students and they can be used to manage or orchestrate consistently environments for research purposes". (Bernuy A., 2007).

In Second Life architecture the middleware component shows its interaction with the object and the Basilica conversation agent (Scheme to facilitate the rapid development of conversational agents involved in collaborative environments). Every time there is a new object in the front-end an instance of a user is created, the object is connected to the middleware to start a new session. The new session period indicates to the conversational agent to generate a new instance of it and to act as the second object of the session. From here the middleware receives a message, translates the message and the messages are sent from one object to another. (Bernuy A., (2007)

In this way is how virtual worlds and Second Life work with intelligent agents, therefore this research analyzes them with a focus on collaborative knowledge management.

Intelligent Agents

"An intelligent agent is a software that assists clients and acts on their behalf", (…) "a software en-

Figure 2. Historical Daily Concurrency Dic 2009 – Nov 2013. This figured is adapted from the reference (Second Life Grid Survey, 2013)

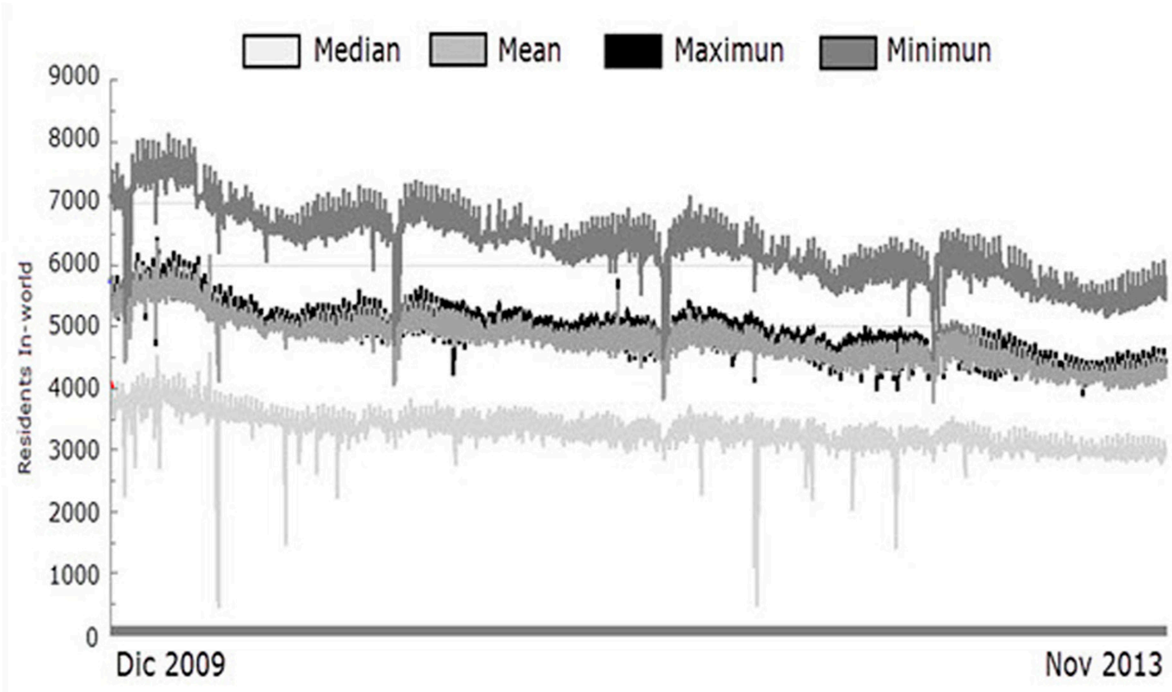
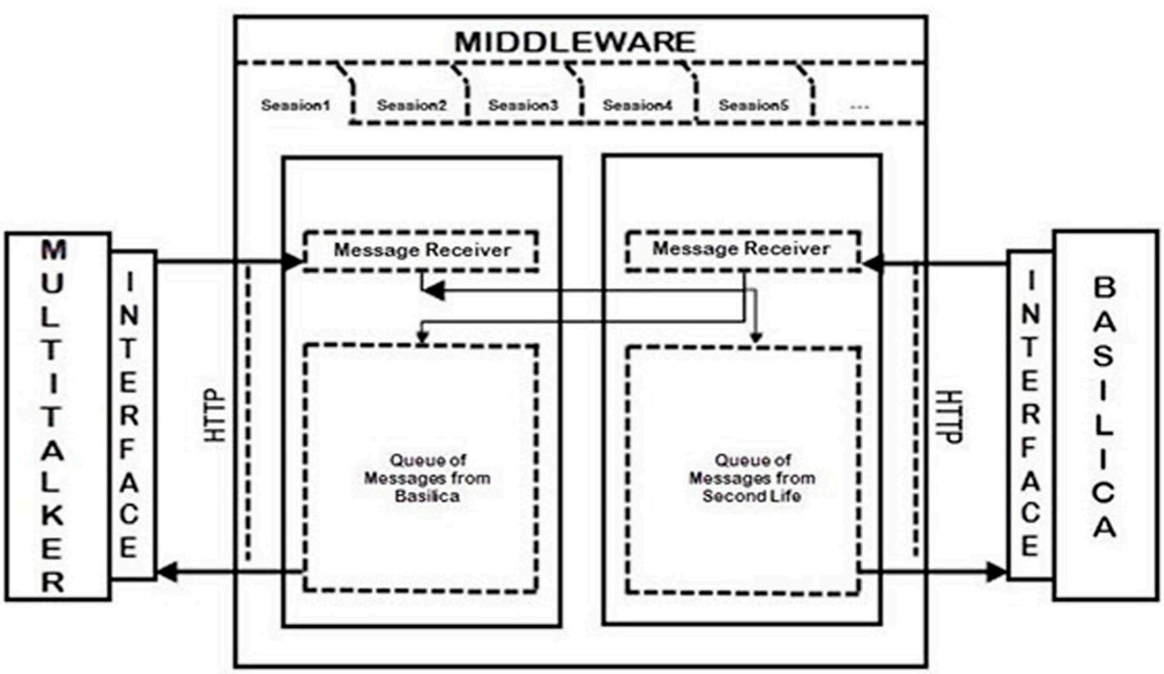


Figure 3. Middleware for Second Life / Integration Basilica from the reference, (Bernuy A., 2007)



tity that, based on their own knowledge, performs a set of operations to meet the needs of a user or another program, whether on his own initiative or because any of these are required", (…) "computer programs that are capable of performing a task or activity without direct manipulation of a human user". Agents have the essential characteristic of learning in different ways: 1) by observing and imitating the behavior of the user, 2) by receiving positive or negative feedback from the user, 3) by receiving user explicit instructions, 4) by asking advice to other agents (Lara, P., & Martinez, J., 2004).

According to Bernuy and Lombardo Bernuy, A. & Lombardo, M. (2005b), among the features those agents have standout be endless processes that run continuously, be able to act based on their experience and be able to move through a telematics net.

For the research, agents have new challenges in the design of an environment that includes the proper characteristics of the people environment and their personal characteristics and cultural patterns.

The research analyzes the classifications available for the research (See Table 1).

This study stands out three of these intelligent agents which are related to the topic: 1) Recovery: Looking, recover and provide information as authentic information and document managers ("information brokers"), 2) Monitoring: give information to the user when a certain event occurs, and 3) Recommendation: helps users in three dimensions: information filtering method (demographic, content-based and collaborative), profile correspondence (when are based on the content) and the user profile matching collaboration techniques (Lara, P., & Martinez, J., 2004).

Agent's Management in Virtual Worlds with MPML3D Language

The Multimodal Presentation Markup Language 3D (MPML3D) is a scripting language based on XML which enable to control the verbal and nonverbal behavior of agents in 3D (Ullrich, S., Prendinger, H., & Ishizuka, M., 2008), comes from the original language MPML, developed in Ishizuka Lab at the University of Tokyo. In 2008 the MPML3D was revised to support scenarios enriched to interact with reactive agents in Second Life and OpenSim, becoming the first agent's online scripting language in 3D world on internet.

The MPML3D integrates with SL and is divided into three different sections: (1) the MPML server, (2) the "official" server (cluster network) from Linden Lab, and (3) the client side of visitors/users of the system. Basically, the system requires a MPML3D script as input in order to allow users within SL (avatars) to interact with the script-driven agents (bots). To actually host a MPML3D-based scenario within SL, the content creator has to use the services that are provided by the MPML3D server. Potential users or visitors just need to use the free, official SL-client software. The actual implementation is based upon the MPML3D framework, working with the MPML3D backend and making interface

Table 1. Intelligent agents available classifications (Lara, P., & Martinez, J., 2004)

Domain	Classifications
Field of action	4) Desktop Agents (OS agents, application agents, etc.). 5) Internet Agents (search agents, filtering, information retrieval, reporting agents, mobile agents, etc.). 6) Intranet Agents (Cooperative Customization agents, database agents, process automation agents, etc.)
Function	2) 1) System Agents, 2) Filtering agents, 3) Profile Agents; 4) Monitoring Agents, 5) Recommendation Agents, among others

with the frontend server of the MPML3D of SL, or frontend with optional clients who can be out of line." (Ullrich, S., Bruegmann, K., Prendinger, H. & Ishizuka, M., 2008).

The MPML3D backend implements the scenario (scene setup and scene plot/-content) as defined in an MPML3D script, and acts as a host for one or more frontends (see Section 4.2). It integrates the parser for the XML-based script source with the dynamic runtime representation of all interdependencies between and the hierarchy of agents conversational activities and perceptions, the so-called "activity network".

In order to keep this part of the MPML3D system flexible, the backend handles scene entities and activities on a consolidated route, leaving to the application the current effective implementation of the interfaces.

First Experimentation with an Agent Avatar in Second Life Based on MPML3D

MPML3D language handles the interaction with an agent that must have been previously created in the virtual world. For our experiment we created an agent avatar named Albert Milodanic. The avatar in Second Life was created following the process of creating customized avatar, no matter which is to be used as an agent.

We used an adaptation of UserInput.mpml script that comes with the installation of MPML3D. It states the agent, the location should appear in Second Life, you set the property to "listen" and actions to be followed by the agent when "hear" the instructions in the virtual world. The agent will "listen" through chat commands that are sent by the avatars that are in the position where it appears. The actions were defined: greetings, anger north, go east and go south.

The backend runs in a command window on the computer where the server is installed MPML3D. The run line is through the Java virtual machine using the command "java-jar backend.jar / scripts / UserInputAgente.mpml.xml-port4000". Once the service is charging backend is ready to run services frontend for different agents in different virtual worlds. The agent avatar is loaded by running the service SL_Frontend.exe (Second Life) and the agent appears in the defined position within the virtual world.

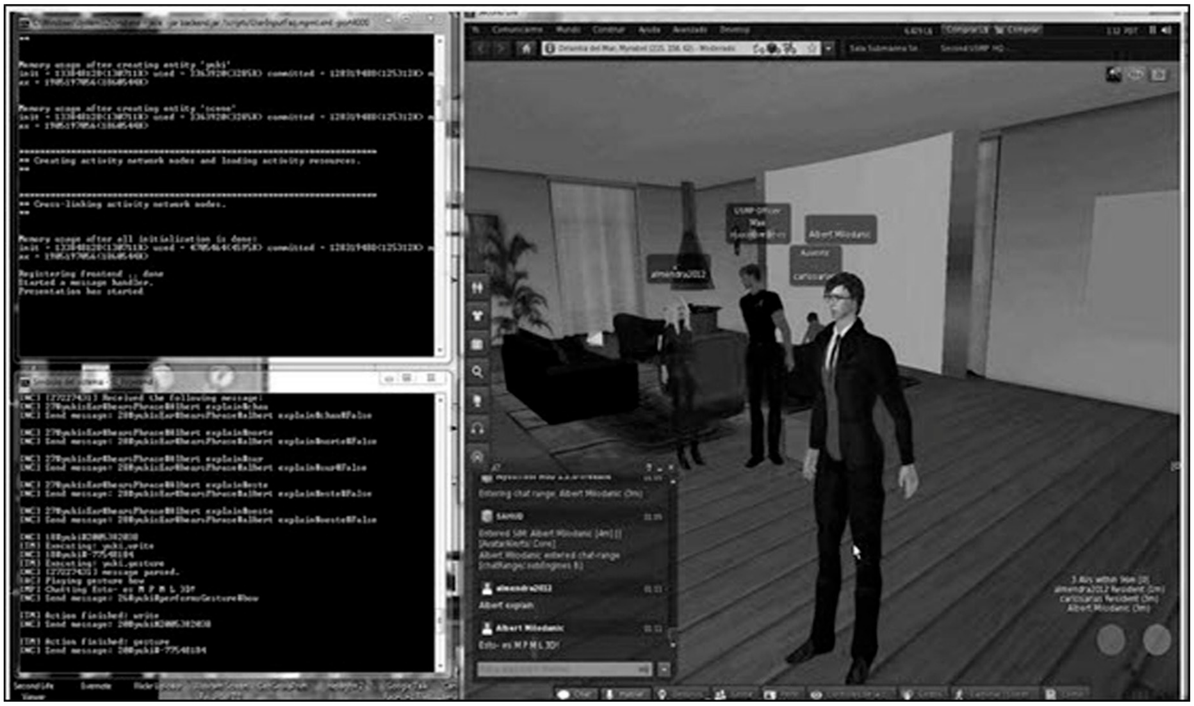
The agent avatar replied without inconvenience to the commands sent by other avatars present, driven by humans via chat, such as hello, go north, go south, go east, and go west and bye. In all cases the agent performed the actions foreseen in the script, responded by chatting and executed movements (some steps) to the addresses listed.

To remove the virtual world avatar agent simply stop the service frontend. After this the avatar disappears from the scene. No need to stop the backend to remove the agent. If you run the frontend, the avatar will enter the virtual world, always controlled by the script with which you ran the backend. If you need to run a different script will be required before closing the backend and running it again but with another script in the command line.

Experiments showed that the language with few commands MPML3D allows a variety of communication possibilities with an agent avatar in the virtual world. The chat communication allow the avatar to present a menu of frequently asked questions to be approached avatars, also answer by chat and navigate to specific points within the region in which you are to guide newcomers and locate avatars in areas where instructors have raised activities.

Based on the first experiment and the results will be a second experiment, where the initial contribution (first experiment) will be validated through experience performing in a real context (learning), to confirm that the application of intelligent agent systems within virtual worlds has features that Second Life platform, and leveraging the capabilities and functionalities of an agent, would allow the evaluation the performance of the agent within these systems, through the observa-

Figure 5. Servers and Agent Avatar receiving instructions in Second Life



tion of their interaction with residents avatars, the application of the structure BDI (Beliefs, Desires, Intentions) and using MPML3D language that allows control of verbal and nonverbal behavior of the agents.

Experience Model

For purposes of this validation, we has prepared a experimental model consisting of a script language managed by MPML3D, through which the agent's behavior is managed, based on a set of possible actions in response to requests from avatars who interact with it, within a specific designed process. The model required to define the context or environment where the experience will be performed, and the role of the participants.

This experimentation is developed in a scenario of education (training) with the participation of teachers, which in this case act as students (person avatars), who that perform specific questions to the intelligent agent, so that the agent responds to each query or question, by doing the pre-determined response for each question. In this process the question is repeated as a way to reaffirms the agent response action in the virtual world.

This process implies that the script language is fed with a designed "chat script", with established keywords that the agent will "listen" and identify within questions of individual person avatars, performing the action scheduled as walk to a specific point, showing the avatar person "response object " by clicking on it and returning to the starting location point of the agent avatar. Then another person avatar make a second question, which will cause a similar action in the other direction to another "object response", after this another avatar person held a third question to originate a new action and finally a different avatar person, will formulate the first question again to confirm the action response of the agent avatar.

Table 2. Communication and interaction between an intelligent agent and an avatar person in the virtual world Second Life through MPML3D language

Person Avatar	Agent Avatar
Enters into the location of the intelligent agent within the virtual world.	The avatar agent runs the greeting via text chat: "Greetings!"
Make a question, which includes the keyword "Syllabus": "Hey, Where can I get the Syllabus of the course?"	"Listens" to the question and identifies the key word "Syllabus" and performs the response action: Reply in text chat: "The syllabus can be found on this object," walk to the location of the response object and report with a "click" on the response object.
Makes a replica in text chat; "Thank you."	"Listens" to the avatar person, identifies the key words "thank you" and runs the farewell text chat: "You're welcome. See you soon."
	Executes the end of the action: Walks back to its initial point.

This process is repeated twice more where the intelligent agent "listens" two questions and different keywords, made by two person avatars different to the first person avatar, that originate different independent response actions in function of each object response and the location of them, i.e. Question 2 = action and response object 2, question 3 = action response object 3.

Finally a fourth person avatar formulates a question which includes the same keyword of the first question "Syllabus" and the intelligent agent does the same response action he made in the first step of this experiment.

This experience should be repeated again with different stakeholder groups, students and teachers. The model is complemented by a survey for all participants to collect results and information

Figure 6. Intelligent Agent making the same response action of the first question

on the effect of the experimentation described on the enrichment of the educational process of teaching and learning training.

COLLABORATION AND TEAM LEARNING IN VIRTUAL WORLDS

Lipnack et al., cited by Van Der Land agree that the "increasing competition, globalization of markets and the casual geographic dispersion of the organizations makes it increasingly important for organizations to enable team collaboration regardless of time and place." (Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F., 2011).

Van Der Land affirms based on Martins, Gibson and Maynard, ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)that "with the advent of worldwide connectivity through Internet and digital technologies advance, the use of virtual teams, because of its feasibility and cost-effectiveness, is becoming a commonplace in organizations. Virtual teams are teams that work together on a common task, regardless of geographical boundaries, temporal and relational, supported by information and communication technology." Lipnack et al. quoted again by Van Der Land (Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F., 2011).

The potential of virtual worlds as a medium as rich and attractive for knowledge sharing and virtual collaboration has been recognized by professionals (e.g., IBM) and scholars, affirms Wilson (Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F., 2011). Despite this increasing focus on 3D virtual environments in the literature, less attention has been paid to how the unique capabilities of 3D virtual environments could affect virtual team collaboration. According to Dennis et al. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)for effective team collaboration, two types of communication tasks must be performed. First, the information about the task needs to be transmitted and processed by the individual group members, a process known as information processing support. Second, group members need to communicate information socially related and need to reach a common understanding on the basis of information processed individually, called communication support.

Van der Land indicates that up to now there is no theoretical model of 3D virtual environment that takes into account the unique capabilities of the media in the 3D virtual environments to support these two processes and present a theoretical model focused specifically on the effectiveness of collaboration in 3D virtual machine. (Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F., 2011).

The research proposes that the component where the information must be transmitted has an improved recognition of relevant information in each process.

One of the features of 3D virtual environments that enable team collaboration support is avatar-based interaction through which all communication is carried out. In 3D virtual environments people are represented by avatars, virtual representations of themselves in a variety of ways. Avatars are digital representation of identity. The avatar-based interaction is a rich form of interaction in which team members can use a variety of communication signals, such as text-based chat, audio, prerecorded animations (e.g., dance moves, gestures). Two related capabilities avatar-based interaction can support collaboration in virtual environments: social presence and control over self-presentation through the ability to manipulate avatars (Van der Land, S., Schouten, A. P., Hooff, B., & Feldberg, F., 2011).

Lim, K. Y. T. (2009), proposes six learning frames designed for virtual worlds not seen as hierarchical or mutually exclusive. These are: a) Learning through exploration, b) Learning Through collaboration, c) Learning through being; d) Learning by building; e) Learning by defense; f) Learning through expression. Of these, learning through collaboration occurs, for example, when students work in teams, whether in problem solving tasks or other forms of structured research in the academic environment.

PROPOSAL FOR COLLABORATIVE LEARNING IN VIRTUAL WORLDS

The literature shows that the capabilities of virtual worlds to support team collaboration are based on two unique features of these, namely (1) the 3D environment itself in which participants are immersed and (2) the avatars based interaction through which all communications in virtual environments are performed. On the other hand, the study also shows that there are different approaches to exploit the collaborative possibilities of virtual worlds in e-learning.

Learning through collaboration is one of them. It occurs when people work in teams, for example, solving problems or researching. The proposal is that the capabilities of virtual worlds for collaborative teams can effectively support collaborative learning. The problem is defined with the question to what extent the capabilities of virtual worlds to support effective collaboration in teams effectively support collaborative learning in these environments?

The research proposes an adaptation from effective collaborative learning model in 3D virtual environments with the hypothesis that immersions in 3D environments and interaction based on avatars of virtual worlds effectively support collaborative learning.

The model proposes that the capabilities of the 3D environment and interaction based on avatars have a proven effect on the two key supports for shared understanding: the information processing support and communication support. If these capabilities of 3D environments have a positive impact on teamwork, the research argues that can have a positive impact on collaborative learning (Figure 4).

CAPABILITIES OF 3D VIRTUAL ENVIRONMENTS TO SUPPORT TEAM COLLABORATION

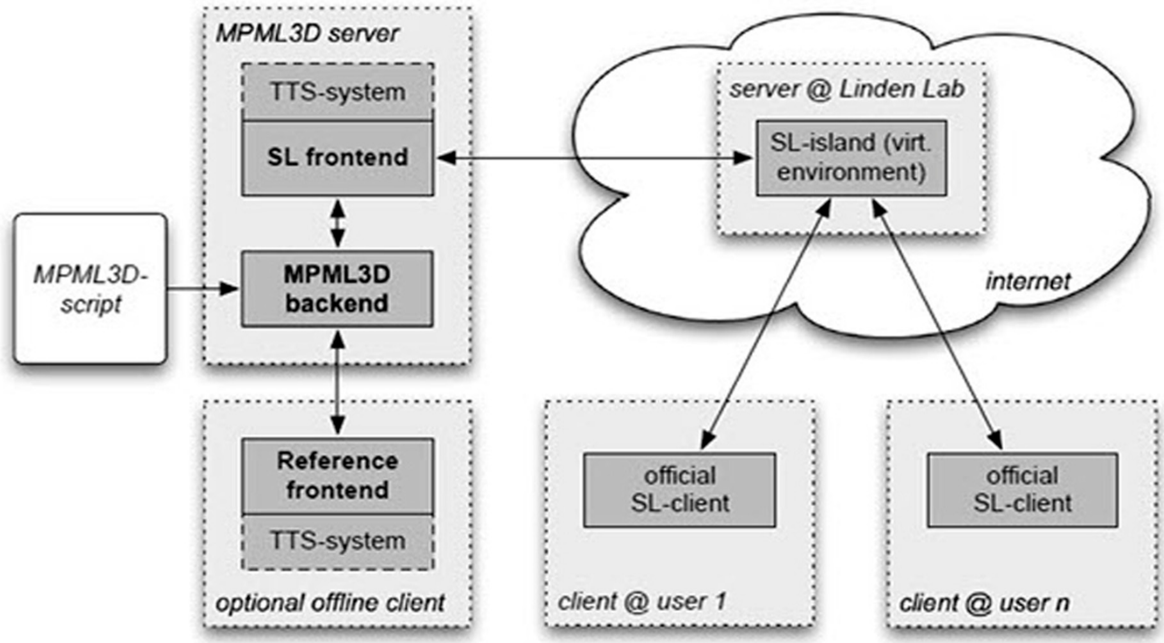
Compared to traditional technologies that support team collaboration and decision making, the specific capabilities that 3D environments provide, result from two unique characteristics derived from these environments that might support team collaboration (1) the 3D environment in which participants are immersed, and (2) the avatar-based interaction through which all communication in 3D virtual environments takes place. In Table 1 (p. 6) the five capabilities that are offered through these two characteristics are presented in comparison to traditional collaboration technologies. This is further explained below. (Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F., 2011)

3D Virtual Environments

The first characteristic of 3D virtual environments that might support team collaboration is the 3D environment itself. A 3D environment offers many visual cues: the environment can be a city, a street, a building, a meeting or conference room, an airport, a tropical island – whatever the preferred design is.

Virtual worlds also offer the possibility to integrate different applications into the interaction – for instance, a video can be shown on a screen in a virtual room, a Power Point presentation can be displayed, and so forth. Moreover, 3D virtual environments offer the ability to manipulate the 3D design for task relevant purposes. For instance, in the context of spatial planning issues, the medium allows users to virtually walk through a hotel lobby or sushi bar, which has yet to be, constructed in real life and to personally experience the final result. (Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F., 2011)

Figure 4. Overview of the system architecture with the different components distributed over several servers, (Ullrich, S., Prendinger, H., & Ishizuka, M., 2008)



The shared environment in 3D virtual environment offers three capabilities that could affect team collaboration: presence, realism, and interactivity. (Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F., 2011)

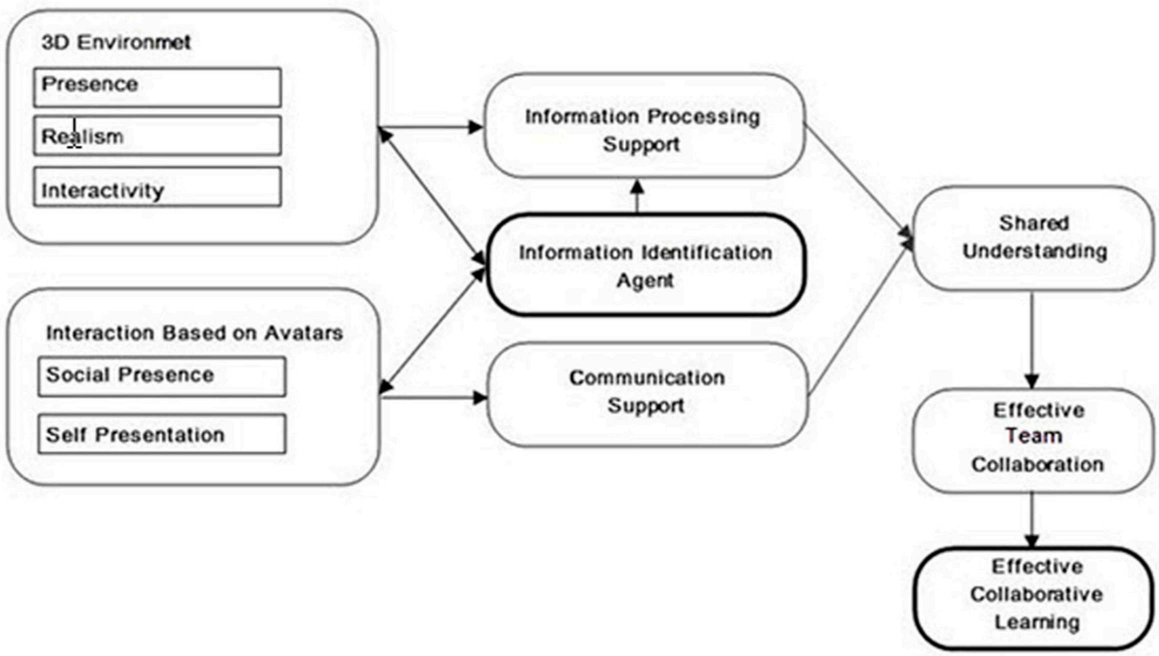
Presence. First, 3D virtual environments offer a greater degree of 'presence' than traditional technologies (e.g. Instant Messaging and email) that support team collaboration. Presence consists of both immersion and involvement. Immersion is the extent to which one feels perceptually surrounded in the virtual environment rather than ones physical surroundings. (Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F., 2011)

Involvement relates to "focusing one's energy and attention on a coherent set of stimuli or meaningfully related activities and events in the environment" by Witmer & Singer, cited by Van Del Land. 3D ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)virtual environments could stimulate immersion because they offer a higher level of stimuli and experiences than other, less rich environments, leading to a stronger feeling of being immersed in the environment. Moreover, 3D virtual environment may stimulate involvement because participants are attentive to relevant visual cues the environment offers that might help them process information. (Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F., 2011)

Realism. Second, realism is the extent to which one believes the virtual environment is real argue that representation and rendering are important technological capabilities of 3D virtual worlds, both of which refer to the process of creating life-like images on screen as well as to how realistically objects are represented in the three-dimensional space.

For instance, in a virtual environment one can navigate through the environment to virtually experience physical locations that do not (yet) exist in real life, for example a virtual representation

Figure 7. Model for Effective Collaborative Learning in Virtual Worlds. Based on the theoretical model that shows how the capabilities of 3D virtual environments affect information processing and communication processes, which leads to a shared understanding, from the reference (Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F., 2011)



of an architectural design. Compared to 2D representations, 3D virtual environments offer more cues and provide a higher degree of reality, which might positively affect information processing. (Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F., 2011)

Interactivity. Third, 3D virtual worlds offer a higher level of interactivity than many traditional collaboration technologies. Interactivity refers to the capability to move and navigate through a virtual environment in contrast to examining static 2D or 3D images the environment, and the ability to interact with and control the environment in real time, For example, 3D virtual environments such as Teleplace allow people to give presentations in and interact with the environment by using tools such as a shared whiteboard and a shared presentation space. Second Life also offers a basic scripting language which allows one to program interactions with the environment. Because 3D virtual environments are highly interactive, users are active rather than passive in their engagement with the information, which may lead to more effective information processing. (Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F., 2011)

In conclusion, these arguments lead to the following proposition:

P1: Compared to traditional collaboration technologies such as Instant Messaging, email and group decision support systems, virtual team members will experience higher levels of (a) presence, (b) realism and (c) interactivity in a 3D virtual environment. (Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F., 2011)

Avatar-Based Interaction

The second characteristic of 3D virtual environments that provides capabilities that might support team collaboration is the avatar-based interaction through which all communication takes place.

In 3D virtual environments, people are represented by avatars, virtual representations of themselves in a variety of forms; we define avatars as "a digital representation of one's identity." Avatar-based interaction is a rich form of interaction in which team members can use a variety of cues to communicate, such as text-based chat; audio, pre-recorded animations (e.g., dance moves, gestures), based on Yee et al. cited by Van Der Land. Moreover, most virtual environments allow participants to create and adapt their own avatar. This also allows team members to add cues to their communication, such as clothing style and physical appearance. Two capabilities related to avatar based interaction may especially support team collaboration in virtual environments: social presence and control over self-presentation through the ability to manipulate avatars. These two capabilities are discussed below. (Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F., 2011).

Social presence. Social presence is generally defined as the awareness of being present with others in a mediated environment combined with a certain degree of attention to the other's intentional, cognitive, or affective states. Avatar-based interaction offers a wide array of symbol sets: it can be synchronous, uses text or voice interaction, and offers more cues than text-based interaction, such as gestures, avatar appearance and avatar behavior. For example a complete set of movements to express some culture characteristics as a dance performed without using text or voice. These cue-rich forms of interaction could enhance social presence. Moreover, people in virtual worlds also experience co-presence because they feel they are in a world together. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)

Combining the feeling of being together with possibilities for rich interaction, social presence thus relates to the extent to which participants feel that the team members who are interacting within the 3D virtual environment are really present in that environment.

Self-presentation. 3D virtual environments offer great control over the appearance of one's avatar, since the shape, skin color, eyes color and shape to a fantastic appearance for an interpretative a roll play. In Any case Self-presentation is an important social process in everyday life and the interaction that occurs within the 3D environment are perceived as real. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)

However, in real life there are physical boundaries that limit one's ability for strategic self-presentation.

Online, these boundaries exist to a lesser extent. People have more freedom to present themselves the way they would like to. These opportunities for strategic self-presentation also exist in 3D virtual environments through the manipulation of avatars. For instance, avatars can be manipulated to look like real-life representations of the participants, or, conversely, to be made anonymous and similar to other team members' avatars. Choices made with regard to avatar manipulation will affect the level of identification (with the avatar, and/or with the team), group dynamics and collaboration within the team. Thus, the increased possibilities offered for self-presentation in 3D virtual environments through avatar manipulation is an important capability in terms of team collaboration effectiveness. In Table 1 below, a comparison of different media on all of the five capabilities is presented. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)

P2: Compared to traditional collaboration technologies, virtual team members will experience higher levels of (a) social presence and (b) control over their self-presentation in a 3D virtual environment. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)

Information Processing and Communication Support in 3D Virtual Environments

We propose that the above capabilities of 3D virtual environments could support team collaboration. To identify the processes through which the capabilities of 3D virtual environments support effective team collaboration, we first turn to the literature on group support systems. Group support systems must be understood as a set of communication, structuring and information processing tools that are designed to work in an integrated manner to support the implementation of group tasks. Research generally distinguishes three ways in which group support systems could facilitate team collaboration:

Communication support: the support of group members' capabilities to communicate with each other, Information processing: the support of group members' capabilities to gather, share and process Information. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)

The specific capabilities of 3D virtual environments are likely to support primarily both communication and information processing. Specifically, the presence, realism, and interactivity that a 3D virtual environment offers, aid information processing for tasks that require visual and spatial components. Avatar manipulation and social presence offered by avatar-based interaction will provide communication support. Thus, our general assumption is that, compared to traditional collaboration technologies, the specific capabilities of a 3D virtual environment will imply that such an environment offers higher levels of information processing and communication support. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)

Information Processing Capabilities

We will now elaborate on why the capabilities presence, realism and interactivity experienced in 3D virtual environments will lead to greater information processing.

First, presence may increase information processing because team members feel immersed and involved in the 3D environment. For example, when team members are actually present in the environment, they may feel more immersed and involved in the decision task about a spatial planning issue. As such, they are more devoted to giving attention to the source of information, which is the primary perquisite to how thoroughly information is processed. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)

Second, realism could support information processing because the more one experiences the 3D virtual environment as being real, the better one is able to make visualizations and understand the desired outcome of a team task (Baker et al., 2009). Visualization aids (e.g. 3D representations of buildings, charts, images) are extremely powerful in simplifying complex issues and tend to minimize the chance of having divergent interpretations by group members. Thus, the higher degrees of realism experienced in a virtual environment are positively related to depth and effectiveness in information processing. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)

Thirdly, the interactivity offered by 3D virtual environments might stimulate information processing because the environment is perceived as more natural than 2D representations. Scholars found that dynamic, moving cues resulted in more attention than static cues and that interaction attributes, such as movement can be more easily detected and processed. Because 3D virtual environments are highly interactive, users are active rather than passive in their engagement with the information, which could lead to more effective information processing. Together, these arguments lead to the following proposition:

P3: The higher levels of (a) presence, (b) realism and (c) interactivity experienced in a 3D virtual world relative to traditional collaboration technologies will lead to a higher level of information processing in these environments. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)

Communication Support

Avatar-based interaction in a 3D virtual environment can offer communication support to teams working together on a task, for the following reasons:

First, social presence offers communication support because it enhances the social-relational processes needed for effective team collaboration. Avatar-based interaction in virtual worlds offers immediate feedback, multiple cues to be transmitted simultaneously, and a wide range of symbol sets to communicate. Therefore, avatar-based interaction is a rich form of interaction, which is a prerequisite for establishing interpersonal relationships. Their research revealed that social presence, the "realness" of interacting with other people in the virtual environment in WoW, was the main attraction for most players to the game. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)

Second, self-presentation through avatar manipulation may be strategically employed by teams to maximize team collaboration and team outcomes. In order for teams to be willing to collaborate and to share information needed to complete a task, team members need to feel as if they are part of their team manipulating avatars' appearance, by for instance giving team members avatars that look similar to each other, may lead to this form of belonging. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)

It may also lead to more equal participation in a virtual project and result in more original solutions in a team task morphed digitally manipulated) a team manager's avatar face in order to represent equally a division of his three team members real-life facial features. Their research showed that this resulted in the manager being perceived as more sympathetic and credible hyper personal theory, the combination of higher social presence and increased control over self-presentation in 3D environments could lead to hyper personal effects, creating increased social attraction among team members. Therefore, we argue that the strategic manipulation of avatars offers communication support. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)

P4: The higher levels of (a) social presence and (b) self-presentation experienced in a 3D virtual world relative to traditional collaboration technologies will lead to a higher level of communication support in these environments. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)

Information Processing and Communication Support, Shared Understanding and Effective Team Collaboration in 3D Virtual Environments

Both information processing support (conveyance) and communication support (convergence) are necessary in order for a team to reach a shared understanding. Shared understanding refers to reaching a common understanding of a task or problem, an understanding of each other's viewpoint, and an overlap in possible solutions. Information processing is necessary for shared understanding as task-related information needs to be shared and processed in order for each team member to create an individual understanding of a task. Achieving an individual understanding of task-related information is the first step to reaching a shared understanding. Communication support contributes to share understanding since the outcomes of the conveyance processes (i.e., the individual understanding) need to be shared and communicated in order to reach a common understanding. Moreover, stress that in order for teams to collaborate successfully team members do not only need to perform well on task-related functions, but they must also work well together socially as a team. Therefore, communication support also entails the social-relational aspects of team collaboration. In sum, in order to reach shared understanding, information processing and communication support is necessary because teams must (a) share task-related information in order to form an individual understanding of a team task, and (b) share and discuss the outcomes of this individual process in order to reach a common understanding. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011) Therefore, we offer the following proposition:

P5: The higher levels of a) information processing and b) communication support experienced in a 3D virtual world relative to traditional collaboration technologies will lead to a higher level of shared understanding in these environments. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)

Shared Understanding and Effective Team Collaboration

Shared understanding, in turn, is considered to be a prerequisite for effective team collaboration. Group members are likely to process any information about the task at hand from a shared viewpoint, which facilitates task performance, especially in decision making and negotiation tasks. Furthermore, shared understanding is an important prerequisite for positive group outcomes such as cohesion and other task performance measures. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)

The concept of effective team collaboration can be broken down into two major constructs: performance and satisfaction. Performance is the actual outcome that is generated by the collaboration process, an output measure that rationally and objectively measures whether earlier defined goals have been achieved. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011).

For instance, when outcome refers to productivity level, it can be measured objectively by the sheer quantity of products a team has produced. Alternatively, when outcome refers to the decision a team has made as result of collaborating, performance, it is measured in a more subjective way (e.g. by asking a manager) or customer to rate the quality of the decision Satisfaction refers to how team members themselves have experienced the process of collaboration. Satisfaction is viewed as a more emotional, subjective measure that reflects how the team members have experienced the process of collaboration. Satisfaction is strongly related to performance. Satisfaction, however, is a subjective construct and captures the perceptions of the individual team members. Campion, Medsker, and Higgs citd by Van Der Land, demonstrated that satisfaction is a valid predictor of the team's effectiveness in terms of performance, since team members are central to the task, and thus subsequently directly influence the team's productivity. All in all, we expect shared understanding to be positively related to the components that together determine effective team collaboration. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)

Thus, our final proposition is:

P6: The higher level of shared understanding in a 3D virtual world relative to traditional collaboration technologies will lead to a higher level of team collaboration effectiveness in these environments. ((Van der Land, S., Schouten, A. P., Hooff, B. & Feldberg, F. (2011)

The Identifying Information Agent

For the research, the inclusion of an identifying information agent allows to increase metacognitive habits as well as their understanding of distributed cognition and social dynamics in a particular context achieving effective collaborative learning.

The researchers experimented with a group of teachers who entered to the virtual world for the first time, made the adaptation process to the 3D environment and began to participate through their avatars (interaction) in terms of achieving a specific common objective in team, which was to develop skills through a building and implementation workshop, culminating in a project with practical use in Second Life. Effective team collaboration was shown when jointly they acquired knowledge about the resources offered by the 3D environment. The communication process performed through the presence and identification with avatars (social presence), resulted in constant interaction within the virtual world during the workshop. In this way the understanding and effective collaboration of the team resulted in an effective collaborative learning, since the group might be able to understand the use of the resources of the virtual world and likewise design and build a personalized space for the objective of the team and apply a simulation of practical use.

SOLUTIONS AND RECOMMENDATIONS

The main goal of this research is to demonstrate the relation between the collaborative logic based on software agents and one virtual words platform in order to build effective results. After this test the research will be able to focus in a more ambitious goal for run the software in new conditions with people with disabilities.

The recommendations are built in the next high level of the systems where we need to demonstrate new results including drivers for collaborations in disadvantages conditions when user doesn`t have mobility and perhaps neither has skills in this new technological world.

FUTURE RESEARCH DIRECTIONS

This research creates the conditions for assessing the impact of the use of intelligent agents within a virtual world in collaborative learning. As part of the future research, it will focus on the integration of the platform MPML3D with simulation and modeling capabilities of virtual worlds like Second Life. A further aspect of our interest is to apply the use of virtual environments supported by intelligent agents in productive education of persons with disabilities.

CONCLUSION

The experience shows that MPML3D language allows a variety of possibilities of communication with an agent avatar in the virtual world.

Virtual worlds have their own capabilities that differentiate them from other forms of interaction. Among them, the 3D environment and avatar-based interaction can withstand the processes required for effective collaboration in teams.

The agent avatars have enriched the collaborative interaction among other reasons because they can mimic the behavior of the user, and they can adapt the environment smoothly.

Effective collaboration in teams in virtual worlds, through collaborative knowledge management, can lead to an effective collaborative learning.

Through MPML3D platform intelligent agents can be easily shaped and controlled within Second Life. This would enhance learning in virtual worlds interacting with other avatars handled by people.

The convergence of knowledge management, intellectual capital, intelligent agents and virtual worlds allow effective collaboration, encouraging the transfer of knowledge and effective learning.

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KEY TERMS AND DEFINITIONS

Frontend-Backend Interface–Engine: Refers to a beginning and end process and keep separated the parts of a system.

Information Ecosystem: System with the capacity to manage information and build relationships between objects viewed into a specific context.

Intellectual Capital: The amount by which the market value of a firm exceeds its tangible assets less liabilities (physical-financial)

Intelligent Agent: Autonomous entity capable of performing a task or activity without direct manipulation of a human user.

Multiplayer Online Role-playing Game: Games that allow thousands of gamers to play in virtual world, as World of Warcraft.

Shared Space Technologies: Technologies that create distributed electronic environments where participants can exploit spatial properties such as containment and movement to manage their communication.

Virtual World: Computer-simulated environments inhabit by residents in which they interact with others, either themselves or graphic representations called avatar.

Chapter 16
Quality Analysis of VoIP in Real-Time Interactive Systems over Lossy Networks

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ABSTRACT

Voice over Internet Protocol (VoIP) systems have been spreading massively during the recent years. However, many challenges are still facing this technology among which is the lossy behavior and the uncontrolled network impairments of the Internet. In this chapter, the authors design and implement a VoIP test-bed utilizing the Adobe Real-Time Media Flow Protocol (RTMFP) that can be used for many voice interactive applications. The test-bed was used to study the effect of changing some voice parameters, mainly the encoding rate and the number of frames per packet as function of the network packet loss. Several experiments were conducted on several voice files over different packet losses, concluding in the best combination of parameters in low, moderate, and high packet loss conditions to improve the performance of voice packets measured by the Perceptual Evaluation of Speech Quality (PESQ) values.

INTRODUCTION

The market penetration of VoIP has massively influenced traditional telephony as witnessed by the popularity of many VoIP services and applications (e.g. SKYPE, Cisco TelePresence, Ekiga and Oovoo (Vaughan, 2012)). It has become one of the most popular Internet Protocol (IP) based real-time communication services in recent years, it is of no doubt that VoIP networks are cost-effective over conventional telephone networks with Time Division Multiplexing (TDM) and leased lines. In real-time interactive systems, VoIP has been entitled an important role in enabling voice based real-time services, such as voice conferencing, that is applied in various sectors and fields every day. According to Zhao & Yagi & Nakajima & Juzoji, (2002). VoIP is taking a firm hold in the telecommunication market for a wide range of interactive applications including telemedicine and e-health.

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Telecommunications is the key to any successful telemedicine activity, and is considered a tool of vital importance to the future of healthcare. For many years, telemedicine was supported by dedicated telecommunication assets- Plain Old Phone Systems (POTS), satellite based, etc. Today, with the widespread of the Internet, VoIP based services are becoming more attractive (Latifi, 2008). However, still facing many challenges mainly the transmission over lossy connections and its consequences on Quality of Service (QoS). In this chapter, experimental tests have been conducted on lossy network impairments and a proposed test-bed is being built as a very efficient tool for testing Internet based interactive systems. The designed VoIP test-bed utilizes an open source, license free voice codec along with a development free publically available version of Adobe Flash Media server (FMS). Those features draw the interest of some commercially well-known companies for online speech therapy telepractice to use a similar design to the one proposed, in their interactive e-health solution, speech-language pathologists to school districts are provided through Telepractice as delivery model commonly referred to as online speech therapy, where the system connects the therapists to children in need of speech therapy in an interactive real-time system, the connection is held between the therapists and the children in need for speech therapy through the use of FMS. The investment in such a system degraded huge financial commitments. However, there is still a room for further developing the quality of the delivered VoIP services.

In fact many companies will act as a model on how VoIP can be utilized in many interactive systems and applications in different fields such as e-health services. However, despite VoIP widespread in many fields and applications, many corporations are still reluctant for introducing VoIP on a larger scale because of many QoS concerns (Mase & Toyama & Bilhaj & Suda, 2001; Sabrina & Valin, 2009), which stress the demand for more research concluding mechanisms and methods to improve its speech quality, which according to ITU E.800 is defined as “the quality of spoken language as perceived when acoustically displayed. Result of a perception and assessment process, in which the assessing subject establishes a relationship between the perceived characteristics” (ITU-T E.800, 2008). To that end, and in order to support VoIP applications over the Internet, two conflicting requirements need to be met. In one hand, shared resources have to be controlled so that resource usage is optimized, on the other hand, VoIP applications are considered one of the most applications that demands strict QoS level and sensitive services to network impairments as the packet loss, available bandwidth, delay, jitter, etc. (Rejaie & Handley & Estrin, 2000; Sabrina & Valin, 2009). According to (Birke & Mellia & Petracca & Rossi, 2007), the authors presented a large dataset of measurements collected from the FastWeb backbone, which is one of the first worldwide Telecom operator to offer VoIP and high-speed data access to the end-users, they found that among the previous stated impairments, the packet loss is the major source of impairment that greatly affects VoIP call quality which has an immense influence on delivered speech, thus it is required to minimize the effect of packet loss impairment and others on speech quality during any interactive transmission to guarantee the best available quality.

When voice frames encounter packet loss during transmission, some frames got lost and the originally transmitted source speech content will be received with lower number of frames according to the congestion encountered in the lossy networks, scoring a lower output score quality assessment. An objective method for end-to-end speech quality assessment known as the Perceptual Evaluation of Speech Quality described in International Telecommunication Union-series P.862 Recommendation (ITU- P.862) (ETSI, 2011) is widely used as an industrial standard for objective voice quality testing. Scoring in this assessment method is of a combination of average disturbance and average asymmetrical disturbance values, in most cases, the output score range will be a Mean Opinion Score (MOS) between 1 and 4.5 (ITU-T P. 862, 2001), such widely used method is utilized to estimate the decreasing quality of the received tested speech in this chapter. The purpose of this chapter is to analyze the performance of VoIP interactive systems under different packet loss conditions, and study the effect of different voice parameters such as changing the encoding quality and also the number of frames per packet, that will enhance massively the voice quality for different network packet loss conditions. To achieve that goal, a test-bed for real-time VoIP conference system has been built and VoIP performance has been experimentally evaluated under different packet loss conditions.

The remaining part of the chapter is organized as follows. Section 2 presents a background presenting the literature review of some related work. Section 3 describes the test-bed design and the used tools. Section 4 presents the research methodology, experimental setup and tests. Section 5 explains the research findings and related discussions, tests and results. Finally, the chapter is concluded along with some proposed future trends in Section 6.

BACKGROUND

The effect of various impairments and assessments of perceived speech over lossy networks have been reported and evaluated by a number of researches. The work reported in (XIAOMIN, 2011) evaluated the speech quality using PESQ for two widely used VoIP codecs, Speex and SKYPE codec SILK, studying how complexity, bit rate, and the buffer size affect the quality of the streamed audio. It was concluded that SILK outperforms Speex but with a minor margin and when quality is better, it will have higher PESQ values, but lower values with burst length of packet loss. Moreover, the results reported that when loss rate is small, there will be very few packets lost hence the PESQ value is high and the quality of the received audio is quite good and vice versa. However, the research was limited to group framing one frame per packet on each transmission time and used only the Real-Time transport Protocol (RTP) with limited range of loss rates. The authors in (Ding & Goubran, 2003; Yamamoto & Beerends, 1997) as well investigated the effects of packet loss on VoIP speech quality. In (Yamamoto & Beerends, 1997) a top-down approach was used to estimate the perceived quality of conversational speech as a function of specific network parameters, allowing the calculation of the QoS at the user level by measuring specific network parameters, the major focus of this study was studying the effect of packet size on the voice quality degradation. The results for the male voice showed no significant effect of packet size on the perceived quality for a given packet loss ratio, while for the female voice, a small effect of packet size was found. However, the authors did not take other VoIP related parameters such as changing the bit rate, and their study was limited to the fixed audio codec of 32 Kbit/second. A similar limitation was found in (Ding & Goubran, 2003) which investigated the effects of packet loss for the fixed rate G.729 codec which simulated random packet losses, with different packet sizes, but was limited to G.729 codec and did not handle variable bit rates codecs. Their study extended E-Model equation used in estimating the VoIP quality to make more accurate MOS estimation when having packet loss.

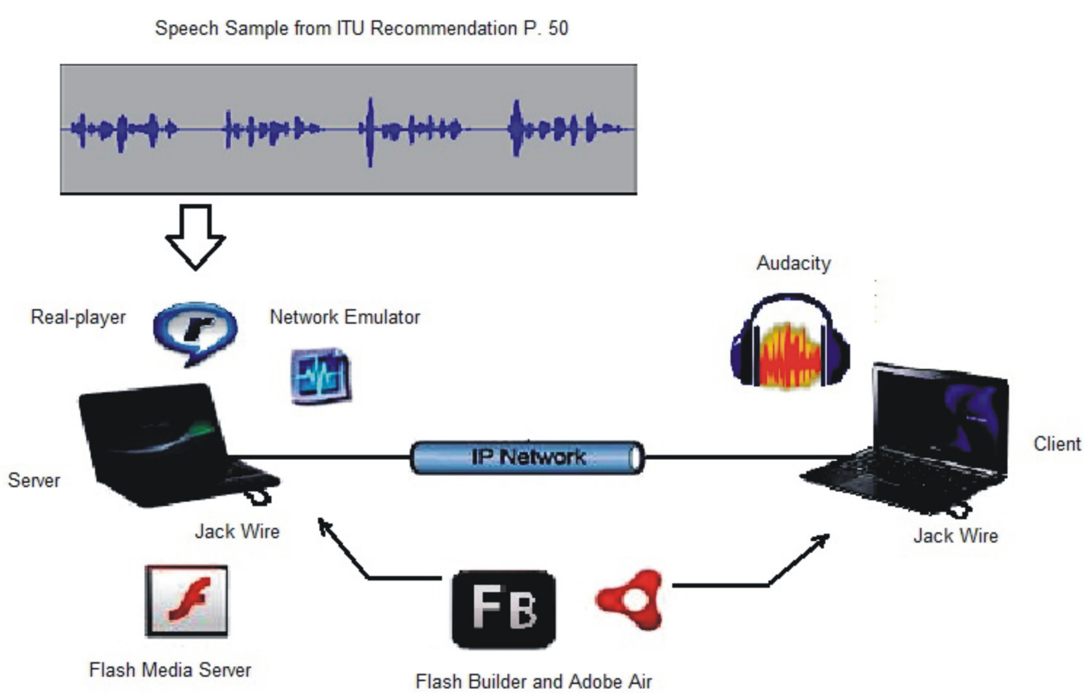
One factor that affects the packet size is the inclusion of more than one voice frame inside the packet; this process is measured using the number of Frames per Packet (FPP). Voice frames are known to have small sizes, thus if one frame is used for each voice packet, the packetization overhead will be large, especially with the relatively large IP, User Datagram Protocol (UDP), RTP header sizes. Nevertheless, the inclusion of more than one voice frame per packet will reduce this packetization overhead, thus the packet payload size will be increased. However, there is a trade-off when increasing FPP, in on hand, it will reduces the packetization overhead, but on the other hand, this process increases the end-to-end delay, and vice versa. Furthermore, losing a packet will result in losing more than one voice frame, which will negatively affect the received voice quality. In the literature, several researchers studied this dilemma, for instance, the work reported in (Hyogon & Myung-Joo, 2002) concluded that frame grouping can significantly reduce the bandwidth requirement of Internet telephony, if it adapts to the fast delay fluctuation. Another approach researchers use to improve the voice quality over the lossy network is to change the encoding rate or the qualities of the voice frames according to the network packet loss conditions. The authors in (Sabrina & Valin, 2009) suggested a system to dynamically change the encoding rate of the voice frame, using a variable rate encoder such as Speex (Zhao & Yagi & Nakajima & Juzoji, 2002) which provides highest quality speech while maximizing the bandwidth utilization and reducing the network congestion.

Diverting from the proposed study research seen in literature which either investigated the effect of number of frames per packet or the effect of changing the encoding rate. In this chapter, a study for the effect of changing both factors simultaneously for different packet loss conditions is presented, with recommendation for the best pair of frame grouping scheme and the best encoding rate for a given packet loss condition. In order to achieve the purpose of this research study, a real-time voice conferencing platform is built utilizing the Adobe Flash technologies and the Real-Time Media Flow Protocol which is fully described in the subsequent sections.

TEST-BED SETUP AND DESIGN

In this section, a description of the structure of the proposed test-bed is shown in Figure 1 along with the tools and technologies used in the implementa-

Figure 1. Test-bed architecture and components



tion. The proposed conferencing software platform is a modified version from the one developed by (Vass, 2010). As seen in the figure, the test-bed consists of the following hardware and software components: two laptops connected together with an Ethernet connection link as the main hardware tools and other software utilities mainly: A Flash Media Server that is installed on the first laptop, which is referred to as the server, a Flash builder Integrated Development Environment (IDE) that is used to build the voice conferencing software utilizing the Flex programming language and Adobe Air, the proposed conferencing platform. Further, in order to record the audio content for off line evaluation, Audacity software is used at the client computer. Moreover, Real- player software is used to play the speech audio files from the server and to transmit them via the Flash Media Server FMS to the client side. Finally, the Network Emulator software was installed on server side to emulate the packet loss of the Internet in a controlled way. In what follows, a brief description for each component is provided.

A. Flash Media Server

The FMS is a proprietary data and media server from Adobe Systems. It works with the Flash Player runtime to create media driven, multi-user Rich Internet Applications (RIAs) allowing multiple Flash Player clients runtime to connect and exchange multimedia contents from the server. FMS is not publicly free but it has a development free version with a limited functionality that can be used for testing and even publishing. It uses server-side Action Script for server programming, and client-side Action Script for Flash Player and Adobe Integrated Runtime (AIR) programming. FMS has a number of transports-streaming protocols such as Real-Time Message Protocol (RTMP), which is integrated above Transmission Control Protocol (TCP) layer, on the other hand, it also supports the Adobe Real-Time Media Flow Protocol (RTMFP) protocol that runs above UDP transport layer, which will be used in the experiments conducted in this chapter.

B. Real-time Media Flow Protocol

RTMFP protocol is proprietary transport protocol based on UDP. It is a communication protocol introduced by Adobe in 2008 and it can send data directly to its destination without sending it through a server, allowing direct communication between connected peering entities including features as low latency, end-to-end peering capability, security and scalability. These properties make RTMFP especially well-suited for developing real-time collaboration applications and solutions are less expensive to scale (Herrera, 2009; Kaufman, 2012). As compared to other existing streaming protocols, RTMFP has significant advantages over TCP-based protocols; since it is built on top of UDP rather than TCP transport layer. UDP is one of the key ingredients to building practical and scalable P2P application for Internet-connected peers. Unlike TCP, UDP is a lossy transport protocol. RTMFP is often lower latency than the older version RTMP due to the fact that RTMFP transmission-time prioritization coupled with UDP unreliability feature. Another key difference is that, unlike RTMP, RTMFP is encrypted over the wire using a 128-bit Advanced Encryption Standard (AES) encryption; helping to position Adobe managed P2P as a trusted solution to use for P2P applications (Hassoun and Heider, 2010).

C. Adobe Integrated Runtime

AIR is a cross-platform runtime system created by Adobe Systems in early 2008 in order to be used to enable web applications and Rich Internet Application to be deployed to the desktop environment instead of web-environment. It can be programmed using many programming languages such as Adobe Flex, Hyper Text Markup Language

(HTML), and Ajax. It is the equivalent for Flash media player used in web-based applications (Tretola, 2008).

D. Adobe Flash Builder

In order to develop a desktop application that utilizes Flash media technology with increased developer productivity, reduced bugs, speed up coding, Adobe created an IDE called the Flash Builder for building cross-platform, rich Internet applications for the desktop and a wide variety of mobile devices. Flash Builder also includes testing, debugging, and profiling tools that lead to increased levels of productivity and effectiveness. Flash Builder is built on top of Eclipse, an open-source IDE, and provides all the tools required to develop applications that use the Flex framework and Action Script 3.0 (Gassner, 2010; Adobe Systems, 2012).

E. Network Emulator

In order to emulate packet loss impairment in a controlled way, the Microsoft Network Emulator for Windows Toolkit (NEWT) is used in the test-bed. The NEWT is a software-based solution that can emulate the behavior of both wired and wireless networks such as packet loss and bit errors using a reliable physical link, such as an Ethernet (Microsoft, 2009).

F. Audacity

The received speech voice samples received at the client with degraded quality had to be recorded to be used in voice quality estimation as will be illustrated later, to that end, Audacity software is used for this purpose. The used recording tool is free, open source, multi-track audio editor and recorder for Windows, Mac, Linux, and other operating systems, cross-platform software for recording and editing sounds. It has many features some of which is the ability to record live audio and record computer playback on any supported operating system (Audacity, 2014).

METHODOLOGY AND EXPERIMENTAL SETUP

In this section, the experimental setup of the proposed test-bed is described along with the experimental methodology, network configuration, and voice performance evaluation using PESQ.

A. Test-Bed Setup and Methodology

The proposed test-bed is an emulation of a voice conferencing system, where one-way call is conducted from the server to the client. In order to do the experimental tests, some audio files with speech contents were chosen from ITU-T P.50 Appendix1 speech database, the ITU test signals for telecommunications (ITU P.50, 1998; ITU-T Test Signals, 2014) according to the recommendations found in ITU-T P.50 (ITU P.50, 1999). Accordingly those audio files were used to emulate a real VoIP session. The experiments use Pulse-Code Modulation (PCM) Waveform Audio file format (WAV) wideband mode speech files, sampled at 16Khz, with 12 seconds average length, with different contents and different genders (female and male) as input sources files in an English spoken language. Furthermore, it is vital to state that the purpose of using these off-line speech files is to achieve repeatable results of the measurements. The experiments were conducted as followed: a speech file was chosen from the ITU database to emulate a VoIP session, the speech file was played out using the real- player software producing an audio signal. Then the audio signal was redirected from the sound card output to the microphone input using a jack wire as shown in Figure 1, which was treated as an input to the server side of the voice conferencing software. At this stage, different audio settings were adjusted before transmitting the audio content to the client over the IP link. Mainly, the encoding rate and the number of frames per packet were used while packetizing the voice contents.

For setting up a speech conference system, a VoIP connection was established by FMS and voice packets were transmitted over the Ethernet link to the client side. As for the network emulator, it is used to emulate a pre-defined packet loss, thus the received speech contents will have some impairments due to the emulated packet loss, which in turns resembles the Internet behavior. Finally, after receiving the speech content at the client side, the content was directed from the speaker to the microphone again using a jack wire to be used as an input to the Audacity program that will save a copy of the received audio content for performance evaluation and assessment. Throughout this setup, different encoding rates with different number of frames per packet were configured over different network packet loss conditions in order to conclude their effect on VoIP performance. As such, extensive experiments were conducted by varying the voice encoding rate, frames per packet, and network packet loss, noting that the speech related parameters (i.e. the encoding rate and the frames per packet) were set using the developed conferencing platform.

In order to change the voice encoding rate, the open source encoder (Speex) is used with the developed conferencing software (Zhao & Yagi & Nakajima & Juzoji, 2002). This encoder has several encoding rates or Qualities (Q) that range from 1 to 10, where Q = 1/10 indicates lowest/highest encoding rate, which requires low/high transmission bandwidth and will result in a low/high voice PESQ quality at the receiver side after the decoding process. More discussion about the Speex bit rates ranges and qualities will be provided in the following section. As for the number of frames per packet, three values were tested: 1, 2 and 3 frames per packet, and regarding the network packet loss, several values were tested using the NEWT software which was installed at the server side. Finally, it is important to emphasize that ultimately the experiments' results were conducted to find out the best combination of these parameters for a given network packet loss conditions evaluating and analyzing eventually the performance of the received voice files using the PESQ objective assessment method.

B. Voice Test-Bed Configuration and Setup

It was noticed through the initial audio volume experiments of the Real-player at the server side and the recording Audacity software at the client side that their configurations do affect the obtained voice quality of the scenario under consideration, a similar observation was found in (Suriol & Mangues-Bafalluy & Maso & Gorricho, 2007) reporting that the audio volume affects the quality of the received voice, therefore, for each scenario, each experiment was repeated several times using different volume levels to find the optimal volume level that leads to the maximum PESQ score. In the test-bed scenarios, the same methodology was adopted to find the optimal volume level configuration, which was concluded by adjusting the input/output slider volume level for both server and client sides. It was configured to 25% at the Audacity software configuration in the former side and 25% for real-one player in the later side. Furthermore, in order to calculate the PESQ, the degraded speech files at the client side were compared with a reference file. And in order to determine the reference file for the conducted experiments, each tested audio file was transmitted using the highest possible quality (Q = 10) over a free-packet loss link to the client side and recorded. Thus the recorded file which represents the best perceived quality the client can obtain is used as a reference for the PESQ calculations.

C. Bit Rate and Network Impairments Setup

As discussed in the previous section, Speex variable codec is used which is capable of encoding 10 different encoding rates. However, not all the encoding rates will result in significant voice quality variations. As such, it was needed to discover the most significant encoding rates or Qualities to be used in the experiments. To that end, multiple series of experiments were conducted to setup the optimized representative bit rate range for Speex codec, and it was concluded reference to the chosen subjective description in the Speex codec manual (Zhao & Yagi & Nakajima & Juzoji, 2002) that Qualities 3,5,7, and 9 are the most significant qualities. Notice that a similar observation of choice was seen as well in (Xiaomin, 2011). As such, we limited our experiments to these qualities only.

D. Voice Performance Evaluation Using PESQ

The ITU-T recommendation P.862 describes the Perceptual Evaluation of Speech Quality algorithm, as an objective method for predicting the subjective quality based on the original reference and the degraded signal speech files. The output of PESQ is a prediction of the perceived quality grade that would be given to degraded files in subjective listening tests. Moreover, the original and degraded signals are mapped onto an internal representation using a perceptual model; whereas the difference in this representation is used by a cognitive model to predict the perceived speech quality of the degraded signal. This perceived listening quality is expressed in terms of subjective MOS, which is an index for speech quality representing the average quality score over a large set of subjective tests. Additionally, there is a time alignment process between both signals and the PESQ calculation returns a value that ranges between -0.5 (worst) and 4.5 (best) (ITU P.862., 2001; Suriol & Mangues-Bafalluy & Maso & Gorricho, 2007).

EXPERIMENTAL TESTS AND RESULTS

In this section, the experimental tests conducted in this chapter are discussed followed by the experimental results followed by its analysis and discussions.

A. Experimental Tests

Different combinations of the designated qualities and frames per packets were tested. The test-bed configuration parameters can be summarized with reference to Table 1. As shown in the table, for each packet loss rate, the voice encoding bit rate or mode was chosen as one of the following values (3, 5, 7, and 9), which corresponded to encoding rates of (9800, 20600, 23800, and 34200) bits per second, respectively (Zhao & Yagi & Nakajima & Juzoji, 2002). Then the following values for the frames per packets were used (1, 2, and 3). The Packet Error Rate (PER) was emulated through the IP link using the NEWT toolkit, applying periodic losses of 0, 2, 4, 6, 8 and 10% by configuring NEWT toolkit to lose one packet for segments of 50, 25, 16, 12 and 10 packets, respectively, as shown in Table 2.

During each experiment, exactly one variable of the previous listed parameters was varied to observe its influence on the received speech quality. Each experiment was repeated at least 20 times, and the results obtained were averaged. So, an average result of the maximum MOS scores was obtained. At each experiment, the server played the speech file using Real-player that was transmitted over the lossy link, thus a degraded copy of speech file was recorded instantly at the client, and then the perceptual quality of the transmitted voice speech to the client was estimated by

Table 1. Summary of test-bed configuration parameters

Packet Error Rate (%)	Mode (Quality)	Bit Rate (Bits Per Second)	Frame Rate (Frames per Packet)
0	3, 5, 7, 9	9800, 20600, 23800, 34200	1, 2, 3
2			
4			
6			
8			
10			

Table 2. Packet-loss configurations for NEWT emulator

Approximate Packet Loss (%)	Description of Periodic Loss
0	No packet is lost
2	1 packet is lost every 50 packets
4	1 packet is lost every 25 packets
6	1 packet is lost every 16 packets
8	1 packet is lost every 12 packets
10	1 packet is lost every 10 packets

calculating the PESQ of this file with respect to the reference speech file.

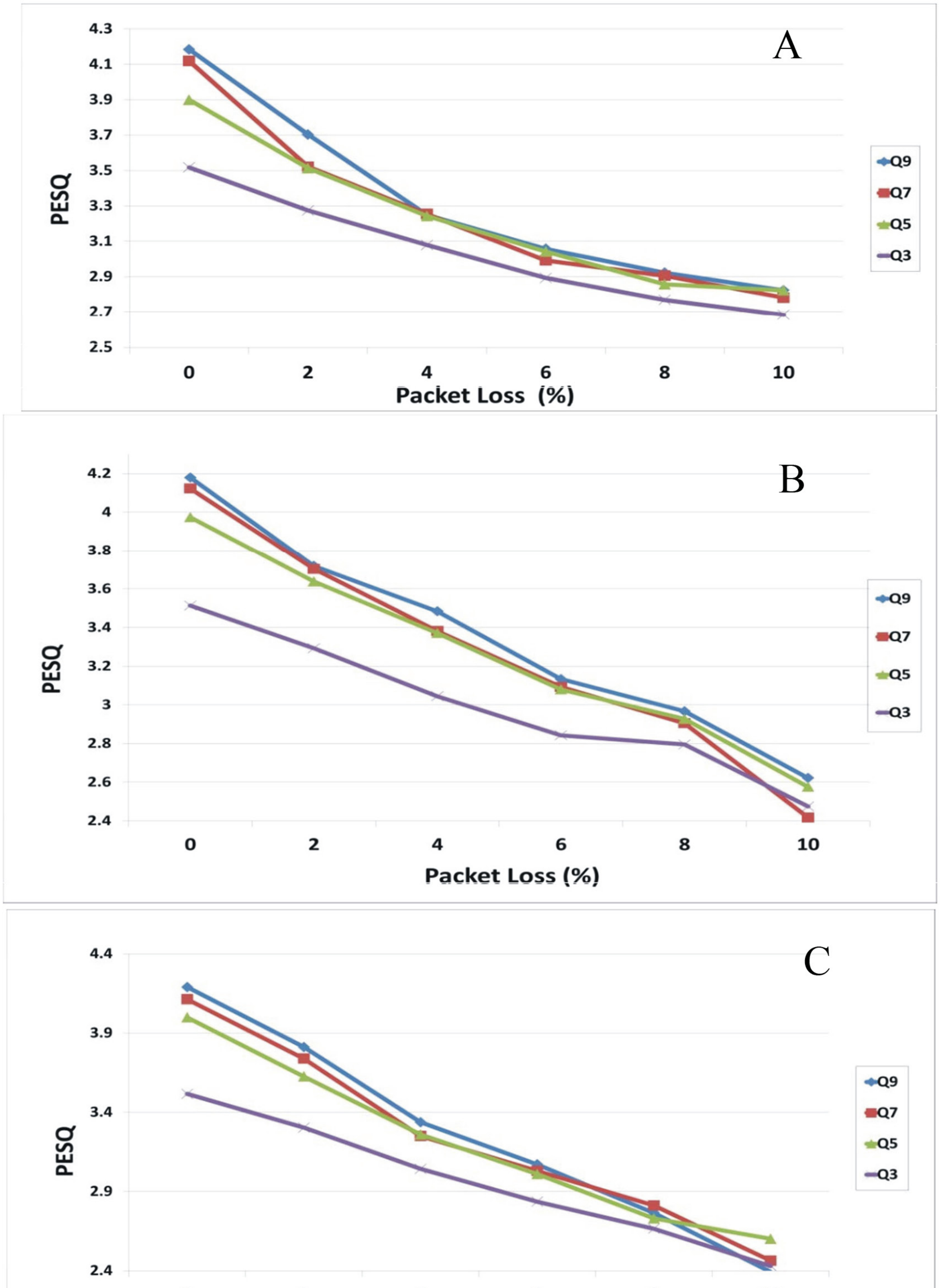
B. Experimental Results

This section studies the effect of varying the above-mentioned configuration parameters on the quality of speech transmission. The data representations are described with reference to two scenarios: the first one studies the effect of changing packet loss with voice quality while fixing the frames per packet, while the second scenario studies the effect of changing frames per packet parameter while fixing the voice quality. The tested values for the bit rate, frames per packet, and the packet loss are listed in Table 1. In what follows, the results of the two scenarios are presented and discussed.

Figure 2 shows PESQ values with different voice qualities and packet loss variations conducted while fixing the frames per packet. The results are shown for one sample voice file (A_eng_m7.wav) taken from the ITU database, the database can be found in this link (ITU-T Test Signals, 2014) where similar observations were noticed for other audio files. The following results can be concluded:

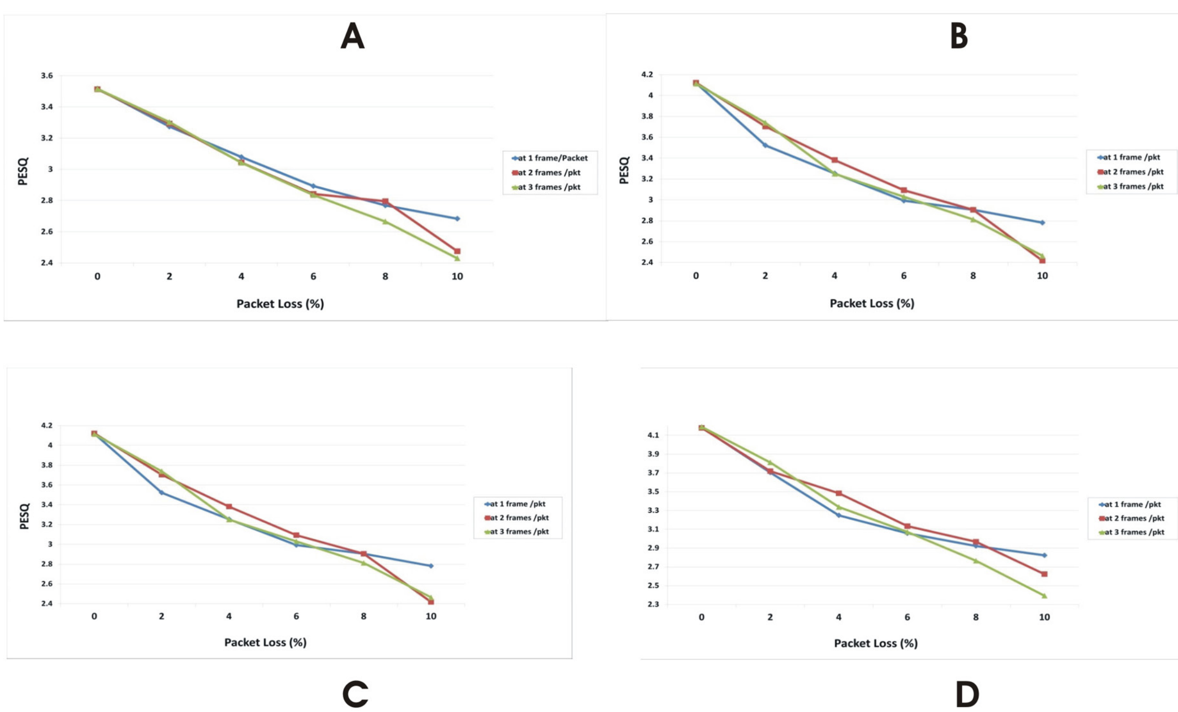
- As expected, at zero packet loss, regardless of the number of frames per packet, the highest Q value (Q9) achieves the best PESQ score, since the received voice signal has only source coding distortion due to the encoding and decoding process, which is inversely proportional with the encoding rate or Q values. So at zero packet loss, it is recommended to use the highest Q value (i.e. Q9) with the highest frames per packet (i.e. FPP = 3), which achieves better received voice quality and less bandwidth consumption due to the large number of frames per packet, which in turns reduces the packetization overhead.

Figure 2. PESQ values for various qualities and packet losses at different number of frames per packet equal to: (a) 1 frame/packet, (b) 2 frames/ packet, and (c) 3 frames/ packet



- When the network suffers from PER emulated by low packet loss (0 - 3%), two sources of distortion affect the audio files, the distortion due to source coding and packet loss. By observations seen in Figure 2 and 3, it can be noticed that it is better to use the highest quality Q9 with FPP equals to 3. To clarify this result, one can notice that in Figure 3 (a, b, and c), the FPP equals to 3 achieves the highest PESQ score. In order to decide on which quality to transmit, Figure 2 (c) illustrates that PESQ scores the highest when FPP equals to 3 and using Q9.
- For moderate to high packet loss values (i.e. 3 - 8%), as depicted by Figure 3, it is noticed that using FPP equals to 2 will score the highest PESQ values regardless of the used Qualities, so in order to decide the best quality to choose, Figure 3(b) shows that for FPP = 2, it is better to still use Q9 within this packet loss interval. Notice that in this packet loss range, some of the tested files showed that it is better to use FPP = 3 for packet loss ranges from (3 - 6%), and FFP = 2 when packet loss ranges from (6 - 8%), where both Q9 and Q7 showed close results. Thus, we would like to mention that more information such as the network delay is needed to make the most appropriate decision regarding the FFP and Quality settings. On other words, when the network experience low end-to-end delay (<150 ms), higher Q and FFP can be used, while lowers values are recommended when the network delay is relatively high, since the corresponding packet size will be relatively low and the transmission time will be low as well, so in this case, the transmission delay will not

Figure 3. PESQ values for various frames per packet and packet losses at different qualities equals to (a) Q3 (b) Q5, (c) Q7, and (d) Q9



add too much to the network end-to-end delay. Notice that considering the delay as one of the parameters in the algorithm decision making is part of our future work and still under investigation.

- Finally, for high packet loss rates (i.e. > 8%), as illustrated in Figure 3 it is noticed that using FPP = 1 has the highest PESQ score regardless of the used qualities. So to decide the best quality to choose, it is clear that all qualities (except Q3) has almost the same PESQ score, so in order to save on the bandwidth consumption, it is better to use Q5, which has the lowest bit rate when compared to Q7, and Q9. Notice that it is not recommended to use large number of frames per packet at high packet losses since losing a packet will result in losing more audio frames, which will increase the packet loss distortion.

CONCLUSION AND FUTURE WORK

In this chapter, we developed a VoIP voice conferencing test-bed based on the Adobe Flash Media technologies that utilizes the Real-Time Media Flow Protocol and the Speex multi-rate voice codec. The test-bed was used to study the effect of changing several voice parameters mainly the encoding rate and the number of frames per packet as a function of the network packet loss. The conducted experiments used the PESQ score as the objective metric for performance evaluation which showed that at low packet loss (< 3%), it is recommended to use high encoding rate (i.e. Q9) and high number of frames per packet (FPP = 3), in moderate to high packet loss conditions (3 - 8%), the experimental results showed that some files showed better performance at FFP = 3 between (3 - 6%) and FFP = 2 between (6 - 8%), while others were better at FFP = 3 for the entire interval (3 – 8%), where both qualities Q7 and Q9 showed close performance, as such, we concluded that more information such as the end-to-end delay is needed to better choose the appropriate FFP and qualities, such as if the network delay is low, high FFP and Q values can be used, while in high delay values, lower values are recommended. For higher packet loss

(> 8%), it was concluded that almost all voice encoding rates (expect Q3) gave us almost the same PESQ values when using FPP = 1, as such, it is recommended to use the lowest quality value (i.e. Q5). For future work, we are currently investigating the effect of end-to-end delay in more details such as it will be part of the algorithm decision process. In addition, more simultaneous voice streams have to be considered while considering the transmission link bandwidth and how it may affect the obtained results.

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KEY TERMS AND DEFINITIONS

Codec: Is software that is used to encode and compress or decode and decompress a digital media file, such as audio. Image, or video.

FFP: The number of audio frames per packet used in the packetization process.

FMS: Is a media server from Adobe Systems. It works with the Flash Player runtime to create media driven, multi-user Rich Internet Applications (RIAs) allowing multiple Flash Player clients runtime to connect and exchange multimedia contents from the server.

PESQ: Is an acronym for Perceptual Evaluation of Speech Quality. PESQ is an ITU standard P. 862 in telecommunications and IP networks and one of the objective quality assessment methods used to represent human subjective tests. It assess the speech quality by comparing the original and the degraded version of the speech sample.

QoS: Is an acronym for Quality of Service defined in ITU-T recommendation E.800 and it is the measurement of service performance effects determining the degree of the satisfaction of the user of such service.

RTMFP: Is an acronym for Real-Time Message Protocol. RTMFP is based on UDP and is developed by Adobe system for video-audio-data transmission, supporting client-server model as well as Peer-to-Peer (P2P) model.

Speex: Is a non-commercial, open-source and free from patent royalties speech codec. It is designed for packet networks and VoIP applications, as well as file-based compression. The Speex algorithm supports a wide variety of variable bit-rate mode to reserve bandwidth and maintain a pre-specified level of speech quality.

VoIP: Is an acronym for Voice over Internet Protocol. VoIP is an alternative technology for Public Switched Telephone Network (PSTN) and circuit switching. VoIP technology digitizes and compresses voice conversations into voice packets which are carried over data centric packet switching networks such as the Internet Protocol (IP) networks. Thus VoIP makes creation of new and innovative services possible with greater possibility for cost reduction in phone calls and infrastructure costs due to the widespread availability of IP networks.

Chapter 17

An Integrative Method for the Evaluation of Network Attack Effectiveness Based on Grey System Theory

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ABSTRACT

On the basis of the grey system theory, which is proposed to tackle the problems of uncertainty and missing information, an integrative method for the effectiveness evaluation of network attacks is proposed, which combines the merits of three different kinds of evaluation methods based on Grey-Clustering Analysis (GCA). Particularly, the proposed method provides a solution to the problem of accuracy drop seen in prevailing grey evaluation methods when the clustering coefficients exhibit no significant difference. With low time complexity, the proposed method performs well in the effectiveness evaluation of network attacks. Simulation results on suitable DDoS scenarios demonstrate the feasibility and power of the method.

BACKGROUND

In the complex evaluation of network attack effectiveness, the key challenges can be attributed to the lack of data for evaluation, incomplete information and uncertainties. Proposed by Deng(2002) to tackle the problem of uncertainty and missing information, the grey system theory holds its inherent advantages in such evaluation. Three most common grey clustering methods include grey varied weights clustering, grey fixed weights clustering and grey clustering analysis

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based on triangle whitening weight. They have been applied to multiple engineering fields such as the evaluation of the ability of knowledge management (Zheng & Hu, 2009), evaluation of military information network (Tang & Zhang & Su, 2008), system risk assessment (Ma, 2009), evaluation of attack effectiveness (Zou, 2011), and data mining (Liu & Dang, 2003). Although all of the three obtain the clustering results by comparing the coefficient vector of grey clustering, they apply grey clustering in different perspectives. The grey varied-weights clustering method is more suitable for problems with evaluation metrics close in meaning and dimension. For evaluations problems with indicators that have different metrics and large differences in magnitudes, improved methods should be considered.

The remaining parts of the work are organized as follows: related works are talked about in Section 2; Section 3 is the main thrust of the work, which includes the basic concepts of the grey systems theory, the description of the integrated grey clustering evaluation model and the experiments verification; Section 4 talks about the future trends of this work, followed by the conclusion in Section 5.

Wang, et al. introduced the grey system theory to the evaluation of network attack effectiveness and proposed a grey fixed weights grey clustering model and evaluation algorithms for the effectiveness of network attacks(Wang & Jiang & Xian, 2009). The grey clustering analysis employed in (Wang & Jiang & Xian, 2009)adopts the canonical method when assigning the grey class labels, which works by comparing the components of the grey clustering coefficient vector. The main disadvantage of such method comes from the ignorance of other components besides the maximum one. While in reality, it's common to see no significant difference in clustering coefficients. The method described in (Wang & Jiang & Xian, 2009) will fail in such situations. To address this issue mentioned above, we propose an Integrated Grey Clustering Method (IGCM) for the evaluation of network attack effectiveness based on fixed-weight grey clustering analysis. Our method classifies the attack effectiveness into multiple categories that are determined by different evaluation metrics and whitening function of corresponding grey numbers. We add exponential components to the classical whitening function to deal with non-linearity for a better clustering result, and the time complexity for the whole algorithm is polynomial.

THE INTEGRATIVE METHOD FOR THE EVALUATION OF NETWORK ATTACK EFFECTIVENESS BASED ON GREY SYSTEM THEORY

Basic Concepts of Grey Systems Theory

Uncertainties are commonly seen in real-world problems. Statistical methods can be used if provided with a large amount of data. For those problems with much less data, one possible solution is the grey system theory. It does not require a vast amount of samples and the samples do not necessarily need to follow certain distributions. The number of samples in the evaluation of network attack effectiveness is usually small, which makes the grey system theory might be a feasible method.

1. Grey Number (Deng, 2002; Liu & Xie, 2008)

In complex systems, some parameters cannot be determined specifically but the ranges of their values are usually known. Grey number is a concept proposed to represent those parameters with ranges rather than exact values. In practice, grey number is the number of possible values in a range or a set, denoted as "$\otimes$".

2. Whitening Transformation of Grey Numbers and Whitening Function (Deng, 2002; Liu & Xie, 2008)

Some grey numbers takes values varying around a baseline value. This basic value, named the whitening value of grey number, is often used as estimation for the exact value of the grey number in system analysis when the grey number is not available. The whitening of grey number refers to the calculation of the whitening value of grey number. A commonly adopted method is to use the equally-weighted mean value if the distribution of interval grey number is unknown. If the distribution of grey number is given, a better way is to utilize a whitening function, which can reflect characteristics of the distribution of grey number values.

The whitening function of grey number (whitening function for short), is a minimum information graph on the cognition flat, which stands for the whitening value of grey number and confirmation rate *f*. A whitening function $f \in [0,1]$ is called "typical whitening function". Generally speaking, the whitening functions are usually designed based on available information without a fixed formula.

In the grey evaluation, grey class *k* is regarded as a grey number, and on a cognition flat, when the sample of a grey class(whitening value) d_{ij} is taken as x coordinate while the confirmation rate *f* is taken as y coordinate, the minimum information graph that generated is called the whitening function of grey class *k*, denoted as f_k, and f_j^k is the whitening function of evaluation metric j. Typical whitening functions include:

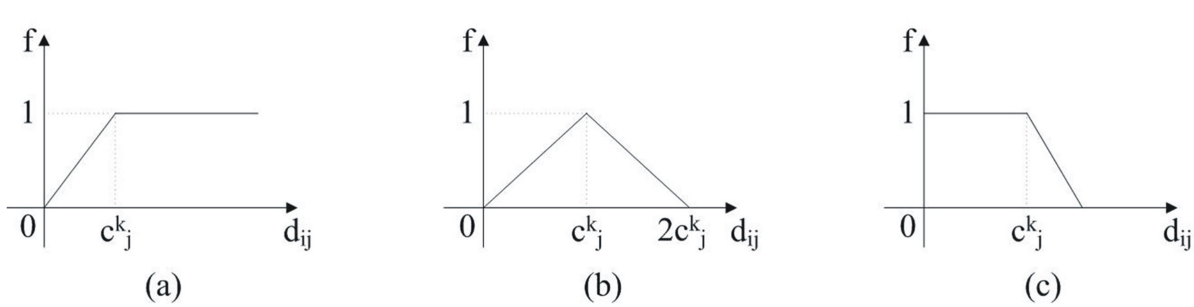
- Upper limit measure whitening weight function $f_j^k(c_j^k, \infty)$,as illustrated in Fig. 1 (a).The grey number satisfies $\otimes \in [0, \infty]$.
- Moderate measure whitening function $f_j^k(-, c_j^k, +)$ (see Fig.1 (b)).The grey number satisfies $\otimes \in [0, c_j^k, 2c_j^k]$
- Lower limit measure whitening function $f_j^k(0, c_j^k)$ (see Fig.1 (c)). The grey number satisfies $\otimes \in [0, c_j^k, 2c_j^k]$.

3. Evaluation method based on grey fixed weight clustering

The process of the evaluation method based on grey fixed weight clustering can be formalized as follows:

Firstly, a sample row $R_i = \{d_{ij} \mid j = 1, 2, \cdots, m\}$ for the evaluation object i is constructed for different evaluation metrics $j = 1, 2, \cdots, m$; then R_i can be transformed to evaluation values with different grey classes $C_k (k = 1, 2, \cdots, s)$; in the end, each evaluation object i is assigned to a specific grey class based on the evaluation values generated.

Figure 1. Three typical forms of whitening function



Evaluation methods based on grey clustering relies on the generation of grey number whitening function, which can generate a set of grey numbers according to different evaluation metrics for each object. Those numbers can then be further utilized when combined with pre-generated grey classes to determine the class label of each object. If the importance of metrics is weighted, then it's called fixed weight grey clustering.

Definition 1: [8] Assume the number of evaluation objects is n, the number of evaluation metrics is m,and there are s grey classes. Each object i is represented by value $d_{ij}(i=1,2,...,n; j=1,2,...,m)$ for each evaluation metric j. $f_j^k(*)(j=1,2,...,m; k=1,2,...,s)$ is the whitening weight function(WWF) of j with respect to grey class k. If the weight of metric j with respect to grey class k is independent of k, which means the weights can be denoted as $w_j(j=1,2,...,m)$ and satisfy $\sum_{j=1}^{m} w_j = 1$, then

$$\sigma_i^k = \sum_{j=1}^{m} f_j^k(d_{ij}) w_j \quad (1)$$

is called the grey fixed weight clustering coefficient of object i with respect to grey class k, that is, the evaluation value of object i on grey class k.

The following matrix

$$\sigma = \begin{pmatrix} \sigma_1^1 & \sigma_1^2 & \cdots & \sigma_1^s \\ \sigma_2^1 & \sigma_2^2 & \cdots & \sigma_2^s \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_n^1 & \sigma_n^2 & \cdots & \sigma_n^s \end{pmatrix} \quad (2)$$

Is a matrix of the fixed weight clustering coefficients.

A typical principle to determine the grey class label is the maximum principle: if $\max\{\sigma_i^1, \sigma_i^2, \cdots, \sigma_i^s\} = \sigma_i^{k^*}$, then object i is assigned a label of grey class k^*.

Generally speaking, the WWF varies according to different applications. The scope of the WWF will restrict the applicable domain of grey clustering evaluation.

In this chapter, we propose an integrative method for the evaluation of network attack effectiveness based on fixed-weight grey clustering analysis. Our method classifies the attack effectiveness into multiple categories that are determined by different evaluation metrics and whitening function of corresponding grey numbers. We add exponential components to the classical whitening function to deal with non-linearity for a better clustering result.

Definition 2(Liu & Lin, 1998): Let σ_i^k be the fixed-weight grey clustering coefficients for the object i with respect to the grey class k, we have the normalized form of σ_i^k as below:

$$\delta_i^k = \frac{\sigma_i^k}{\sum_{k=1}^{s} \sigma_i^k}, \quad (3)$$

$\delta_i = (\delta_i^1, \delta_i^2, ..., \delta_i^s)$ $(i=1,2,\cdots,n)$ is the normalized clustering coefficient vector for object i.

$$\Pi = (\delta_i^k) = \begin{pmatrix} \delta_1^1 & \delta_1^2 & \cdots & \delta_1^s \\ \delta_2^1 & \delta_2^2 & \cdots & \delta_2^s \\ \vdots & \vdots & \ddots & \vdots \\ \delta_n^1 & \delta_n^2 & \cdots & \delta_n^s \end{pmatrix} \quad (4)$$

is named the normalized clustering coefficient matrix.

Definition 3(Dang & Liu & Zhai, 2005): Assume there are n objects for clustering, s different grey classes, let $\eta = (1,2,...,s-1,s)^T$, the below equation defines the integrated clustering coefficient for clustering object *i*.

$$\omega_i = \delta_i \cdot \eta = \sum_{k=1}^{s} k \cdot \delta_i^k (i = 1, 2, ..., n) \qquad (5)$$

$\eta = (1, 2, ..., s-1, s)^T$ is named the weight vector for integrated clustering coefficients. It is straightforward to prove that $1 \le \omega_i \le s, i = 1, 2, ..., n$.

Definition 4 (Dang & Liu & Zhai, 2005, Dang & Liu & Tang, 2004): Given that there is no significant difference between the clustering coefficients of object i, if $\omega_i \in \left[1 + (k-1)(s-1)/s, 1 + k(s-1)/s\right]$, object i belongs to grey class k.

Definition 5: Assume $\omega_i \in \left[1 + (k^* - 1)(s-1)/s, 1 + k^*(s-1)/s\right]$, $\omega_j \in \left[1 + (k^* - 1)(s-1)/s, 1 + k^*(s-1)/s\right]$ if $\omega_i > \omega_j$, then we consider that the evaluation performance of object i is better than that of object *j* in grey class k^*.

The workflow of our method is demonstrated in Figure. 2.

Algorithm for Evaluation

Our algorithm for evaluation is explained as follows:

Step 1. Determination of evaluation metrics and corresponding weights

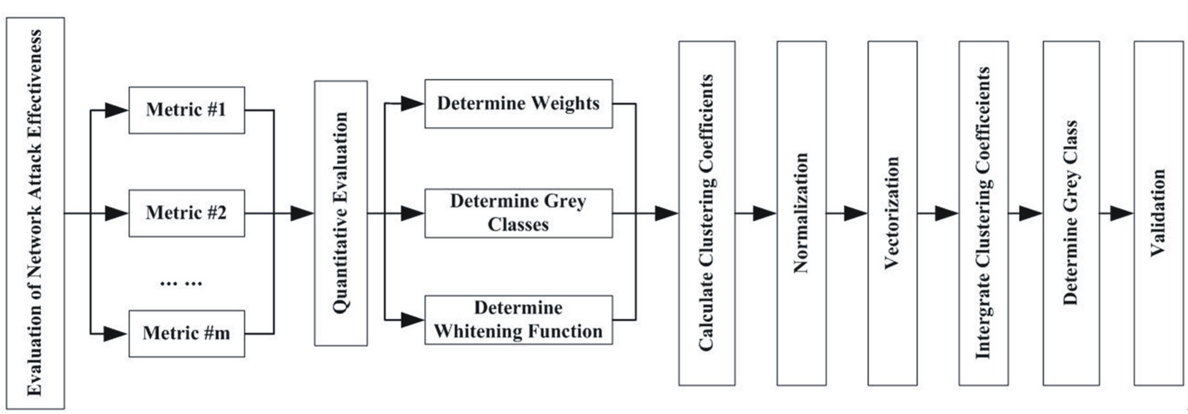
The metrics for evaluation $I = \{I_1, I_2, ..., I_m\}$ are specified according to the type of attack to be evaluated.

There are multiple ways to determine the weights $W = \{w_1, w_2, ..., w_m\}$ for each metric, including the AHP method(Guo & Zhang & Sun, 2008; Lan & Xu & Huo & Liu, 2006), the rough-set method(Zhang & Wu, 2000; Wang & Yao & Yu, 2009), etc. Our selection of weights is explained in Section 4.

Step 2. Construction of sample matrix and unification of sample polarity

Assume $d_{ij} (i = 1, 2, ..., n; j = 1, 2, ..., m)$ is the sample value for attack i with respect to evaluation metric j. The sample matrix D for evaluation is constructed as:

Figure 2. Integrative evaluation model for network attack effectiveness based on grey clustering



$$D=\begin{pmatrix} d_{11} & d_{12} & \cdots & d_{1m} \\ d_{21} & d_{22} & \cdots & d_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ d_{n1} & d_{n2} & \cdots & d_{nm} \end{pmatrix}$$

In which, $(d_{i1},d_{i2},\cdots,d_{im}), i=1,2,\cdots,n$ is the sample row for attack i; $(d_{1j},d_{2j},\cdots,d_{nj})^T, j=1,2,\cdots,m$ is the sample column for evaluation metric j.

For the convenience of evaluation, we unify all the sample data to be of the same polarity (maximum polarity here), with a greater metric value representing a better effectiveness of attack. For sample data that takes minimum polarity, a transformation is carried out. An easy way is to take reciprocal of the original value.

Step 3. Determination of grey class and construction of a reasonable whitening function

The number of grey classes and the grey number of grey classes are dependent on specific requirements of certain evaluation. Assume there are *s* grey classes and the WWF of metric j with respect to grey class k is denoted as $f_j^k(*)(j=1,2,\cdots,m;k=1,2,\cdots,s)$. The WWF is critical for the evaluation. The function value should be decreasing with an increasing distance from the level range of evaluation metrics.

Three canonical WWFs are illustrated in Equation (6), (7)and (8):

$$f_j^k(d_{ij})=\begin{cases} \dfrac{d_{ij}}{c_j^k}, d_{ij}\in[0,c_j^k] \\ 1, d_{ij}\in(c_j^k,\infty) \\ 0, d_{ij}\notin[0,\infty) \end{cases} \tag{6}$$

$$f_j^k(d_{ij})=\begin{cases} \dfrac{d_{ij}}{c_j^k}, d_{ij}\in[0,c_j^k] \\ \dfrac{d_{ij}-2c_j^k}{-c_j^k}, d_{ij}\in(c_j^k,2c_j^k] \\ 0, d_{ij}\notin[0,2c_j^k] \end{cases}. \tag{7}$$

$$f_j^k(d_{ij})=\begin{cases} 1, d_{ij}\in[0,c_j^k] \\ \dfrac{d_{ij}-2c_j^k}{-c_j^k}, d_{ij}\in(c_j^k,2c_j^k] \\ 0, d_{ij}\notin[0,2c_j^k] \end{cases}. \tag{8}$$

In theory, for grey class k, $f_j^k(d_{ij})$ should decrease dramatically as $|d_{ij}-c_j^k|$ increases. That is, a larger difference between the evaluation object and the grey class features will lead to a much smaller whitened value of the sample object. However, traditional WWFs are less steep, which cannot achieve the best clustering results. As an improvement, we introduce exponential WWF in this work, as demonstrated in Equation (9), (10), (11).

$$f_j^k(d_{ij})=\begin{cases} e^{\frac{d_{ij}-c_j^k}{d_{ij}}}, d_{ij}\in(0,c_j^k] \\ 1, d_{ij}\in(c_j^k,\infty) \\ 0, d_{ij}\notin(0,\infty) \end{cases} \tag{9}$$

$$f_j^k(d_{ij})=\begin{cases} e^{\frac{d_{ij}-c_j^k}{d_{ij}}}, d_{ij}\in(0,c_j^k] \\ e^{\frac{d_{ij}-c_j^k}{d_{ij}-2c_j^k}}, d_{ij}\in(c_j^k,2c_j^k) \\ 0, d_{ij}\notin(0,2c_j^k) \end{cases}. \tag{10}$$

$$f_j^k(d_{ij}) = \begin{cases} 1, d_{ij} \in [0, c_j^k] \\ e^{\frac{d_{ij}-c_j^k}{d_{ij}-2c_j^k}}, d_{ij} \in (c_j^k, 2c_j^k) \\ 0, d_{ij} \notin [0, 2c_j^k) \end{cases} . \qquad (11)$$

Step 4. Calculation of clustering coefficients

Given the WWF $f_j^k(*)(j = 1,2,...,m; k = 1,2,...,s)$, weights $w_j(j = 1,2,...,m)$ of evaluation metrics, sample data $d_{ij}(i = 1,2,...,n; j = 1,2,...,m)$ of attack i with respect to evaluation metric j and Equation(1), the clustering coefficient σ_i^k of attack i with respect to grey class k.

Step 5: Normalization of clustering coefficients and construction of clustering coefficient vector

Use the results from Step 4 and Equation (3), the normalized clustering coefficient δ_i^k of attack i with respect to grey class k can be obtained.

The normalized clustering coefficient vector is denoted as $\delta_i = (\delta_i^1, \delta_i^2 ... \delta_i^s); (i = 1,2,...,n)$.

Step 6: Calculation of integrative clustering coefficients

Use vector δ_i from step 5, the weight vector of clustering coefficients $\eta = (1,2,...,s-1,s)^T$, as well as Equation (5) to calculate the integrative clustering coefficient ω_i of attack i.

Step 7: Determination of the grey class

Generate evaluation for each attack according to the results from Step 6. The value range of integrative clustering coefficients are divided into ***s*** ranges of equal length that are not overlapping $\left[1, 1+(s-1/s)\right], \left[1+(s-1/s), 1+2(s-1/s)\right], ..., \left[s-s-1/s, s\right]$, if the integrative clustering coefficient $\omega_i \in \left[1+(k-1)(s-1)/s, 1+k(s-1)/s\right]$ of attack i, then attack i is considered as belonging to grey class k. If multiple attacks are classified to be grey class k, a further investigation of each integrative clustering coefficient can tell which ones are more effective.

Complexity Analysis

The cost of the above algorithm includes the calculation of weights for evaluation metrics, calculation of clustering coefficients and determination of grey class labels.

The calculation of weight for evaluation metrics can be calculated in advance through training samples. Thus here we mainly consider the cost introduced by the latter two calculations.

Time complexity for the calculation of clustering coefficient is $o(msn)$, for normalization is $o(msn)$. The time complexity for the calculation of integrative clustering coefficient is $o(ns)$. The time complexity of the determination of grey class is $o(nlbs)$ using binary search, in which n is the number of evaluation objects, m is the number of evaluation metrics, s is the number of grey classes. In summary, the time complexity for the whole algorithm is $o(msn + nlbs)$, which is polynomial.

RESULTS AND EVALUATION

In this section, an evaluation of the effectiveness of our model and algorithm is carried out on DDoS attacks. Selected metrics include: utilization of server CPU and RAM, utilization ratio of network bandwidth, rate of packet loss, delay in service response, recovery time and the functioning mechanism for attacks. There is no open dataset for the evaluation of DDoS attacks. We generate various sample data for the evaluation of DDoS attacks by setting corresponding attack scenarios.

The characteristics of DDoS attack dataset generated are demonstrated in Table. 1. The dataset include 10 different types of DDoS attacks. Details of the symbols are explained as follows:

a: change of server CPU utilization ratio;
b: change of server RAM utilization ratio;
c: network bandwidth utilization ratio;

Table 1. DDoS attack dataset

Attack	a	b	c	d	e	f	g
1	92%	78%	81%	34%	9.5s	2.5m	srvc
2	10%	61%	30%	14%	1.1s	7.5m	wr
3	28%	40%	30%	16%	4.5s	0.9m	wr
4	71%	81%	94%	35%	6.5s	9m	sysc
5	20%	10%	22%	1%	0.1s	0.15m	wr
6	94%	79%	68%	40%	3.2s	2.7m	sysc
7	74%	71%	58%	10%	1.8s	3.25m	srvc
8	13%	10%	20%	20%	7.0s	5.35m	wr
9	80%	40%	48%	11%	3.1s	4.25m	wr
10	20%	17%	20%	11%	4.4s	7m	wr

Table 2. WWFs of each metric with respect to different grey classes

Grey Class 1	Grey Class 2	Grey Class 3	Grey Class 4
$f_1^1(c_1^1,\infty)=f_1^1(0.9,\infty)$	$f_1^2(-,c_1^2,+)=f_1^2(-,0.7,+)$	$f_1^3(-,c_1^3,+)=f_1^3(-,0.5,+)$	$f_1^4(0,c_1^4)=f_1^4(0,0.3)$
$f_2^1(c_2^1,\infty)=f_2^1(0.8,\infty)$	$f_2^2(-,c_2^2,+)=f_2^2(-,0.65,+)$	$f_2^3(-,c_2^3,+)=f_2^3(-,0.4,+)$	$f_2^4(0,c_2^4)=f_2^4(0,0.1)$
$f_3^1(c_3^1,\infty)=f_3^1(0.8,\infty)$	$f_3^2(-,c_3^2,+)=f_3^2(-,0.6,+)$	$f_3^3(-,c_3^3,+)=f_3^3(-,0.4,+)$	$f_3^4(0,c_3^4)=f_3^4(0,0.2)$
$f_4^1(c_4^1,\infty)=f_4^1(0.4,\infty)$	$f_4^2(-,c_4^2,+)=f_4^2(-,0.2,+)$	$f_4^3(-,c_4^3,+)=f_4^3(-,0.1,+)$	$f_4^4(0,c_4^4)=f_4^4(0,0.01)$
$f_5^1(c_5^1,\infty)=f_5^1(8,\infty)$	$f_5^2(-,c_5^2,+)=f_5^2(-,6,+)$	$f_5^3(-,c_5^3,+)=f_5^3(-,1,+)$	$f_5^4(0,c_5^4)=f_5^4(0,0.1)$
$f_6^1(c_6^1,\infty)=f_6^1(8,\infty)$	$f_6^2(-,c_6^2,+)=f_6^2(-,6,+)$	$f_6^3(-,c_6^3,+)=f_6^3(-,2,+)$	$f_6^4(0,c_6^4)=f_6^4(0,0.25)$
$f_7^1(c_7^1,\infty)=f_7^1(3,\infty)$	$f_7^2(-,c_7^2,+)=f_7^2(-,2,+)$	$f_7^3(-,c_7^3,+)=f_7^3(-,2,+)$	$f_7^4(0,c_7^4)=f_7^4(0,1)$

d: rate of packet loss of the server
e: response delay of the server;
f: service restoration time
g: functioning mechanism of attacks, which can be resource consumption, collapse of service and collapse of system, represented by wr, srvc and sysc, respectively.

The evaluation result is represented by 4 grey classes, i.e. K={1, 2, 3, 4}, representing "very good", "good", "moderate", "poor". We adopt the weights for evaluation metrics of DDoS from[7]

$$w=\{0.213, 0.162, 0.122, 0.089, 0.113, 0.136, 0.165\}$$

The sample matrix is obtained as follows:

$$D = \begin{vmatrix} 0.92 & 0.78 & 0.81 & 0.34 & 9.5 & 2.5 & 2 \\ 0.10 & 0.61 & 0.30 & 0.14 & 1.1 & 7.5 & 1 \\ 0.28 & 0.40 & 0.30 & 0.16 & 4.5 & 0.9 & 1 \\ 0.71 & 0.81 & 0.94 & 0.35 & 6.5 & 9 & 3 \\ 0.20 & 0.10 & 0.22 & 0.01 & 0.1 & 0.15 & 1 \\ 0.94 & 0.79 & 0.68 & 0.4 & 3.2 & 2.7 & 3 \\ 0.74 & 0.71 & 0.58 & 0.1 & 1.8 & 3.25 & 2 \\ 0.13 & 0.10 & 0.20 & 0.2 & 7.0 & 5.35 & 1 \\ 0.80 & 0.40 & 0.48 & 0.11 & 3.1 & 4.25 & 1 \\ 0.20 & 0.17 & 0.20 & 0.11 & 4.4 & 7 & 1 \end{vmatrix}$$

The WWFs are listed in Table 2 according to our algorithm. The equations of the WWF s for metric 1 are listed below:

$$f_1^1(d_{ij}) = \begin{cases} e^{\frac{d_{ij}-0.9}{d_{ij}}}, & d_{ij} \in [0, 0.9] \\ 1, & d_{ij} \in [0.9, 1] \\ 0, & other \end{cases}$$

$$f_1^2(d_{ij}) = \begin{cases} e^{\frac{d_{ij}-0.7}{d_{ij}}}, & d_{ij} \in [0, 0.7] \\ e^{\frac{d_{ij}-0.7}{d_{ij}-1}}, & d_{ij} \in [0.7, 1] \\ 0, & other \end{cases}$$

$$f_1^3(d_{ij}) = \begin{cases} e^{\frac{d_{ij}-0.5}{d_{ij}}}, & d_{ij} \in [0, 0.5] \\ e^{\frac{d_{ij}-0.5}{d_{ij}-1.0}}, & d_{ij} \in [0.5, 1.0] \\ 0, & other \end{cases}$$

$$f_1^4(d_{ij}) = \begin{cases} 1, & d_{ij} \in [0, 0.3] \\ e^{\frac{d_{ij}-0.3}{d_{ij}-0.6}}, & d_{ij} \in [0.3, 0.6] \\ 0, & other \end{cases}$$

Equations for other WWFs can be obtained similarly.

According to the weights of evaluation metrics and the equations in Step4, the values of WWF for a certain grey class multiply the weight can give the clustering coefficient for that grey class. For instance, the WWF values of attack metric 1, 7 are: 1.00, 0.97, 1.00, 0.84, 1.00, 0.11, 0.61. Then the clustering coefficient for attack 1 with respect to the grey class 1 is shown in Box 1.

By doing so, the fixed-weight clustering coefficient matrix can be obtained:

$$\sigma = (\sigma_i^k) = \begin{vmatrix} 0.80 & 0.57 & 0.26 & 0.00 \\ 0.31 & 0.41 & 0.35 & 0.42 \\ 0.20 & 0.39 & 0.47 & 0.42 \\ 0.91 & 0.58 & 0.16 & 0.00 \\ 0.04 & 0.10 & 0.17 & 0.99 \\ 0.77 & 0.50 & 0.15 & 0.00 \\ 0.54 & 0.73 & 0.43 & 0.00 \\ 0.24 & 0.38 & 0.13 & 0.66 \\ 0.42 & 0.60 & 0.44 & 0.17 \\ 0.21 & 0.33 & 0.27 & 0.52 \end{vmatrix}$$

Then the normalization gives:

Box 1.

$$\sigma_1^1 = 1\times 0.213 + 0.97\times 0.162 + 1\times 0.122 + 0.84\times 0.089 + 1\times 0.113 + 0.11\times 0.136 + 0.61\times 0.165 = 0.80\,.$$

$$\Pi = (\delta_i^k) = \begin{vmatrix} 0.49 & 0.35 & 0.16 & 0.00 \\ 0.20 & 0.28 & 0.24 & 0.28 \\ 0.14 & 0.26 & 0.32 & 0.29 \\ 0.55 & 0.35 & 0.10 & 0.00 \\ 0.03 & 0.08 & 0.13 & 0.76 \\ 0.54 & 0.35 & 0.11 & 0.00 \\ 0.32 & 0.43 & 0.25 & 0.00 \\ 0.17 & 0.27 & 0.09 & 0.47 \\ 0.26 & 0.37 & 0.27 & 0.10 \\ 0.16 & 0.25 & 0.21 & 0.39 \end{vmatrix}$$

Further more, the integrative clustering coefficients for ten types of attacks are: $\omega_1 = 1.6728$, $\omega_2 = 2.5971$, $\omega_3 = 2.7516$, $\omega_4 = 1.5468$, $\omega_5 = 3.6263$, $\omega_6 = 1.5647$, $\omega_7 = 1.9339$, $\omega_8 = 2.8543$, $\omega_9 = 2.2194$, $\omega_{10} = 2.8177$.

Evaluation result for each attack is obtained by Step 7 of our algorithm:

$\omega_1, \omega_4, \omega_6 \in \left[1, 1 + 3/4\right]$: the effect of attack 1,4,6 is "very good";

$\omega_7, \omega_9 \in \left[1 + 3/4, 1 + 6/4\right]$: the effect of attack 7, 9 is "good";

$\omega_2, \omega_3, \omega_8, \omega_{10} \in \left[1 + 6/4, 1 + 9/4\right]$: the effect of attack 2,3,8,10 is "moderate";

$\omega_5 \in \left[1 + 9/4, 4\right]$: the effect of attack 5 is "poor".

The methods in [7] gives the following results: the effect of attack 1,4,6 is "very good";the effect of attack7,9 is "good";the effect of attack 3 is "moderate";the effect of attack 2,5,8,10 is "poor". Traditional methods make decision based on the fixed-weight clustering coefficient (FWCC) vector. FWCC vector for attack 2 is $(0.31, 0.41, 0.35, 0.42)$, The coefficient of attack 2 grey class 2 and 4 differ only by 0.01. It would not be reasonable to draw a conclusion that attack 2 belongs to grey class 4. This is where our method outperforms the others.

Evaluation results using FWCC evaluation algorithms, integrative clustering evaluation algorithms using canonical whitening functions and our methods are listed in Table 3. According to [10], when the significant variant coefficient $\theta \geq 1 - 2/s$, that is $\theta \geq 0.5$ in our case, fixed-weight clustering evaluations would have the same result as our method. A comparison between our method and the integrative clustering analysis using canonical WWFs proves that exponential WWF based method has a better performance.

In the identification of metric weights, our method utilizes the importance concept of rough-set theory and calculates the metric weights based on the sample data. Compared with other methods, no domain expert is needed, which makes our result more objective. Moreover, our method does not rely on a large amount of information and does not require sample data to follow certain distributions. This makes the calculation fast and straightforward. In addition, our method does not need massive training in the same conditions as neural network based methods, which resolves the problem of low convergence. Our method can not only evaluate the effectiveness of a single attack but also sort the effectiveness of different attacks of the same kind.

Table 3. Comparison of evaluation methods

Attack	Canonical Fixed-Weight Clustering Analysis	Integrative Clustering+ Classical WWF	Integrative Clustering+ Exponential WWF	θ	Significant?	Consistent?
1	Class 1	Class 1	Class 1	0.14	NO	YES
2	Class 4	Class 2	Class 3	0.00	NO	NO
3	Class 3	Class 3	Class 3	0.03	NO	YES
4	Class 1	Class 1	Class 1	0.20	NO	YES
5	Class 4	Class 4	Class 4	0.63	YES	YES
6	Class 1	Class 1	Class 1	0.19	NO	YES
7	Class 2	Class 2	Class 2	0.11	NO	YES
8	Class 4	Class 3	Class 3	0.20	NO	NO
9	Class 2	Class 2	Class 2	0.10	NO	YES
10	Class 4	Class 3	Class 3	0.14	NO	NO

FUTURE TRENDS

In the future work of network attack effectiveness evaluation, the complex factors including lack of data, incomplete information and uncertainties must be overcome to enhance the feasibility of the evaluation method. And with the development of the multi-step cooperative attack, Advanced Persistent Threat(APT) for instance, concealment and self-adaptability have become the main characteristic of an attack, which means it is difficult to establish a determinate metric system to implement the attack effectiveness evaluation. Under this condition, it is meaningful to carry on our evaluation work based on grey system theory.

The following step of our work will focus on the validation on varieties of network attack scenario, and improve the feasibility of our algorithm according to the evaluation performance.

CONCLUSION

Various network attacks via all sorts of methods pose great challenges for network security. Evaluation of network attack effectiveness is of great importance for network security research. In this chapter, we propose an integrative evaluation method for network attack effectiveness based on integrative grey clustering analysis. Our method addresses the disadvantages of traditional evaluation models based on grey clustering and demonstrates that the use of exponential WWF can help improve the performance where there is no significant difference of the clustering coefficients. Experimental results demonstrate the feasibility and correctness of our method. Our method is also featured by advantages like low time complexity, intuitive result display and straightforward procedures.

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KEY TERMS AND DEFINITIONS

Evaluation of Network Attack Effectiveness: Quantification evaluation of network attack effectiveness base on metric system.

Grey Clustering Analysis: Adopt canonical method when assigning the grey class labels, which works by comparing the components of grey clustering coefficient vector.

Grey Number: Grey number is the number of possible values in a range or a set rather than exact values.

Grey System Theory: A theory proposed to tackle the problems of uncertainty and missing information.

Integrated Grey Clustering Method: Classifies the attack effectiveness into multiple categories that are determined by different evaluation metrics and whitening function of corresponding grey numbers.

Whitening Transformation: The whitening of grey number refers to the calculation of the whitening value of grey number.

Whitening Value: The basic value of grey number, used as estimation for the exact value when grey number is not available.

Chapter 18

Vision of Best Practices for IMS Implementation

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ABSTRACT

The IMS technology is a framework architecture for delivering IP multimedia services, which allows voice and multimedia applications to communicate from multi-access scenarios (Wireless, PacketCable, DSL, etc.), thus allowing the convergence of fixed and mobile networks. The authors carry out an investigation into the current state of the art of this technology, focusing on its architecture, operating principles, and especially on the current state of development in Argentina. They make a forecast of what will happen in the next three years and their vision of what today are the best practices for its implementation.

INTRODUCTION

In this document, we describe the basic operation of the IMS architecture. To do this, we analyze the different layers of the architecture (Access, Transport, Control and Application).

Then, we perform a more detailed analysis of certain features of the Transport and Application layers, such as different levels of CSCF (Call Session Control Function), the HSS (Home Subscriber Servers) and AS (Application Servers). Just as an example we introduce some flowcharts associated with a registration and a normal call, where the full operation of all previously explained components can be checked.

Then, we introduce part of the results of different opinions obtained in meetings with market specialists involved in the development of this technology. At these meetings, we discussed about the relevant issues associated with IMS, and the information we have obtained is reflected in several tables.

To complete the study, we have evaluated existing technologies at present and the degree of development of them. With the information obtained, the experiences, the meetings and the whole of the investigation, we share our vision of best practices for implementation in the medium term in Argentina.

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BACKGROUND

IMS Architecture Overview

The IMS is an umbrella that aims to integrate all the information and communications technologies for new services that can be implemented to make full and integrated use of the existing communications services.

The idea of the architecture is to define a model that separates the offered services (voice, video and data) from the access networks used for these services (fixed telephony, cellular networks, cable companies, etc.).

Considering that the services that can be implemented are varied and open to the creativity of designers, we shall introduce a simple example for easy understanding. Suppose we are talking with out mobile phone and we are arriving to our office, which has Wi-Fi equipment. IMS would allow our mobile phone leave the connection of the cellular network and continue it (like a normal handoff) through the Wi-Fi. In this case, the access network would be changing.

We may also want to come to our desk (in our home or office), and continue our communication from a Soft-Phone that we have in our Tablet or from a fixed telephone line. In this case, we are changing the terminal.

The above is only a minimum example of services that can be implemented on an IMS network. We hope they were easy-to-understand examples that allow us to visualize how the access network or the terminal will be irrelevant in the future.

The IMS architecture is designed in a structure of levels, planes or layers, and each layer having its network elements and functionalities. The layers are described below:

Access Layer

The access layer can represent all high speed access, such as xDSL (x Digital Subscriber Line), cable networks, Wi-Fi, WiMAX, LTE (Long Term Evolution), among others.

Transport Layer

The transport layer represents an IP network. This network can integrate QoS (Quality of Service) mechanisms with MPLS (Multi Protocol Label Switching), DiffServ (Differentiated Services), RSVP (Resource Reservation Protocol), among many others.

The transport layer is mainly compunded by routers (edge routers for access and core routers for transit).

Control Layer

The control layer is made of several Session Controllers, which are responsible for routing signaling between users and for the invocation of the services. These nodes are called CSCF (Call Session Control Function). In this layer, we can also find the HSS (Home Subscriber Server) and the MRF (Multimedia Resource Function), which is also known as IP Media Server (IP MS). The MRF is divided into two parts, the MRFC (MRF Control), located in the control layer, and the MRFP (MRF Processor), located at the transport layer. The interconnection between MFRC and MRFP is performed via the H.248 protocol.

Application Layer

The Application Layer introduces the applications (also known as value added services) offered to the users. Depending on the organization of the control layer of its IMS Stack, the Service Provider could offer integrated services by itself or eventually by third parties. This layer is compounded by the AS (Application Servers).

Competencies of Each Layer

Figure 1 shows where the competencies of the most important layers can be observed:

The term Subsystem is because it is not a independent architecture that replaces the existing or legacy ones. In fact, this is a subsystem that is inserted into existing networks, allowing legacy systems interoperate with the new technologies. This can be done by means of the SIP Protocol (Session Initiation Protocol) as the signaling protocol for the elements of the control layer as the base architecture.

Figure 2 shows a simplified IMS architecture with the blocks mentioned in the present document, with the inclusión of additional elements, such as BGCF (Breakout Gateway Control Function), MGCF (Media Gateway Control Function) and MGW (Media Gateway). These three elements are relevant for the interconnection between the IMS with PSTN legacy networks of the same provider or external ones.

The Control Layer

As mentioned above, one of the most important elements in the IMS control layer is the CSCF (Call Session Control Function). This element is further subdivided into 3 components in order to distribute tasks more efficiently when working with large networks (Carriers), and separate them into different physical machines assigned to each

Figure 1. IMS layered architecture (from http://sociedadinformacion.fundacion.telefonica.com)

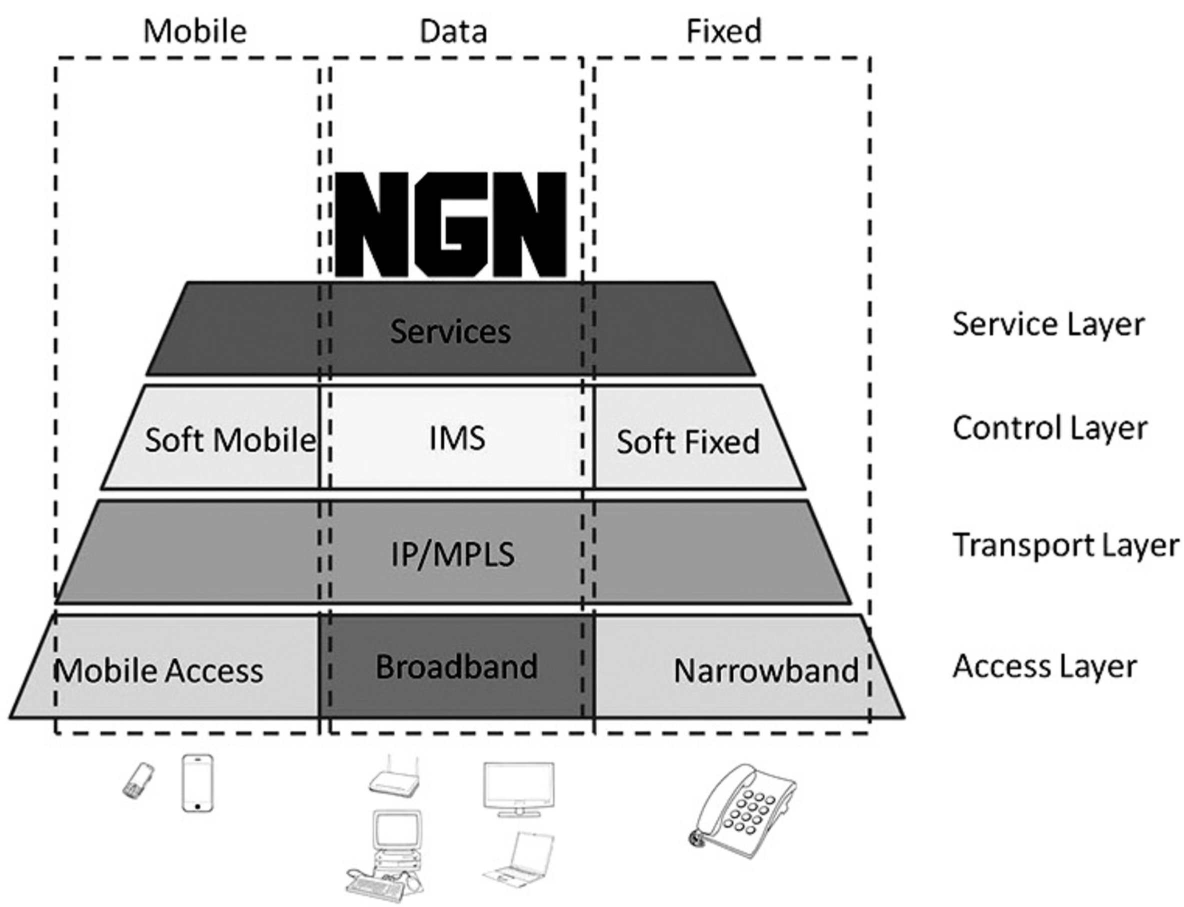
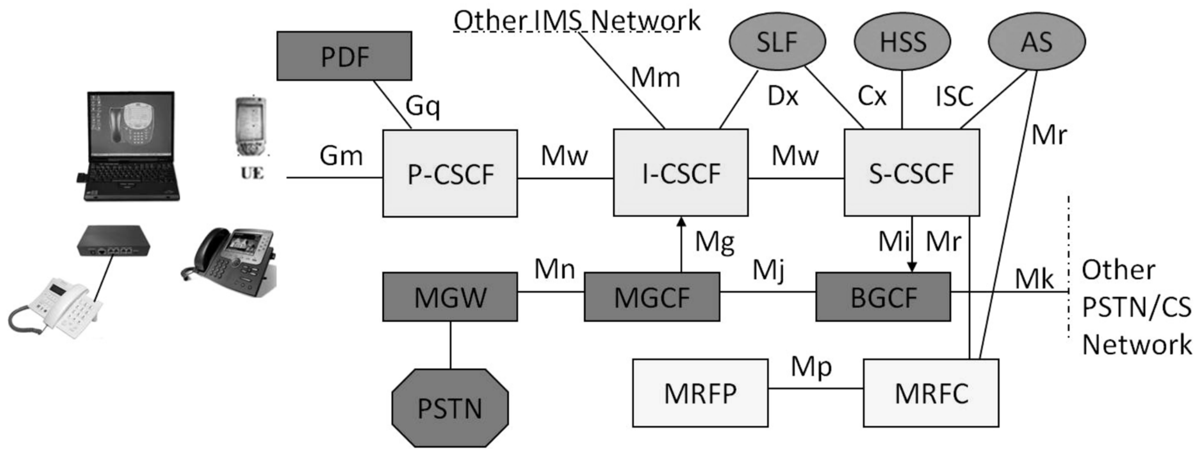


Figure 2. Simplified IMS architecture



of these tasks, and then linking them through well-defined interfaces and thus being able to operate in a multi-provider scenario.

The IMS architecture was designed to provide comprehensive and complex support to the services associated to a large number of users. At the same time, there can be a scalable architecture which can have any kind of traffic level. This means that the CSCF servers can be dynamically allocated to the users.

The layered structure allows separating the roles of each member of the architecture. For example, the CSCF servers mentioned above have the function of redirecting the packets that are carrying the SIP signaling to and from the terminals and applications where the services will be executed. It means that the CSCF servers do not resolve the services or standardize applications, since they (the applications) are performed in an upper layer.

In other words, a brief summary of the control layer main task is to facilitate the access of applications to different types of terminals and access technologies (fixed or mobile).

The CSCF components are P-CSCF (Proxy CSCF), S-CSCF (Serving CSCF) and I-CSCF (Interrogating CSCF).

P-CSCF: Is the input interface of Customer's signaling through the Core IMS. It works as an IMS SIP Proxy server for all the users. It accepts all SIP requirements originated in the terminal Equipment (or addressed to it), and processes them internally or forwards them to another server. The P-CSCF also takes care of control and resource management for all sessions created through this Server. It can be located on a local network or a visited one (in the case of mobile networks). It has an interface to the PDF (Policy Decision Function), to which provides information for the admission of the media and to implement QoS policies inside the network.

S-CSCF: It is the main element of any IMS network in terms of signaling. The S-CSCF is the CSCF component which is mandatory in the IMS network. The S-CSCF is the control point in the network that allows operators to control all sessions and all the services' provision. It is a SIP server that always resides in the local network of the subscriber. The S-CSCF creates a link between the public user identity (SIP Id) and the IP address of the terminal, and interacts with the customers' database (HSS - Home Subscriber Server) in order to get the user profile and authentication vectors. All SIP messages originating from the terminal or addressed to it have to go through the S-CSCF.

In this element, the messages are processed and subsequent tasks are determined based on the contents of them. The S-CSCF is also responsible for allowing the user to contact the appropriate application server, and interacts with the application servers and forwards SIP messages between them. The IP address of the S-CSCF can be incorporated in the Service Route field of the SIP message in the registration process, and thus making posible a direct access to the S-CSCF from the P-CSCF, bypassing the I-CSCF.

I-CSCF: It is a Proxy SIP server that provides the link to the CSCF with external networks. This module selects an S-CSCF for a user and forwards the SIP messages between them. The selection of S-CSCF is based on required capabilities and the available ones, together with the topology, allowing the possibility of a load balancing between S-CSCFs with the help of the HSS. If the Core will feature several HSS, the I-CSCF will need to initially contact the SLF (Subscription Locator Function) for the purpose of obtaining the address of a HSS for the subscriber.

Mentioned above several times, the IMS architecture includes other important functional entity, the HSS (Home Subscriber Server). This Server uses the Diameter protocol for the connection with the S-CSCF and the AP (Application Servers). If there is more than one HSS in the network, an SLF (Subscriber Location Function) can indicate the user's address to the appropriate HSS servers. The Home Subscriber Server contains subscription information associated with subscriber profiles. On the other hand, it performs user authentication and authorization, and can provide information about the subscriber's location and IP data.

All applications and services in the IMS Core are performed in SIP Application Servers.

The Application Layer

The SIP AS (Application Server) is the network element where the service logic is executed. These servers can be dedicated to a single service or even handle more than one. In the IMS Core, it is also possible to combine different Application Servers for the purpose of creating a unified end user experience. For example, a user could simultaneously combine Presence and Video Call services, although the services themselves are hosted in different SIP Application Servers. The main benefit of using Application Servers is the ease and speed with which services can be provided centrally. The centralization of services in one or a few Application Servers facilitates the processes of updating and improving services for all users, preventing problems of incompatibilities due to the management of out-of-date software releases.

It is important to mention that in the ETSI/TISPAN standard, associated to the IMS architecture for fixed networks, the HSS Server (discussed in the control layer) is also considered as a component of this layer.

Quality of Service in IMS

As IMS integrates different class of traffic like telephony, video, on line gaming, etc. it must provide to each application the appropriate QoS. The IMS specification allows many different end-to-end QoS models, and gives flexibility to operators so they can choose the most appropriate solution according to their particular needs. There are two issues to consider, the intra-domain QoS, and the inter-domain QoS. There are many options but the more commons to provide QoS on the packet switched IP domain are the Integrated Service model and the Differentiated Service (DiffServ) model.

IntServ or integrated services is an architecture that specifies the elements to guarantee end to end quality of service (QoS) on networks. The model is defined in RFC 1633. In IntSev every router in the system implements IntServ, and every application that requires some kind of guarantees has to make an individual reservation. The end points request a certain QoS and the network grants it. All the routers in the path have to store state information about every flow. The protocol used by the Integrated Services architecture is RSVP (Resource reservation Protocol) it is specified in RFC 2205 and has been updated by RFC 2750 and RFC 3936. Integrated Service works well in small networks but does not scale well because the routers have to store information about every flow and perform lookup before routing any packet. Maintain per-flow QoS becomes a monumental task for large networks.

The DiffServ or Differentiated Service architecture is specified in RFC 2475 and RFC 3260. The DiffServ servers need to maintain minimum state information about the flow and enables a quicker treatment for the packets flowing through them. In this Architecture, packet's header is identified by 8-bit standardized codepoints called Differentiated Service Code Points (DSCP). In this model the router is aware of the treatment that needs to be given to each packet; the treatment is referred to as the Per Hop Behavior (PHB). Packets containing same codepoint receive identical forwarding treatments by routers and switches in the path. The packets carry the DSCP information in their IP headers, in IPv4 it is placed in the 'Type of Service' field and in IPv6 it is placed in the 'Traffic Class' field. The DiffServ is an escalable way for implementing QoS in large networks.

Inter-domain QoS is another issue, where we find two potential problems; the first is technical, in which we have to deal with QoS protocols used by each domain. The second problem is administrative and consist in manage the differences between the SLAs provided in each domain. The solution to this problem is the use of intermediating equipment's (QoS Gateway) to makes the necessary conversions to respect the characteristics of each QoS domain.

Security in IMS

The main aspects of security are integrity, confidentiality, and availability. We can divide IMS security in two different areas, the Access security and the Network security. The Access security is associated with authentication and authorization processes for the establishment of the IP session, performed during the Registration of a typical IMS terminal. The protection of user identity is the main requirement in Access security. Network security is associated with the protection of the traffic. If a link between two nodes interconnects different networks, with a different security domain, we use Security Gateways (SEG) for traffic protection. In this case we use IPsec ESP (Encapsulated Security Payload) specified in RFC 2406 and IKE (Internet Key Exchange) specified in RFC 2409 for session establishment and maintenance.

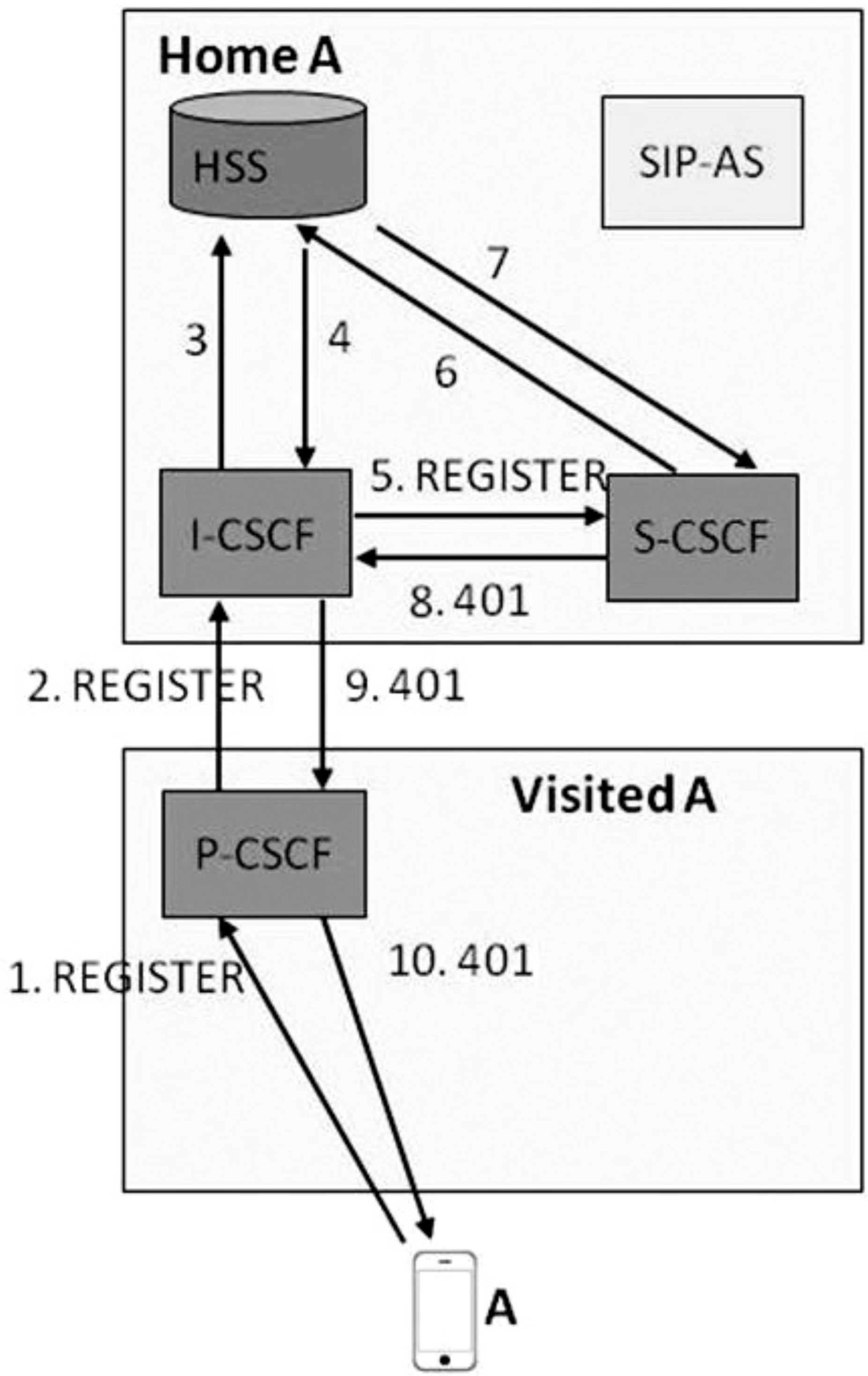
Registration of a Typical IMS Terminal

Each step of the registration process of a SIP terminal in IMS architecture is explained below.

PART 1

- **1:** The UE starts with a SIP REGISTER request including the public and private user ID to the P- CSCF
- **2:** The P- CSCF performs a DNS request to find the I-CSCF in the user home network. It adds a field to indicate the visited network connected at this time and forwards the SIP REGISTER request to the I-CSCF.
- **3 and 4:** The I-CSCF receives the SIP REGISTER request and sends the Diameter UAR (User Authorization Request) to the HSS. The HSS checks that the user ID is correct and roaming agreements are present for that user in the visited network, and sends a Diameter UAA (User Authorization Answer) back to the I-CSCF.
- **5:** I-CSCF receives the UAA containing the S-CSCF assigned to the user. Another

Figure 3. IMS registration process – Part 1



possibility is that it could receive the criteria for selecting one S-CSCF. In this case, the I-CSCF would select a suitable S-CSCF and would forward the registration request to this new S-CSCF.

- **6 and 7:** S-SCSF sends a Diameter MAR (Multimedia Authorization Request) request to the HSS for downloading the authentication vectors to challenge the terminal. This request includes the address of the S-CSCF so that the HSS knew which S-CSCF is assigned to the user. The HSS sends the Diameter MAA (Multimedia Authorization Answer) response with the authentication vectors.
- **8, 9 and 10:** The S-CSCF answers the SIP REGISTER request message with a SIP 401 Unauthorized response containing the information to carry out the security challenge. This response reply goes through the I-CSCF and P-CSCF until it reaches the user.

PART 2

- **11:** The user sends a new SIP REGISTER request including security challenge response and forwards it to the P-CSCF.
- **12, 13 and 14:** this new request reaches the I-CSCF, which sends a new UAR to the HSS to find the S-CSCF, to which forwards the SIP REGISTER request.
- **15, 16 and 17:** The S-CSCF receives the SIP REGISTER request and authenticates the user, sends a Diameter SAR (Server Assignment Request) request to the HSS to inform that the user is registered and requires downloading the user profile. This download is included in the Diameter SAA (Server Assignment Answer) response of the HSS.
- **18 and 19:** The S-CSCF informs to the Application Servers (those contained in the user profile) about the registration that the user is performing, because it will make an impact on the services.
- **20, 21 and 22:** The S-CSCF confirms that the user is registered by sending a SIP 200 OK response through the I-CSCF and P-CSCF, and finally reaches the user.

Steps of a Basic IMS Call

We will now focus on the steps of a basic call.

- **Steps 1 and 2:** Depending on the location, the user connects to the appropriate IMS network (P-CSCF), which forwards the SIP INVITE request to the S-CSCF that already had on the table for this client at the time of registration.
- **Step 3:** The S-CSCF checks that the destination in the SIP INVITE request is in another network, and redirects it, previously doing a DNS lookup in order to find the IP address of the I-CSCF in the destination network.
- **Steps 4 and 5:** The I-CSCF has to check (with the HSS) which is the S-CSCF associated with the destination user and redirects the SIP INVITE request.
- **Steps 6 and 7:** The S-CSCF has the customer profile (already registered), and forwards the SIP INVITE request to the IP address of the appropriate P-CSCF in order to redirect the signalling packet.
- **Step 8:** The end user receives the SIP INVITE request and replies with a SIP 200-OK response, together with the audio/video codecs and RTP/RTCP ports for the RTP path.
- **Steps 9, 10, 11, 12, 13 and 14:** The SIP 200-OK response is redirected to the calling terminal to set the RTP flow. RTP path is established.

Figure 4. IMS registration process – Part 2

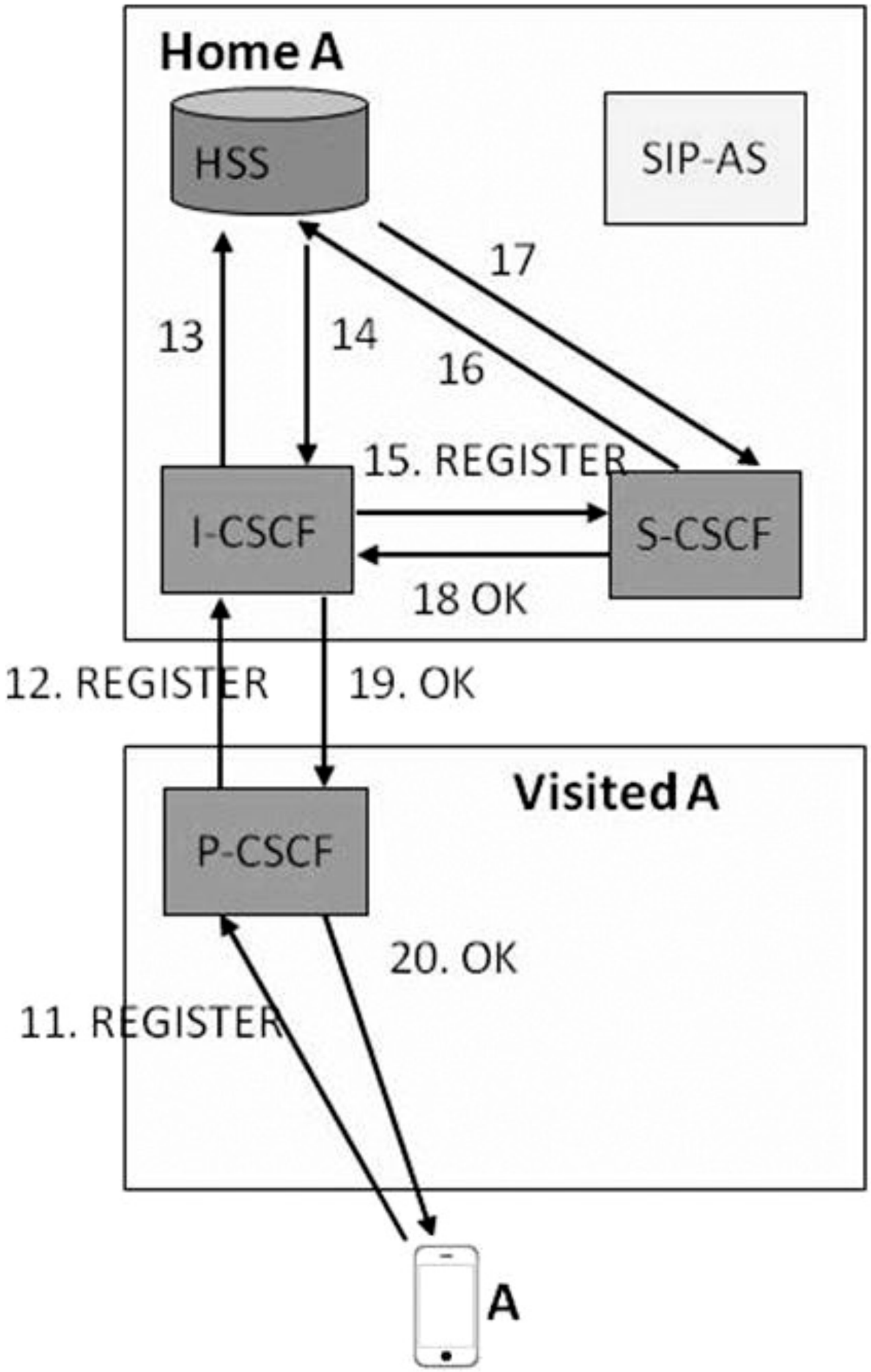
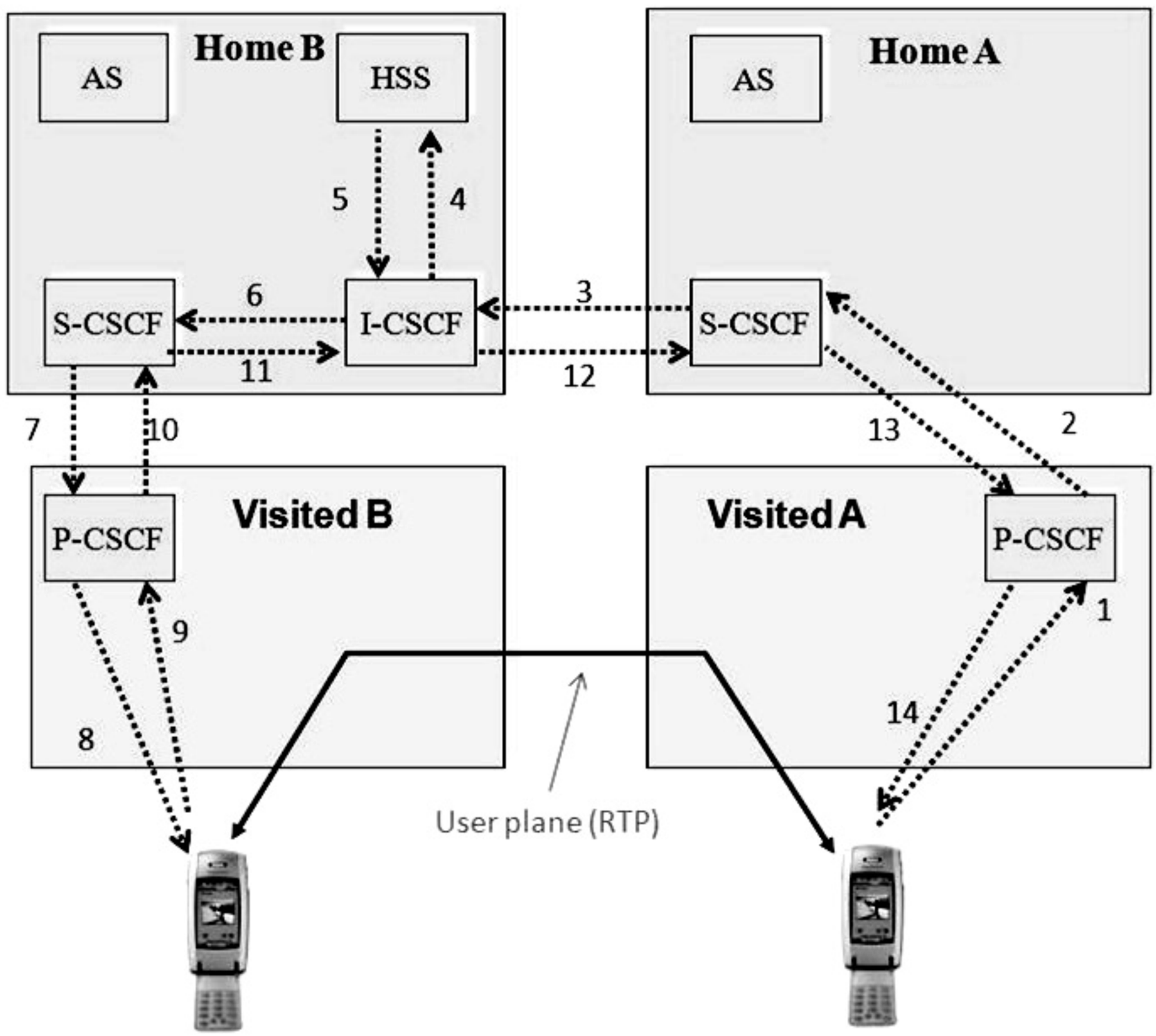


Figure 5. Basic IMS Call



In the case of a communication where users (either the originator or the receiver) have additional value added services (conference, music on-hold, call forwarding, messaging box, etc.), additional SIP signaling messages have to be routed from the S-CSCF to the appropriate AS, according with the profile of each customer, and act accordingly (eg, start some service or redirect the session).

BEST PRACTICES FOR THE IMPLEMENTATION OF IMS

Issues, Controversies, Problems

There is a wide range of technologies for the implementation of IMS, and each manufacturer develops solutions that comply with the regulations no longer proprietary. On the other hand the large

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The Current View of Technology Especialis Argentina

After several meetings with specialists in the IMS technology, we can make the following comments.

Regarding the barriers to entry for the development of this technology, two factors are sighted quite clearly.

First of all, some difficulty is perceived regarding the way of fund deployment (the Business Case does not match yet). Moreover, the complexity of the technology makes the implementation should be done gradually, since most existing services will be affected in the long-term.

The detail of the perceptions of specialists regarding barriers to implementation can be seen in Table 1.

We also asked about what services are considered the drivers for the development of IMS. The perception here is that the main driver of this technology will be the RCS (Rich Communication Suite), followed by Mobile IP and the Application Stores developed by the operators. In Table 2 we can see the results of this consultation.

According to the different brands, we have worked on the 5 most important ones that are developing IMS solutions, and we observed that one of them (Ericsson) has the leadership with

Table 1. Barriers to the implementation of IMS

A Business Case for the moment does not close	15%
Lack of standards that facilitate compatibility	8%
Gaps in Basic Services emulations	8%
Availability Terminals	4%
Complexity	15%
General Confusion	11%
Coordination problems between areas of Mobile / Fixed	8%
There are cheaper alternatives	8%
Do not know / no answer	23%

Table 2. Drivers for the development of IMS

HD Voice	5%
Mobile IP	24%
RCS	33%
Operator App Store	19%
IP Centrex	5%
Others	9%
Do not know / do not answer	5%

Table 3. Global positive perception about IMS Providers

Alcatel – Lucent (ALU)	14%
Nokia Siemens Network (NSN)	17%
Huawei	18%
ZTE	14%
Ericsson	36%
Do not know / do not answer	1%

an overall of 36%, followed by all the other ones with a positive perception between 14 and 18%. The detail can be found in Table 3.

SOLUTIONS AND RECOMMENDATIONS

Our Vision on best practices for the implementation of IMS services is to select and use technology (supplier) that has better perception by specialists. This has the advantage, among others, that much of the architecture modules are actually integrated software modules that are being executed in servers. The fact that they are integrated prevents the existence of interoperability faults between the different modules, which could occur in the solutions in which they reside on different hardware and even, in some cases, with equipment and software from different vendors.

The comparison between fully integrated solutions by the same manufacturer versus a multi-vendor integrated solution is a historical discussion on the development of telecommunications. Experience shows us that the very new technologies require debugging processes and generally are resolved more quickly when all the variables needed to work with are concentrated within a single company.

Regarding the carriers that provide IMS services, a gradual integration of the different services is recommended, so that it is easier to verify the reliability and stability. The migration of existing services already running on other platforms is also recommended, allowing a quick turn back in the case of appereance of unexpected faults.

Regarding the Business Case, the downward trend in overall communications services is observed, so that the income that the IMS technology will support will initially emerge from the strategic assessment that carriers give to their implementation (assessment that has to be high). The dump of the existing services that are being performed today with other platforms will provide income to the business plan at the initial stage.

Once deployed the IMS and migrated the existing services, marketing areas will develop products that will be oriented to both Small and Medium Enterprises and Large Companies. Due to the layered structure, the IMS technology enables development of applications by companies that do not need to be related with the networks that will contract the IMS services to the carriers.

This scenario of creation of new services will generate new revenue from enterprises, service providers and end customers, which will make an affordable business plan.

FUTURE RESEARCH DIRECTIONS

IMS technology is under testing and deployment. If we look prospectively to 3 years, we can see that suppliers must work hard on developments to achieve a good performance with different access networks, and high levels of reliability and security. They must devote significant resources in debugging their systems, as some pilot tests and some first commercial implementations will be made in these years, and is at this stage where the problems that have to be debugged will appear.

While most of the rules are already defined, they use to be recommendations that providers interpret and implement in different ways.

For mobile access, it is essential to tender new frequency bands in the regions that need to incorporate 4G networks (LTE).

The details of the interconnection between the carriers that implement IMS are another item that has to be considered. This will begin with the completion of the first pilot tests and will occur by the end of this period, or perhaps for the fourth year, since the interconnections between carriers require that everyone had stable networks. With the IMS interconnection between carriers, the multimedia services will achieve full interoperability, leaving the encapsulation within each provider.

At the end of these three years, the convergence between fixed and mobile technologies is also expected, especially driven by the IMS architecture with LTE as the access technology, working together in an IP Core.

The IMS architecture presents security challenges that must be addressed; the architecture has multiple interfaces that must be secured.

Providing quality of service (QoS) for users is one of the main goals of IMS, in order to meet the requirements of QoS of applications. This takes more important in cases of multi-carrier environments, where signaling pass through multiple IMS cores.

IMS was designed assuming that IPv6 would be the protocol used on the Internet, but IPv6 has not been deployed yet, and will not be deployed in the near future. IMS therefore had to be modified to work with IPV4 and IPV6, adding constraints on routing.

CONCLUSION

The IMS creates independence between supply and development of services and how to access them, both in terms of the network as compared to client terminals. The architecture allows multi-vendor scenarios and includes new actors in context, like ICT companies that specialize in service developments and can be detached from the network.

Service Providers observed in this technology, the ability to increase revenues through the implementation of new services and lower costs associated with the services provided today, improving their revenue sources.

The IMS technology is in its development phase, especially with respect to operational deployments, although some of them already exist at the pre-commercial level. In Argentina, the major Carriers are working on the issue. Large providers have the equipment for the implementation of new services, so some pilots being made, soon to be the first services to be offered to customers.

This shows that the IMS technology is already established in Argentina, and also in the region, with the future of communications, and will be an important step towards the convergence of Information and Communication Technologies event.

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KEY TERMS AND DEFINITIONS

Cellular Network: Is a radio network distributed over land through cells where each cell includes a fixed location transceiver known as base station. User equipment, such as mobile phones, is therefore able to communicate even if the equipment is moving through cells during transmission.

IMS: The IP Multimedia Subsystem or IP Multimedia Core Network Subsystem is an architectural framework for delivering IP multimedia services.

Information and Communications Technologies: Refers to all technologies that provide access to information through telecommunications. It is similar to Information Technology, but focuses mainly on communication technologies. In short, it is includes the Internet, wireless networks, cell phones, and other communication mediums.

Multimedia: Multimedia includes a combination of text, audio, dynamics and statics images with an interactivity content forms.

Telecommunications: Refers to the exchange of information by electronic and electrical means over a significant distance. Telecommunications devices include telephones, internet, fiber optics, satellites, radio and telegraph, for example.

Wireless Networks: Are computer networks that are not connected by cables of any kind. The bases of wireless systems are radio waves, an implementation that takes place at the physical level of network structure.

Chapter 19
The Role of Electronic Commerce in the Global Business Environments

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ABSTRACT

This chapter presents the role of electronic commerce (e-commerce) in the global business environments, thus describing the overview of e-commerce, the strategy of e-commerce, the applications of e-commerce, the barriers to e-commerce adoption, the value chain of e-commerce, and the benefits of e-commerce. E-commerce is one of the most recognized forms of electronic technology applied to businesses. The effectiveness of e-commerce is significant for modern organizations that seek to serve suppliers and customers, improve business performance, foster competitiveness, and acquire routine success in global business. Thus, it is necessary for modern organizations to explore their e-commerce applications, expand a strategic plan to analyze their feasible advancements, and directly respond to e-commerce needs of customers. Applying e-commerce in the global business environments will significantly enhance organizational performance and achieve business goals in the digital age.

INTRODUCTION

E-commerce is the transaction of goods and services over the Internet (Gökmen, 2012). E-commerce practitioners have long tried to promote the technological characteristics of the Internet to support better information seeking and decision making by consumers online (Wu & Lin, 2012). Continual innovations and achievements in enabling technologies are necessary for developed countries to sustain their leading positions in the global economy (Xing, Li, Bi, Wilamowska-Korsak, & Zhang, 2013). Technological, organizational, and environmental contextual factors adapt the ability of e-businesses (Rashidirad, Soltani, & Salimian, 2014).

Emerging e-commerce systems are anticipated to be available anytime, anywhere, and utilizing various official or personal computing devices (Lian, Chen, & Michael, 2013). E-commerce and electronic business (e-business) have become an essential component of business strategy for

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economic development (Georgiadis & Chau, 2013). Modern technology allows businesses to efficiently transact in electronic markets (e-markets) (Nicolaou, 2011). It is essential to explore new methods to represent and measure e-commerce effectiveness from a business perspective (Wu, Gide, & Jewell, 2014).

E-commerce trading practically supports the users with complete information and comments on the products and vendors in global business (Ma, Li, & Zhou, 2014). Customer and organizational resources should be jointly recognized to suitably explain perceived value in e-commerce (Paredes, Barrutia, & Echebarria, 2014). The strength of this chapter is on the thorough literature consolidation of e-commerce. The extant literature of e-commerce provides a contribution to practitioners and researchers by describing a comprehensive view of the functional application of e-commerce to appeal to different segments of e-commerce in order to maximize the business impact of e-commerce.

BACKGROUND

An ever-increasing use of Internet positively affects the importance of e-commerce Web sites (Sohrabi, Mahmoudian, & Raeesi, 2012). Electronic services (e-services) are the emerging areas of attraction to operations management (Oliveira & Roth, 2012). Firms of all sizes should recognize the importance of e-commerce while developing business plans and strategies in order to expand business profits by leveraging emerging technologies to their benefits (Mora-Monge, Azadegan, & Gonzalez, 2010). E-commerce involves the dimensions of business-to-consumer (B2C) and business-to-business (B2B) (Karagozoglu & Lindell, 2004). B2B and B2C are typical on the Internet (Shojaiemehr & Rafsanjani, 2013).

Information and communication technology (ICT) and the Internet are developed as an area of high priority on management's agenda. Technological improvements have made it practicable for small and medium-sized enterprises (SMEs) to become dynamic in global markets through information technology (IT) (Cho & Tansuhaj, 2013). IT has effectively altered the growth and character of the retail trade sector in the prosperous economies (Watson, 2011). If the government arranges free e-commerce facilities for SMEs, it can stimulate SMEs to adopt e-commerce (Solaymani, Sohaili, & Yazdinejad, 2012). E-commerce allows business development for marketing channel intermediaries and reinforces their existing business operations and strategic management (Aldin, Brehmer, & Johansson, 2004).

ROLE OF ELECTRONIC COMMERCE IN GLOBAL BUSINESS

This section presents the overview of e-commerce, the strategy of e-commerce, the applications of e-commerce, the barriers to e-commerce adoption, the value chain of e-commerce, and the benefits of e-commerce.

Overview of Electronic Commerce

As the Internet became more commercialized and users began to engage in the World Wide Web in the early 1990s, the term electronic commerce was coined, and e-commerce applications promptly expanded (Turban, King, Lee, Warkentin, & Chung, 2002). Web-based utilizations are one of the most extensively used types of software, and have become the determination of many e-commerce and communication businesses (Dobolyi, Soechting, & Weimer, 2011). The dynamic forces affecting the global economy and commerce are the increasing rate of globalization and advances in ICT (Kaynak, Tatoglu, & Kula, 2005). The development of new business models supported by IT for e-commerce has become an influential issue in business community (Wang, 2001).

E-commerce is considered as an international phenomenon (Kaynak et al., 2005). Gibbs et al. (2003) defined e-commerce as the application of the Internet to buy, sell, or support products and services. Online commerce introduces consumers with a suitable way of shopping outside of their local supervision (Alm & Melnik, 2012). Firms adopting and implementing e-commerce solutions are profitable at the market level (Porter, 2001). The expanding growth in ICT and the resulting rapid emergence of e-commerce have greatly been reshaping the business world. E-commerce has reached a phase of change where the progressive ideas become more developmental in the nature of global business (Lee, Claudine, Chris, & Sean, 2001). E-commerce is defined in a diversity of management ways by researchers (Saffu, Walker, & Hinson, 2008).

Applying e-commerce favorably leads to improved brand management (Ind & Riondino, 2001; Varadarajan & Yadav, 2002) and better customer relationship management (Bradshaw & Brash, 2001). Brand loyalty is positively related to the performance of customer relationship management (Kasemsap, 2014a). Kasemsap (2014b) suggested that organizations in emerging markets need to put more marketing efforts in developing brand management system in order to enhance the marketing performance and reach business goals in the digital age.

E-commerce is the process of buying, selling, or exchanging products, services and information utilizing computer networks including the Internet (Turban et al., 2002). The broad acceptance of high speed Internet access and it's utilization for routine tasks are causing changes in users' expectations concerning Web site performance and reliability (Poggi, Carrera, Gavaldà, Ayguadé, & Torres, 2014). E-commerce provides new opportunities for the delivery of marketing channel options and the development of new business services (Sung-Eui, 2005).

In e-commerce environments, the reputation of sellers is an essential issue to potential buyers in making decisions (Zhang Wang, & Zhang, 2014). E-commerce refers to buying and selling products or services over the Internet and electronically conducting business (Bhatt & Emdad, 2001). Agent-based e-commerce is considered to offer many business advantages to users (Serrano, Such, Botía, & García-Fornes, 2014).

The improvement of Web technology drives many organizations to modify their marketing strategy since it positively affects the way customers control the flow of information (Almunawar, Anshari, & Susanto, 2013). Web technologies bring opportunities for e-commerce organizations to facilitate the shopping experiences of their customers (Bilgihan, Okumus, Nusair, & Bujisic, 2014). Web community becomes economically interesting with the growing size of community where organizational members are dynamic participants in sharing knowledge (Adiele, 2011). New competitive conditions rely less on dimensional parameters while the stakeholders within every type of industry tend to change, and new markets arise based on the efficiency developed by technology for new products and services (Poulymenakou & Tsironis, 2003).

Technological promotion has brought a whole new way of distributing financial services around the world (Narayanasamy, Rasiah, & Tan, 2011). Most studies of e-commerce have focused on developed Western countries. While it is significant to consider e-commerce in the context of more advanced countries, e-commerce impacts the developing countries (Van Slyke, France, & Varadharajen, 2005). The benefits of e-commerce are recognized in the developed countries such as Australia (Berrill, Goode, & Hart, 2004), as well as in the developing countries such as Chile (Grandon & Pearson, 2003).

The slow development of e-commerce in Africa, the Middle East, and certain parts of Asia is described by the lack of essential physical infrastructure (i.e., lower personnel computer penetration, poor telecommunication infrastructure as most of these countries possess analogue systems as opposed to the digital systems of developed Western countries, and ineffectively managed telecommunication systems) as well as auxiliary institutional environment that promotes the structure of transactional integrity (Oxley & Yeung, 2001). The emerging markets of Latin America and the Caribbean are greatly investing to create ICT infrastructure that will enhance e-commerce activity.

The broad application of ICT is important to the structural transformation of firms (Song & Liu, 2013). E-commerce offers a collection of opportunities to raise business performance. E-commerce plays a considerable role in the international economy, thus conducting transactions of goods and services by means of ICT, particularly the Internet (Xu, Gong, & Thong, 2006). Policymakers in emerging markets can take steps to advocate e-commerce by SMEs by setting up the dedicated information Web sites similar to those offered by the governments of industrialized countries (Kaynak et al., 2005).

The improvement of e-commerce has provided many transaction databases with helpful information for investigators exploring dependencies among the items (Chamazi, Bidgoli, & Nasiri, 2013). Globerman et al. (2001) defined the Internet-based commerce as any commercial transaction where the buyer and seller come together through the electronic media of Internet, form a legal agreement concerning the pricing and delivery of special goods and services, and finish transaction through the delivery of payments and services.

Strategy of Electronic Commerce

To be profitable in the global economy, e-commerce businesses need to maximize the overall value of fulfilled orders, while limiting costs of delivery (Cleophas & Ehmke, 2014). One of the important challenges faced by organizations is how to promote the basic benefits of e-commerce to build the forms of interorganizational systems with their suppliers and customers in the process of improving e-commerce benefits and supply chain (Gunasekaran, Ngai, & McGaughey, 2006; Min & Mentzer, 2004). Selecting a specific e-commerce application is a strategic decision that must be made in the context of the organization's competitive strategy.

B2C e-commerce revenue growth and venture capital contribute to the adoption of Internet-based selling technology (Ho, Kauffman, & Liang, 2011). Strategic approach to e-commerce decisions is progressively important (Straub & Klein, 2001). Strategic alignment of competitive strategies and dynamic capabilities may allow e-businesses to establish superior value for their stakeholders (Rashidirad, Soltani, & Syed, 2013). The characteristic of e-commerce such as personalization for customer is affordable to the large organizations (Korper & Ellis, 2001).

Among the strategies of e-commerce categorized in the management literature (Sekhar, 2001), the suitable e-commerce options for SMEs include the growth of their customer base, thus facilitating their customer service and improving their purchase management. E-commerce strategy associated with customer growth entails operating a Web site to supply product information, thus building brands and selling online products (Sekhar, 2001). The accomplishment of a Web site depends on its ability to improve consumers' perceptions of privacy assurance (Lowry et al., 2012). Economic activity on Web platforms is embedded in the combination of virtual and community-based relations that change the behavioral norms of a local culture (Avgerou & Li, 2013).

Reputation systems are important in e-markets, where they help buyers decide whether to purchase products and services (Fouliras, 2013). Reputation systems help buyers select sellers by accumulating seller information reported by other buyers (Noorian, Zhang, Liu, Marsh, & Fleming, 2014). Buyers dealing with new sellers should be able to consider other buyers' experiences with those sellers to make a better decision (Morid &

Shajari, 2012). Heim and Sinha (2001) created a product-process matrix for electronic B2C operations based on an electronic service product and electronic service process structure.

Online business transactions and the success of e-commerce depend on the practical design of a product recommender mechanism (Li, Wu, & Lai, 2013). Recommendation systems provide strategies that help users search or make decisions within the overwhelming information spaces concerning e-commerce (Cheng, Chou, & Horng, 2013). Recommendation systems are the significant components of many Web sites and have brought massive economic benefits for online shoppers and e-commerce organizations (Gu, Dong, & Zeng, 2014). In recent studies on the e-commerce-related recommendation systems, the choice-based conjoint analysis has been described as a process for measuring consumer preferences in global business (Pfeiffer & Scholz, 2013).

E-commerce is recognized as knowledge management (KM) (McLean & Blackie, 2008). Kasemsap (2013a) stated that the useful training programs are essential to help executives and managers establish their strategic skills for promoting employees' knowledge-sharing behavior. Organizational learning, organizational innovation, and organizational performance help organizations obtain sustainable competitive advantage in global business (Kasemsap, 2013b). Kasemsap (2013c) explained that organizations should recognize the significance of KM in maintaining knowledge creation and knowledge-sharing behavior to increase employees' performance. Learning motivation is practically correlated with the learning transfer in global education (Kasemsap, 2013d). Organizational learning, KM, and knowledge-sharing behavior lead to better organizational performance (Kasemsap, 2013e).

The potential of knowledge occurs when it is shared within the functions of organization in order to meet current customers and their expected requirements (Mohammad, Rashid, & Tahir, 2013). Kasemsap (2014c) described that KM, strategic orientation, and organizational innovation lead to improved organizational performance. Organizational learning is practically related to KM in modern organizations (Kasemsap, 2014d). Leaders of global businesses should provide information and communication technology skills for organizational employees to enlarge their knowledge in the information age (Kasemsap, 2014e).

Educational attempts to generate social networks should be systematically implemented for minimizing the lack of knowledge (Kasemsap, 2014f). KM involves the creation, transfer and application of knowledge in modern organizations. Organizational culture, organizational learning, and KM significantly lead to better job satisfaction (Kasemsap, 2014g). Kasemsap (2014h) suggested that KM is positively correlated with job performance.

The strategy of e-commerce with a focus on purchase management is suitable for cost leadership and hybrid strategies regarding business efficiencies resulting from lower transaction costs and less time and effort involved in the operations of supply chain (Barnes-Vieyra & Claycomb, 2001; Phan, 2003). Getting the pricing right has emerged as one of the strategic keys to the success of e-commerce (Wu, Li, & Xu, 2014). The Internet has supported tools offering marketplaces the probability to expand through the Web applications (Lubrica, Mukhtar, & Abdullah, 2011). The Internet has led to effective changes in financial relations and in consumer buying behaviors (Martín & Jiménez, 2011).

Customer loyalty is necessary for the survival and achievement of any store (Chiu, Wang, Fang, & Huang, 2014). Online searching frequency has helpful impacts on both online and in-store shopping frequencies (Cao, Xu, & Douma, 2012). Retaining customers, especially in the context of Internet shopping, is very crucial because of the low costs in comparison and switching (Kim & Gupta, 2012).

In the field of operations strategy and operations system design, the product-process matrix is broadly defined as a leading paradigm for strategic vision (Sung-Eui, 2005). Manufacturing process options in the product-process matrix require to be replaced with delivery process choices (Boyer, Hallowell, & Roth, 2002). The service strategy design matrix presents the characteristics of product/service process matrix, where the level of service delivery processes vary from the face-to-face delivery of services offered by highly skilled experts to the full self-service marketing channels where customers utilize technology in order to get services (Sung-Eui, 2005).

Applications of Electronic Commerce

The amount of research concerning Internet marketing has quickly grown since the beginning of the Internet age (Corley, Jourdan, & Ingram, 2013). The increase in number of cloud computing, wireless network and e-commerce applications has faced many crucial challenges including integrity verification, authentication, access control, and attack prevention, which are practically current emerging issues needed to be systematically solved to make modern network environments more secure than before (Leu, Lin, & Castiglione, 2013).

In order to implement e-commerce strategy, organizations should build business infrastructure and launch suitable online e-commerce operations. Online shopping has become a key strategy for online retailers to attract more customers, enlarge market boundaries, and develop more benefits (Lai, Ulhas, & Lin, 2014). Customers' evaluations have important impacts on customers' satisfaction (Lin, Wang, Wang, & Lu, 2014). Customers' trust and expectation have beneficial influences on customers' satisfaction (Kim, 2012).

Information is the most relevant element that is systematically utilized by decision makers (Gettinger & Koeszegi, 2014). E-commerce strategy requires Web site operations through which information about organization and its products, promotion and marketing efforts, and purchase capabilities are offered. Usability of an organization's Web site is an important aspect for the success of e-commerce strategy. E-commerce Web site must be designed and constructed with customer's ease of use in mind (Pavlou, 2003). E-commerce Web site from a functional perspective provides a simple navigation, straightforward access to information without clicking through many Web pages, and ability to quickly load (Korper & Ellis, 2001).

Multi-tiered Web applications must deliver their services with superior availability in order to encourage customers to select online services over the traditional brick-and-mortar options (Lu & Gokhale, 2013). Trusted quality of Web service (QoWS) issue is important for e-commerce applications (Wang, Zou, Sun, & Yang, 2012). E-commerce approaches to the purchase management utilizing B2B e-commerce software and supply chain management software are the expensive investment mainly adopted by large organizations (Korper & Ellis, 2001; Zhu & Kraemer, 2002). The adoption of e-commerce leads to a variety of benefits that involve cost reduction, product quality improvement, new customer or supplier contacts, and the generation of new ways of selling the existing products (Chaudhury & Kuilboer, 2002). E-commerce is an important vehicle driving the procedure of globalization (Gibbs et al., 2003).

E-commerce technology has the ability to become a critical source of competitive advantage because it is a cost-effective way of reaching customers and competing on par with larger counterparts (MacGregor & Vrazalic, 2005). There are some specific e-commerce activities, which include the shipment of goods by roadway and railways, dissemination of important information about workers, dispatch of bill of ladings by electronic method, and protection of industrial and commercial ownership rights (Kaynak et al., 2005). Ngai and Wat (2002) emphasized the major factors of e-commerce usage in terms of Intranet, interorganizational systems, electronic payment system, financial services, retailing, online publishing, auctions, training, and marketing.

A new paradigm is needed for e-commerce in the process of entering foreign markets and in the management operations within business markets (Karavdic & Gary, 2005). The Internet and e-commerce have become internationally prevalent, thus bringing countries together into the global economy (Gibbs & Kraemer, 2004). E-commerce tends to be associated with the activities of sales and procurement (Cassivi, Leger, & Hadaya, 2005). E-commerce embraces the ability to exchange information with business partners and customers, thus involving the adoption of supply chain management tools (Lefebvre, Cassivi, Lefebvre, & Leger, 2003). With the evolution of business process management and of service-oriented architecture, the focus has shifted to the appearance of electronic services that integrate business processes and modify functionalities available to customers (Chou & Seng, 2012).

Barriers to Electronic Commerce Adoption

Larger business has benefited from the adoption of e-commerce, comparing with small business (Riquelme, 2002). E-commerce barriers are studied by researchers in order to help small business get the benefits of using e-commerce (MacGregor & Vrazalic, 2005). However, the practical rate of adopting e-commerce in small business remains low (Magnusson, 2001). The step of e-commerce expansion into small business is attributed to various barriers faced by modern organizations. Consumer distrust is beginning to be perceived as a significant e-commerce issue (Riquelme & Román, 2014).

The barriers of e-commerce adoption have been documented in many researches (Quayle, 2002; Riquelme, 2002). When e-commerce is owned and managed by a small enterprise, the cost should be definitely recognized as well as fault tolerance, high availability, and scalability (Jung, Cui, Eom, & Yeom, 2014). One of the most cited barriers to e-commerce adoption is that it is too expensive to implement. If the finance is readily available to small business, high cost may not be a barrier to the adoption of e-commerce. Some of these barriers include the high costs related to e-commerce, the lack of technical resources to implement e-commerce, the complexity of e-commerce technology, and the difficulty of measuring return on investment.

The Internet users may be vulnerable to various types of Web threats, which may cause economic damages, identity theft, loss of personal information, brand reputation damage, and loss of customer's confidence in e-commerce and online banking (Mohammad, Thabtah, & McCluskey, 2014). Most online traders are greatly conscious of different threats and attacks such as credit card fraud, identity theft, spoofing, hacking, phishing, and other abuses, leading to low trust in online business transactions (Musau, Wang, & Abdullahi, 2014). Increasing turnover in e-commerce is linked with a growing risk of payment fraud (Ruch & Sackmann, 2012). Product returns have been recognized as an inevitable cost for online sales, forfeiting any possibility of cost savings (Liu, 2014).

The lack of trust between commercial entities and purchasers can restrict the potential of e-commerce (Antoniou & Batten, 2011). Fillis et al. (2003) stated that e-commerce in small business is recognized in terms of conceptualization and dissemination. Stockdale and Standing (2004) classified e-commerce barriers into four categories (i.e., the lack of resources, skill levels of employees, security concerns, and preparation of small business).

External barriers are categorized into supply barriers (difficulties obtaining finance and technical information), demand barriers (e-commerce not fitting with the products/services or not fitting with the way clients did business), and environmental barriers (security concerns). Internal barriers are subdivided into resource barriers (i.e., the lack of management and technical expertise) and system barriers (e-commerce not fitting with the current business practices). The common barriers facing smaller business in the e-commerce environment are the lack of standards, supply chain integration, and global trading (Stockdale & Standing, 2004).

Value Chain of Electronic Commerce

The term value chain is used to explain the significance of processes through which value is added to goods and services (Cassivi et al., 2005). The study of marketing channels is usually approached from a functional aspect while supply chain is approached from a process perspective. Marketing channel and supply chain processes include the functions of refinement and repositioning (Aldin et al., 2004). Refinement consists of activities that aim at interorganizational collaboration with value creation in marketing channel, or the supply chain. Refinement represents the process level of value creation. Repositioning consists of internal and external enhancements in customer and supplier relations, thus representing market enhancement and positioning related to given members in the marketing channel. Below are the details of value chain-related refinement and repositioning.

Refinement

Refinement is the e-commerce business development based on the unique competencies performed by organization. The creation of value have centered on the value chain (Porter, 1985). The drivers of product differentiation and value creation refer to what activities to perform and how to perform them within value chain regarding suppliers/channels, timing, location, and the sharing of activities among business units (Porter, 1985). Organizational resources are transformed to business activities through capability building.

E-commerce generates the saving of administrative cost regarding the reduction of manual data entries that give fewer errors and better utilization of resources (Porter, 2001). Organizational changes include role changes as the systems accept the parts of regular work, but new processes, internal and external to the firm, may also result in structural change that is a source for profitability (Porter, 1985).

Repositioning

To be successful in e-commerce, it is not sufficient for organizations to only add value in value chain. Managers and marketers in organization must create the value with a focus on the total value-creating systems and work together with suppliers, allies, and customers to produce the value. Porter (1996) stated that the value is created when an organization does things in a different way than its competitors.

Porter (2001) stated that combining business activities and multiple marketing channels improves the response to dynamic requirement and is a sustainable source to gain competitive advantage. In the developed outside-in view, the effects of e-commerce are dependent on the relative influence of the competitive forces encountered by the firm. The significance of business relationships is recognized in the industrial environment. The increased presence of firms and the reduced transaction costs change the boundaries of the firms. E-commerce offers an opportunity to support service for the areas of customer service suited for digitization (Aldin et al., 2004).

Benefits of Electronic Commerce

E-commerce, along with the Web site as basic infrastructure, offers several tangible and intangible benefits (Kim, Shaw, & Schneider, 2003). The literature review of e-commerce and information system is stated about the impact of digitally-enabled supply chain management on cost and delivery performance (Chen & Pauraj, 2004; Devaraj, Krajewski, & Wei, 2007; Li, Sikora, Shaw, & Tan, 2006). E-commerce communication technologies such as Internet-based technologies enable organizations to access information faster, easier, and at real time.

Service-based e-commerce systems support a flexible, low-cost business model to enable customers to focus more on their core business (Lian et al., 2013). E-commerce and information system allow faster processing speed, greater correctness, reduced production lead time, reduced production costs, reduced transaction cost, increased delivery speed, and increased delivery dependability (Chen & Pauraj, 2004; Devaraj et al., 2007; Li et al., 2006).

For e-commerce to reach its full capability, consumers must have practical protection during online shopping, and their fundamental rights must be appropriately protected (Dahiyat, 2011). The impact of IT on organization is discussed for many years, since researchers have found the positive and negative impacts of IT on organization (Thatcher & Oliver, 2001). Process level is the condition of business value, where the impact of technology is simply understandable. Several empirical studies measure IT performance.

Murphy and Simon (2002) measured enterprise resource planning (ERP) benefits in three levels: operational, managerial, and strategic level. ERP system is systematically useful in supporting management with the types of information in order to make critical decisions (Kasemsap, 2015). Esteves (2009) developed a road map of benefits using ERP in medium-sized enterprises. Mukhopadhyay and Kekre (2002) quantified both operational and strategic impacts of electronic integration in a B2B procurement environment for suppliers. Both strategic and operational benefits are enhanced by the use of electronic integration (Mukhopadhyay & Kekre, 2002).

The useless operation of many e-commerce retailers in commodity markets/undifferentiated products (i.e. paper clips) and quasi-commodity markets/differentiated products (i.e., books, CDs, and new cars) may be attributed to low barriers to entry along with new customer acquisition costs (Korper & Ellis, 2001). SMEs accomplish in highly differentiated product markets supported by organizational innovation, specific product design, and high product quality (Kuratko, Goodale, & Hornsby, 2001).

FUTURE RESEARCH DIRECTIONS

The strength of this chapter is on the thorough literature consolidation of e-commerce. The extant literature of e-commerce provides a contribution to practitioners and researchers by describing a comprehensive view of the functional application of e-commerce to appeal to different segments of e-commerce in order to maximize the business impact of e-commerce. The classification of the extant literature in the domain of e-commerce will provide the potential opportunities for future research. Future research direction should broaden the perspectives in the implementation of e-commerce to be utilized in modern organizations.

It is important that more practical and research inquiry is focused on how to combine both e-commerce perspectives and international business literature in order to establish a research agenda for the international marketing practitioners and researchers from around the world to focus on international marketing in expanding the social network communications. Future research directions should build a cumulative research stream to contribute to the application of strategic issues and organizational performance in adopting and implementing e-commerce in the knowledge-based organizations.

CONCLUSION

This chapter presented the role of e-commerce in the global business environments, thus describing the overview of e-commerce, the strategy of e-commerce, the applications of e-commerce, the barriers to e-commerce adoption, the value chain of e-commerce, and the benefits of e-commerce. E-commerce is one of the most famous forms of electronic technology applied to businesses and that its impact on competitive strategy and its formulation is regarded to be fundamental.

E-commerce enables business development in activities, processes and services, as well as structural and segmentation changes. The development of e-commerce promotes an organizational change of roles and responsibility within the organization and between organizations. E-commerce increases the commercial ability toward customer satisfaction, thus maintaining competitive costs and pricing in modern business. In order to gain competitive advantage, businesses should completely embrace e-commerce adoption and make executives and managers aware of the potential of Internet-based commerce.

Increasingly competitive environments demand the marketing channel flexibility and rapid market response capability. Internet-based commerce can reduce the barriers in conducting business by lowering the cost of extending geographic reach. Executives and managers should ensure that they are able to acquire the enabling and enlightening theoretical and practical skills related to the utilization of e-commerce. Business challenges that lie ahead for the executives and managers include how to increase online sales through e-commerce, differentiate their e-commerce attempts to gain competitive advantage, and use e-commerce to achieve cost advantage in global business.

The use of e-commerce positively impacts the organization in various ways ranging from operational benefits to strategic benefits. E-commerce efforts need to be recognized in a business context in order to effectively utilize the potential of e-commerce. It would be valuable to explore the business procedures that organizations can differentiate their e-commerce involvement to sustain competitive advantage. Applying e-commerce will greatly improve organizational performance and gain sustainable competitive advantage in global business.

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KEY TERMS AND DEFINITIONS

Business: An economic system where goods and services are exchanged for money.

Competitive Advantage: A superiority gained by an organization when it can provide the same value as its competitors.

Electronic Commerce: The business conducted through the use of computers or other electronic appliances without the exchange of paper-based documents.

Emerging Markets: The new market structures related to digitalization, deregulation, and globalization.

Information Technology: A set of tools, processes, and methodologies and associated equipment employed to collect, process, and present information.

Internet: A process of connecting a computer to any other computer anywhere in the world through routers and servers.

Small Business: A designation for organizations of a certain size in terms of annual turnover and total value of assets.

Strategy: A plan chosen to bring about a desired future such as the achievement of a business goal.

Value Chain: The interlinked value-adding activities that convert inputs into outputs and help create competitive advantage.

Chapter 20
E-Commerce for Italian Textile Manufacturers:
Limitations and Human Factors

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ABSTRACT

In the current chapter, the authors intend to present the strengths and the weaknesses from the standpoint of graphic computing, managing and productive computing, and the human factors that prevent boosting on-line sales. They analyze the reality of several businesses or industries, which are gathered under the word "group" and belong to the textile sector with high profits because of the high volume of invoicing, a hundred-year-old tradition, with important customers of the European, American, and Asian international fashion, etc. in a northern Italian region known as Lombardy. Paradoxically, the textile sector in that region, like others in Europe, is one of the environments where computing and the breakthroughs and the advantages in new technologies are difficult to introduce these days. The human factor is the main cause because of organizational structures of a vertical and/or family type.

INTRODUCTION

The expansion of the Internet took place quickly in the education sector, in the leisure sector and in the relationship between the public administration and its citizens (Salas & Peyton, 2009; Foley, 1996; Fremantle, Weerawarana, & Khalaf, 2002; Stafford, 2003; Cushing & Pardo, 2005). One of the main reasons why E-commerce has not expanded quickly in Southern Europe is a lack of security when carrying out payments using credit cards (Weigold, Kramp & Baentsch, 2008; Buchmann, May & Vollmer, 2006; Holland & Westwood, 2001). In contrast to the fact that the Spanish ATM network is the biggest in Europe since the 90s, Spain showed one of the lowest numbers of Internet users who made their purchases through the Internet that is, below 10%. At the end of the last decade, the banks started to issue "purse" or "pre-paid" credit cards, where the user can deposit the money before carrying out the operations in the Internet. This product is boosting the E-commerce among both young and adult users. Obviously, now we are talking

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about users without accessibility problems to the internet, since they grew up with information technologies. However, some studies show that the problems in E-commerce increase exponentially in the case of blind users for example, due to the traditional motives of design and usability of the interactive systems (Bussi et al., 2011). This means in the communicability era there are still users who have remained stuck with their one or even two decade old problems (Cipolla-Ficarra, 2008). Interestingly, one of the skills of many blind users is the development of touch. The difficulty of providing touch sensations still prevents some industries from carrying out e-commerce, instead forcing buyers and sellers to gather in international fashion fairs to see and touch the goods (Dickerson, 1999; Kunz & Garner, 2007). The commercialization of great volumes of clothes whether it is for the industrial or the artisan sector requires manufacturers and those in charge of tailoring, to travel to fairs in Europe, Asia and America, thus increasing the costs for both sides (Diamond & Diamond, 2002). This requires the setting up of a stand or showroom for the manufacturer, along with the travel of the marketing staff, etc. On the other hand, the buyers have to spend hours and hours among all the clothes manufacturers, to see and touch the different clothes samples, grouped in special catalogues. This is one of the main current problems preventing online commercialization in the textile industry (McFadyen, 2008; Plant, 2000; Van Heck & Vervest, 2007). The problem in principle lies in the sense of touch. Although in the current multimedia system there is the possibility of emulating tastes and smells, there is no similar thing for touch as yet. Consequently, this is an interesting area to be developed, whether it is from the point of view of graphical computing, such as simulations, emulations and scientific visualizations of the clothes and the end products –shirts, trousers, coats, etc. (Wu, Au & Yuen, 2003; Grana, 2003; Meller & Elffers, 2002; Goldenthal et al., 2007; Kaldor, James & Marschner, 2008). Figures 1, 2, 3, 4, 5 and 6 are some examples from textile computer graphics. Numerous data sources for e-commerce strategies exist in the business management and production systems (Bosch, 2007; Rosenberg, 2007), that is,

Figure 1. CAD simulation for a shirt –dobby (characterised by small geometric patterns and extra texture in the cloth)

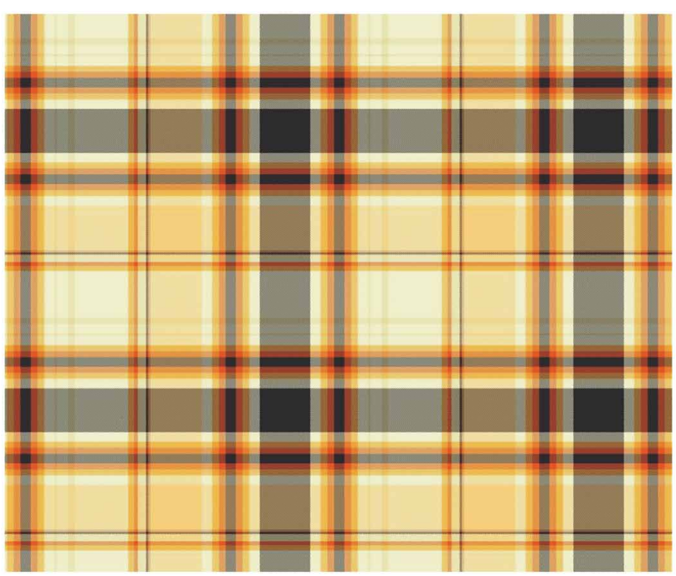


Figure 2. Examples of CAD simulation for textile –dobby (cotton, linen, etc.)

Figure 3. Examples of CAD simulation for textile –Jacquard weaving (it produced on a special loom, are characterized by complex woven-in designs, often with large design repeats)

Figure 4. CAD textile for Dobby –DobbyCAD (www.tex-cad.com)

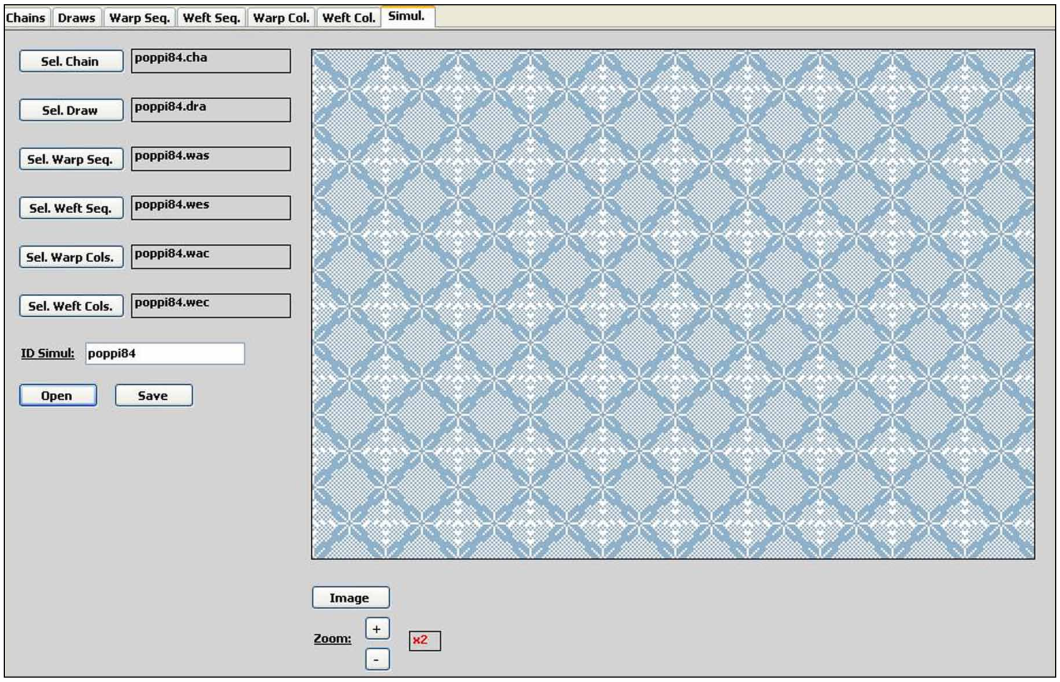


Figure 5. CAD textile for Dobby, Jacquard, etc. with colour options –ArahWeave (www.arahne.si)

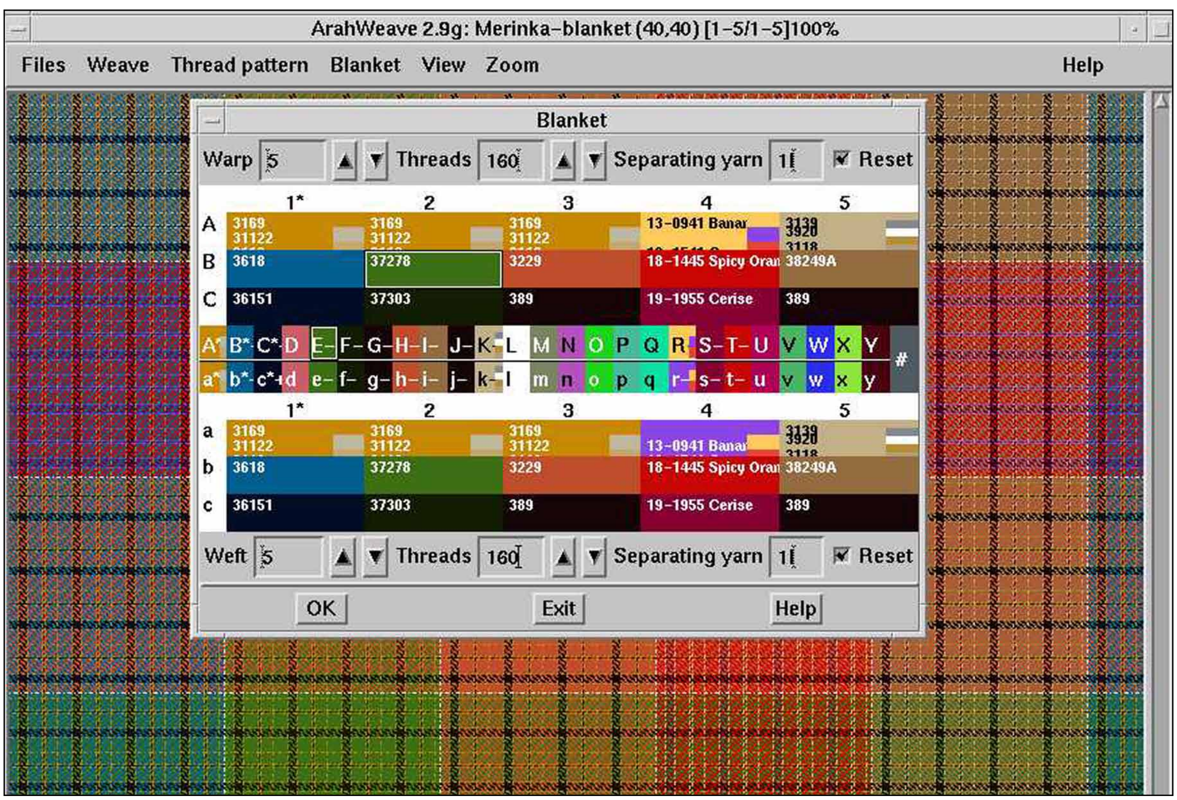
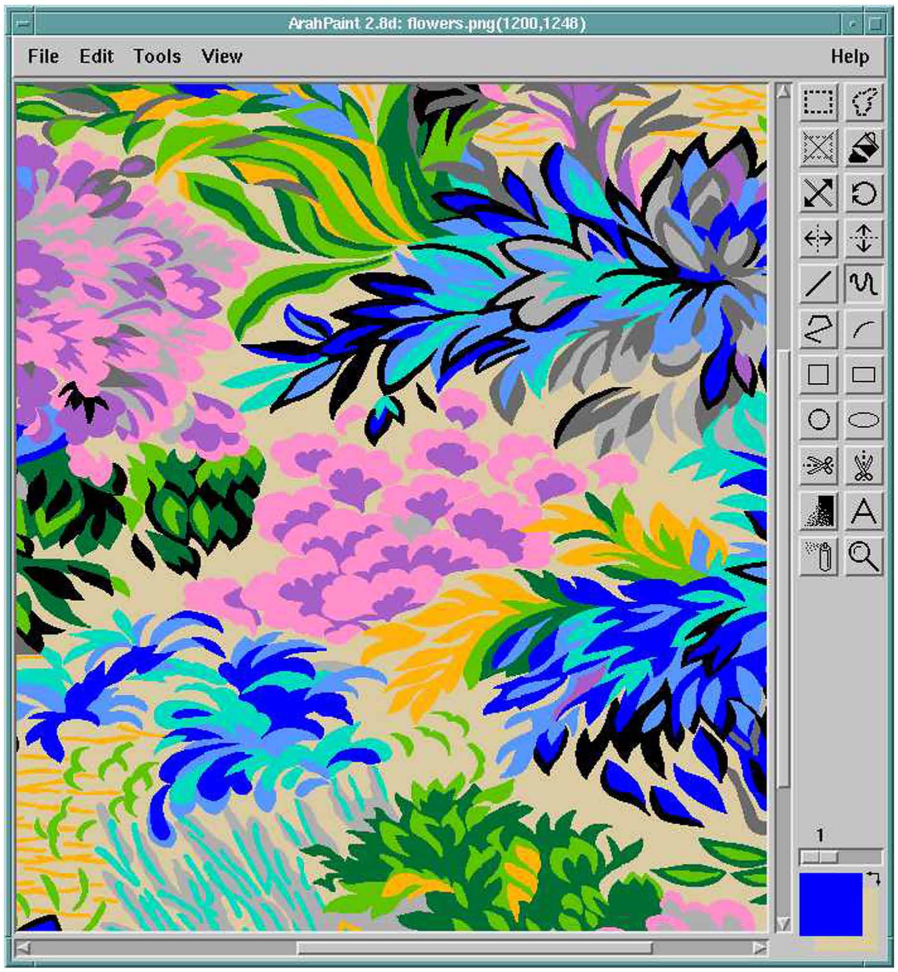


Figure 6. A good textile CAD system has a lot components from computer graphics, 2D and 3D computer animation (i.e., the Paint application for images), etc. to CAM (Computer-Aided Manufacturing)



textile CAD, programming of the production in the looms, commercialization, distribution of the shipments, etc. Without any doubt an interesting sector of computer graphics, human-computer interaction, human-computer communication, interactive design, software and systems engineering (Volino & Magnenat-Thalmann, 1997; Volino & Magnenat-Thalmann, 2001; Choi & Ko, 2005; Hauth, Etzmuss & Strasser, 2003; Kang & Cho, 2002; Cipolla-Ficarra, 2010).

In the current work we intend to present the strengths and the weaknesses from the standpoint of graphic computing, computing in managment and manufacturing, and the human factors that prevent boosting on-line sales. In our case, we will analyze several businesses gathered under the word "group" which belong to the textile sector with high profits because of the high volume of invoicing. They have a hundred year old tradition, with important customers of the European, American and Asian international fashion markets and are situated in a northern Italian region known as Lombardy. Paradoxically the textile sector in that region like others in Europe is one of the environments where computing, the breakthroughs and the advantages in new technologies are difficult to introduce these days. The human factor is the main cause since we are in the face of organizational structures of a vertical and/or family type (Cipolla-Ficarra, 2010a).

In the late 90s, some top fashion stylists relied on virtual characters to simulate their catwalks on the Internet, using commercial software and PCs., as in the case of products such as ClothReyes, 3D Studio, Maya, etc. Whereas in the textile industrial sector of Lombardy (regarded as one of the engines of Europe), they kept on using Windows 95 in the administration, productive, managerial etc. environment with Pentium computers which acted as servers. In these cases, the success or the failure of E-commerce, does not only depend on the intrinsic factors of the kind of product to be marketed, but rather on the entrepreneurial mindset that exists in the field of human factors.

Through the heuristic analysis it is possible to detect those points on which the investments in software and hardware cannot solve the communicability problems for E-commerce, especially those deriving from human factors. The main strategies used by the marketing department will also be presented, after reaching a consensus with the industrial direction, to solve the serious shortcomings in the training of their employees in the new technologies, and which do not allow the use of some of the advantages stemming from the simulations and emulations of clothes in 2D and/or 3D through the CAD systems. All of this is to the detriment of the E-commerce in the textile environment.

STATE OF THE ART

The democratization of the Internet in the 90s entailed the phenomenon of online marketing of contents to take the first positions in the on-line search engines such as Google, Yahoo, Lycos, and others that do not exist anymore. From that time one remembers the programming in the Html websites, when the important thing was to appear and participate in that democratizing process. Once the stage of novelty of the new mass media was overcome, it became open to the public in general or freely accessible in public libraries, universities, schools, tourist information stands, airports, cybercafés, etc., and it became necessary for for every enterprise, industry, public or private institution to develop their own website, in order to promote their products and services on-line. It was the stage of duplication of real information to on-line or virtual information. Others, in contrast, see in that possibility of communication the generation of profit or non-profit virtual institutions. In the first case we are talking of a crystal-clear situation, that is, through the window of the Internet we can see that there is a real institution, often magnified for marketing reasons, but real. In contrast, in the virtual business we see a mirror situation, that is, only what is shown on-line exists.

The strategies used in traditional marketing found at that time in the Internet an interesting option to generate benefits in the least possible time whether it is for the real businesses and industries, or for the so-called virtual businesses and products (i.e., fashion) at the end of the 20th century (Hamilton, 1987; Kawamura, 2005). The generation of virtual businesses with funds stemming from real businesses and/or industries led to the creation of a kind of unreal bubble whose burst took place in the early years of the 21st century, thus generating severe economic troubles and even the closing of businesses and centennial industries belonging to the textile, metallurgic, sectors, etc., which had invested in the magic mirror of e-commerce.

Bubbles of the e-commerce which in the Catalan case appear linked to the autonomic college teaching centres, boosted by political factors –pseudo nationalism (Cipolla-Ficarra et al., 2013) which have the control of the traditional media in the local environment. That is how smoke curtains are made in front of the mirror of the virtual businesses from the fledgling schools? which are opened in Catalonia in the 90s. An exaggerated number in comparison with the population rate who potentially may go to college, or the on-line courses of the virtual universities such as the Universitat Oberta de Catalunya (UOC –www.uoc.edu). This newly created universities use as lines of research for their future professionals, the latest technological breakthroughs, and especially e-commerce. Without scientific, theoretical and experimental foundations, businesses and industries are included in those projects, some of them centenary in the manufacturing sector, which close down their business because of the explosion of the fake bubble of e-commerce, where the economic and/or financial authorities didn't carry out any kind of control in the face of that unbounded momentum boosted from the local universities. In few words, the failure of the first era of Catalan e-commerce is due to limitless greed encouraged from the local universities and with a great power of persuasion in the local traditional mass media (local, regional, national and international) to draw capital to fake projects. As a result, at the same time, centenary business and industries had to stop their activities. Consequently, the early e-commerce wasn't a synonym of sure success for the great businesses, industries and institutions but rather losses and risk of closure of the activity they developed.

In the centre and north of Europe, some countries, like Germany, the Netherlands, Belgium and the Scandinavian countries, among others, e-commerce was the ideal solution to solve real problems stemming from the climatic conditions of winter, for instance. In those countries, e-commerce had a serious approach from its inception, where the local universities didn't generate smoke curtains as in the Catalan case. Telework was boosted, the on-line cooperation groups of clients and service providers, etc. Besides, the virtual firms were founded with the highest level inside the European commercial register, that is, corporations, in comparison with the family or limited partnerships of the Southern European countries. In short, in those geographic areas there was a strong belief in that kind of businesses and e-commerce. The first problems arise when those businesses start to open their branches in Southern Europe and the modus operandi was totally different from the cultural and functional point of view. One example was the way of carrying out the outsourcing services for the maintenance of the computer network in the Lombardian textile businesses, where the technicians, in situ, made the heads of the electronic data centre or calculation centre (CED –*Centro Elaborazine Dati*, in Italian) sign services reports for 10 or 12 hours, without specifying the tasks that had been made. The interested reader may look up the following bibliographical references for the details of that way of acting of some centenary industries in Lombardy.

MARKETING VERSUS SCIENCES: FROM BUSINESSES TO PEOPLE

The human factors in the new technologies play an essential role. Those factors may lead the potential users of the interactive systems to the quick acceptance or rejection of the latest technological breakthroughs (Lamb & Kallal, 1992; Hamilton, 1997; Kunz & Glock, 2004). The problem lies in how these new technologies, which offer on-line or off-line services are perceived by the users. Here arises the issue of generating an institutional image which is lasting in time and which is synonymous of quality and reliability. In the case of the real enterprises, the main responsible for those tasks were the departments of marketing and PR. However, for cost reasons, these activities have been cut down to a single department at the beginning of the new millennium, especially in the national firms. Other multinational firms or firms with marketing and/or production in several countries resort to the strategy of a small internal department, with one, two or three employees for such jobs and the outsourcing of all the other activities. This reality can be seen with exceptional clarity

Figure 7. Negative example of the outsourcing services in the computer science context where the reports of the computer services in centennial textile firms did not only lack an internal control, but also the servers for the management of the emails, production, etc., were weekly formatted thus servers, generating a myriad inconveniences in production and human conflicts. The head of the CED only devoted themselves to signing the total of hours submitted by the outsourcing technicians (i.e., 7 hours and 30 minutes). The reader interested in this example may look up the following bibliographical references (Cipolla-Ficarra & Ficarra, 2011; Cipolla-Ficarra, Nicol & Ficarra, 2011).

Mod.	Rev.
06	01

RAPPORTO DEL LAVORO

Il Cliente: Albini

Numero	Data	Presso il Cliente	
1422	21-03-2002	~~Sì~~ No	Ora d'arrivo ____ Ora di partenza ____

DESCRIZIONE DELL'ATTIVITA' SVOLTA

consulenza.

Nome del tecnico	FIRMA DEL CLIENTE PER ACCETTAZIONE	Attività + Viaggio	7,5
Firma del tecnico		TOTALE ore da fatturare	7,5

in the centenary Lombardian textile sector, even those which put before their trade mark the term "group". Under this name is spread in the new millennium the fashion of grouping all the branches, virtual businesses and other activities of the set of societies that make up that business or industry. What is surprising is that the Lombardian textile sector has its industrial activities in third countries, inside and outside the European borders. However, they hold the factual power so that the end products bear the label "Made in Italy", when in fact the clothes are made outside the Italian borders. Therefore, we have two key elements of Italian productive textile marketing, which went from the 20th to the 21st century. None of them has a 100% credibility in the new millennium. First the loss of reliability of the production label as quality brand which can be used as a flag of prestige in worldwide marketing (Diamond & Diamond, 2002). Second: the on-line presentation as big corporations, resorting to visual marketing ploys, mainly. That is, e-commerce generated a false image of the reality they represented. A simple way of detecting these false groups is through the configuration of the database network which circulates in the intranet among the different HQ. It is very likely that by switching off certain severs the rest of real or virtual businesses of the group, inside and outside its borders, stop working, since they are programmed in a special way, virtually emulating certain IP (Internet Protocol) domains, but physically it is the same.

This yearning to generate a corporation image has reached the point of coming across those people who sell services for graphical illustration, music, informatics, teaching, etc., who market themselves in their on-line sites as if they were a real brand. In our days, any activity that is made in the academic sector must be sold as if it was a commercial product. To verify that you only need to see the constant advertisement in the add banners of the newspapers' pages at the moment of reading our messages in Hotmail, Google, Yahoo, etc. Paradoxically, in the current temporal context, scientific knowledge has become a value that has to be presented to the rest of society as a product or commercial service, with a value equal to zero. The equal to zero value is due to the fact that scientific knowledge is communicable, that is, it isn't private, but public (Bunge, 1981). Scientific knowledge communicates information to whoever has been trained to understand it. There are certainly vague notions even in the development of the science, although not in the final presentation of the scientific work. What is inapprehensible may be related to painting, poetry, music and the other arts, including the category of design in the presentation of artistic information on the screen of a multimedia system, but not of science, whose language is informative and not expressive. Incomprehensibility itself is, in contrast, an issue of scientific research, whether it is linguistic or psychological. Communicability is possible thanks to accuracy, and is in turn a necessary condition for the verification of the empirical data and of scientific hypotheses. As Mario Bunge (1981) states, even though for political or commercial reasons they may be kept secret for some time, at least some pieces of knowledge, they must be communicable in principle so that they can be regarded as scientific. The communication of results and the science techniques do not only perfection general education but multiply the chances of their confirmation or rebuttal.

Here is a great contradiction with the textile sector in Southern Europe, which has been unable to generate R&D labs nor to respect the epistemological principles of the sciences (Bunge, 1981; Ander-egg, 1986), but have always demanded from the public sector that they transferred their knowledge quickly and for free. Something which is a normal praxis in some college labs, who in return get absolutely nothing from the private sector, not even equipment to carry out the experiments, for instance. Not for nothing some authors of semiotics call this activity dictatorial (Greimas), and the internal organizational chart of the command staff in certain multinational groups back up this statement. Currently it is easy to see how the main responsible for the financial and employment debacle in some Catalan or Lombardian provinces are the main directors of masters related to marketing and the textile world, in private or public teaching institutions. That is, that they in their centenary industries not only have not built research labs to increase the quality of their products and/or services, but they outsource this function to the state, through labs which are remote-operated from those industrial and business groups in exchange for solving related problems with a zero cost for them, getting potential staff for their facilities, participating in the profits of the courses, of the specialization where they participate (the students are customers in this stage, once training has finished, they are employees with garbage contracts in their national and international premises). Oddly enough, the university knowledge of those heads of service is equal to zero in the productive aspects such as CAD/CAM or style (the key sector of a textile industry), chemistry, computer science, telecommunications, etc. That is, their presence in these courses obeys to reasons of the making or the strengthening of the corporation image of the

Figure 8. In a textile firm, the CAD department is the main centre of CAM production. That is, computer graphics for the design of the clothes must meet the demands of the designers but the information must also be easy to understand for the operators who handle the looms. An interface of a textile CAD system.

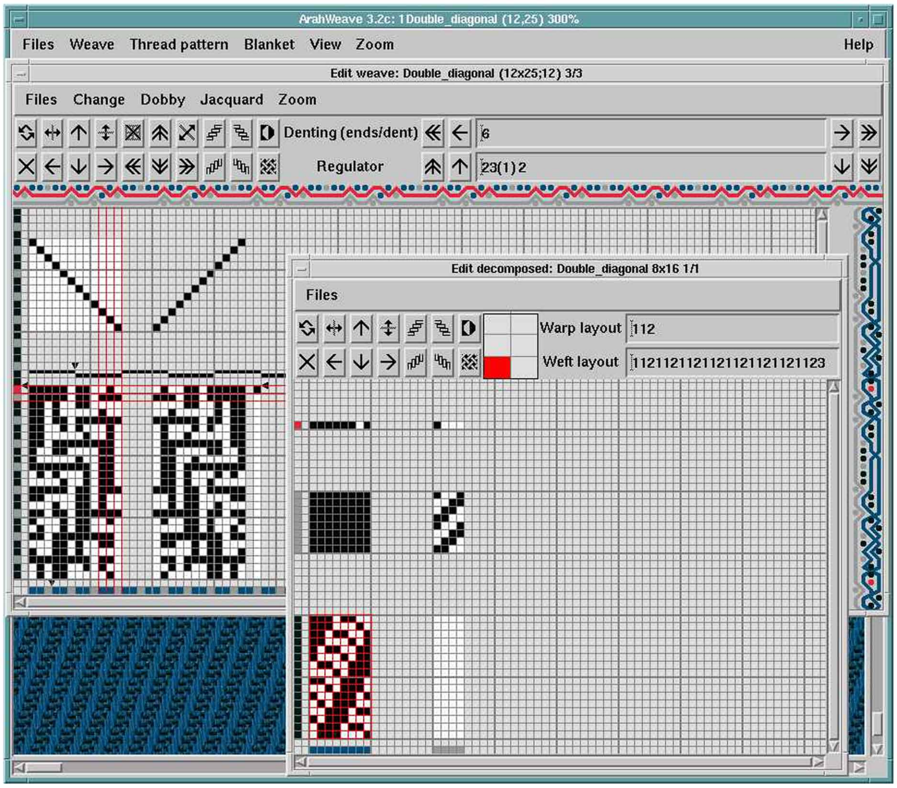


Figure 9. The looms tasked with carrying out the designed cloth

group: a general manager who is in charge of the high level courses in public universities, is a key to get important subsidies of the EU, whatever is the project they present from the private firm or industry. Even in entrepreneurial groups which invoice figures over 9 digits yearly, especially in the areas where the parochialism model enunciated by Cipolla-Ficarra prevails (Cipolla-Ficarra, 2014).

MARKETING AND NARCISSISM

Having in a territory real or virtual firms, centenary or not, which for marketing reasons are capable of blemishing the essential principles of the sciences is not positive. This negativity returns as if it were a boomerang, generating huge damages to the community where such institutions are involved, especially for the future generations. These drawbacks are magnified with the echo effect (the clients tend to associate the names of the cities with those products and/or services which prevail with some qualitative values) inside the global village and in the era of communicability expansion (Cipolla-Ficarra, 2010Cipolla-Ficarra, 2010). Marketing narcissism is easily recognizable in those institutions which display the number of employees the group has, the gross total that they bill per year, but do not display the number of employees the group has, the gross total that they invoice yearly, but not updated to the last balance sheets of the crisis times, pictures in their websites with the highest political or religious authorities, sportsmen, visits to arts exhibits, attendance to classical music concerts or singers of great fame, insertion of links to religious or public welfare, stress the presence of foreigners in their premises (as a rule, in environments where the discrimination rate of the workers is high, and besides they need to clean the image towards outside) promote the local press at the moment of the awards, make demonstrations of their products in environments or sites of a middle or high level, but locked to the general public and to the specialized press, constantly associate themselves to cultural events of national or international profile but not sponsor economically anything, etc. Evidently from image semiotics, it is very easy to analyze this narcissism (Ander-egg, E., 1986).

Narcissism on-line has been boosted through the Web 2.0. It is not hard to come across those Italian textile businesses which have motley links in each one of the channels or platforms of great circulation, such as Youtube for video, Wikipedia for textual contents, professional profiles in Linkedin, personal websites in Facebook, etc. In those examples we can find the narcissists firms or the professionals. In the case of the latter, imagination is the limit, since there is no legal barrier that can stop them. One of the negative consequences of the democratizing process of the Internet is that there is no way of controlling those who go from freedom to abuse with the purpose of performing narcissist marketing. Obviously the Italian textile sector like the rest of Europe is no exception to that reality.

The common denominator among narcissist firms and businesses is that they do not have the sufficient experience or knowledge to produce by themselves the hypermedia projects to promote themselves on-line. To the contrary, these are activities they outsource. The businesses will choose those who have won awards or are to be found far away from where they have their headquarters to prevent certain modus operandi from being " trustworthy collaborators ", A term that is continually repeated in the mountain areas of Southern Europe. It begs the rhetoric question: What secrets are there to develop a website in the textile or personal environment of those narcissists?

CONSEQUENCES OF OVERBLOWN NARCISSISM

Overblown nationalism is what sets in motion big projects in the ITC in the textile world, for instance.

There is no solid pre-planning in them and they haven't measured exactly the consequences due to the human and economic factors that may entail the lack of experience and authoritarianism, even inside those businesses who boast themselves of being centenary. The chaos is such that automatically the overall sales drop, because at the moment of launching a new managerial system, those allegedly responsible for the project have no idea of how to solve the smallest problems which these activities entail. We are describing a project of overall management (administration offices, sales, marketing, labs, design, etc. plus production) which may involve as many as three years of planning meetings and another three years of correcting the mistakes once it is running with a total figure of 150 users, inside and outside Italian borders. Obviously, a project that has been subsidized by the EU, although the industry bills per year 9 digits of euros. The strength of the marketing leads to the project being presented to the local media as the cutting-edge of world technology, because the software of the database is identical to that used in the US company Boeing. The reality is that it is an authoritarian scam, organized by the high industrial management, and its alleged heads to appease the talk of the town of the project's disaster.

In regard to authoritarianism in the fashion sector which was enunciated by Greimas (Nöth, 1995) in the framework of the new technologies, we have some good examples: a memo in late June with the message "no summer holidays" to tell the employees from a calculation centre that they have to sign acceptance of the cancellation of the summer vacation because of the project of the new managerial system, which will be implemented within 180 days. Other common malpractices are to look for scapegoats, that is, people inside the firm on whom to blame the dysfunctions of the new system, although they have never participated in the meetings or have the information to solve the problems of their sector, replacing all the computer hardware (including the servers, wiring and network switcher closets) because that may be the source which generates mistakes or may slow down the access to the databases, getting calls from the general manager on weekends to people alien to the project, such as the responsible for the database, because in the firm "nothing works" with the new managerial system. However, narcissism is such that even the general manager himself and the main shareholders will not admit the mistakes and will make pressure in the local industrial union so that the alleged brain of the project gets recognition in the shape of a "public award" for the excellent project it has been to set in motion the new managerial system, the advantages it means to the firm, spreading to the community where it is located (while the looms of the firm are taken out of the Italian borders, with the silence of the trade unions). Obviously, in the websites of that firm nobody will mention the waste of money in extra work hours to pay 50 technicians, analysts, systems engineers, computer and software who work simultaneously to avoid the entrepreneurial collapse and the stoppage of the production. Those who speak of the misfortunes experienced as a result of the lousy management of the launch will simply be excluded from the firm and will never again find a job in that community. The price to all the work done and the collaboration to solve other people's problems without having any information, is banishment or forced exile. At the same time, the local university will award the disastrous management of the general manager and those heading the project, leaving him space to teach a master and specialization programmes inside the textile sector. Obviously the external mask of the carnival of Venice or the mirage on-line can show some humanistic virtues, such as:

- Search of the common good and respect for the dignity of the human being since conception.

Figure 10. The interface of a new managerial system for a Lombardian centennial textile and it doesn't work at the moment of the switch on the new system (mistake messages)

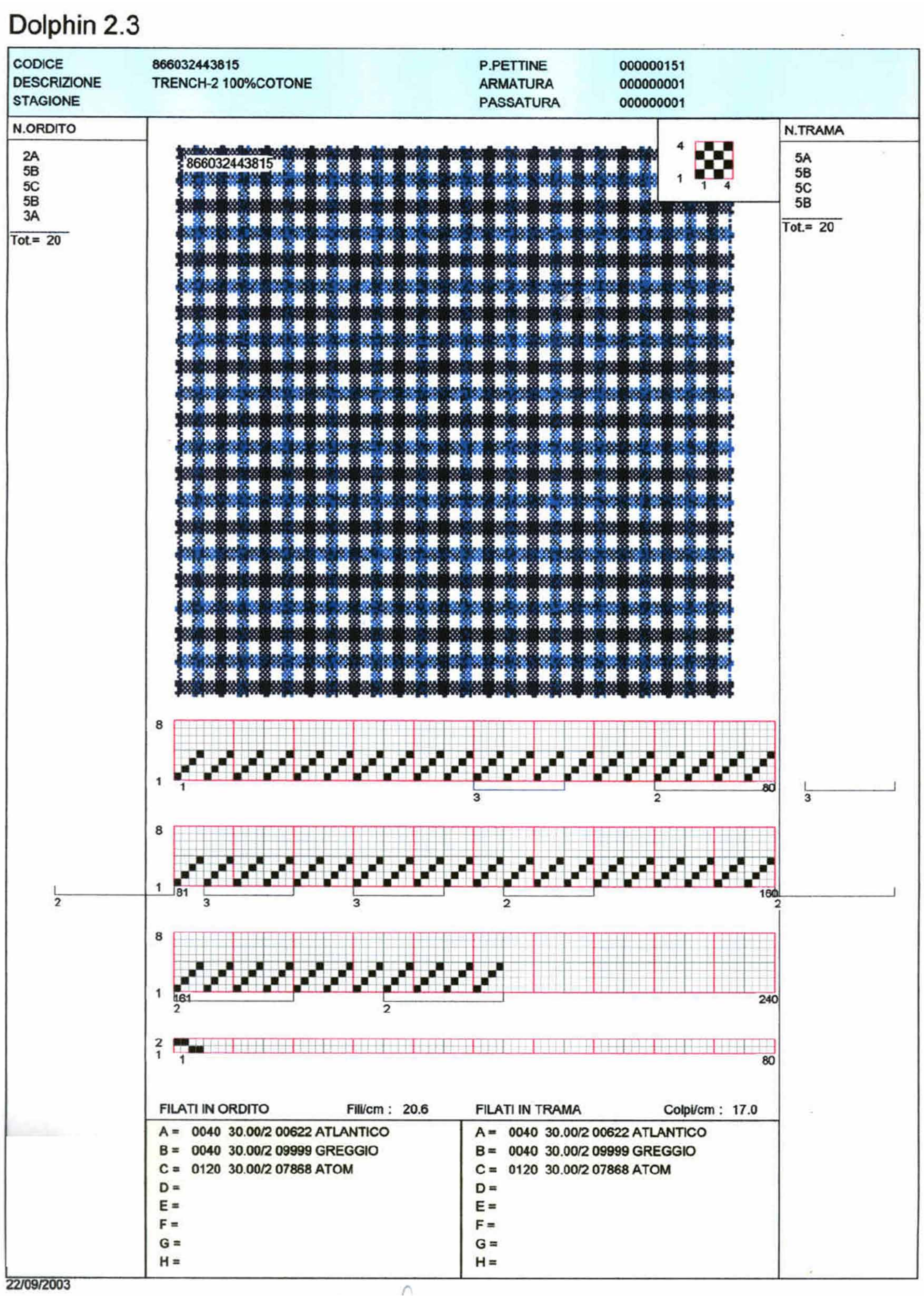


Figure 11. Technical information of the Italian CAD/CAM systems for the generation of clothes

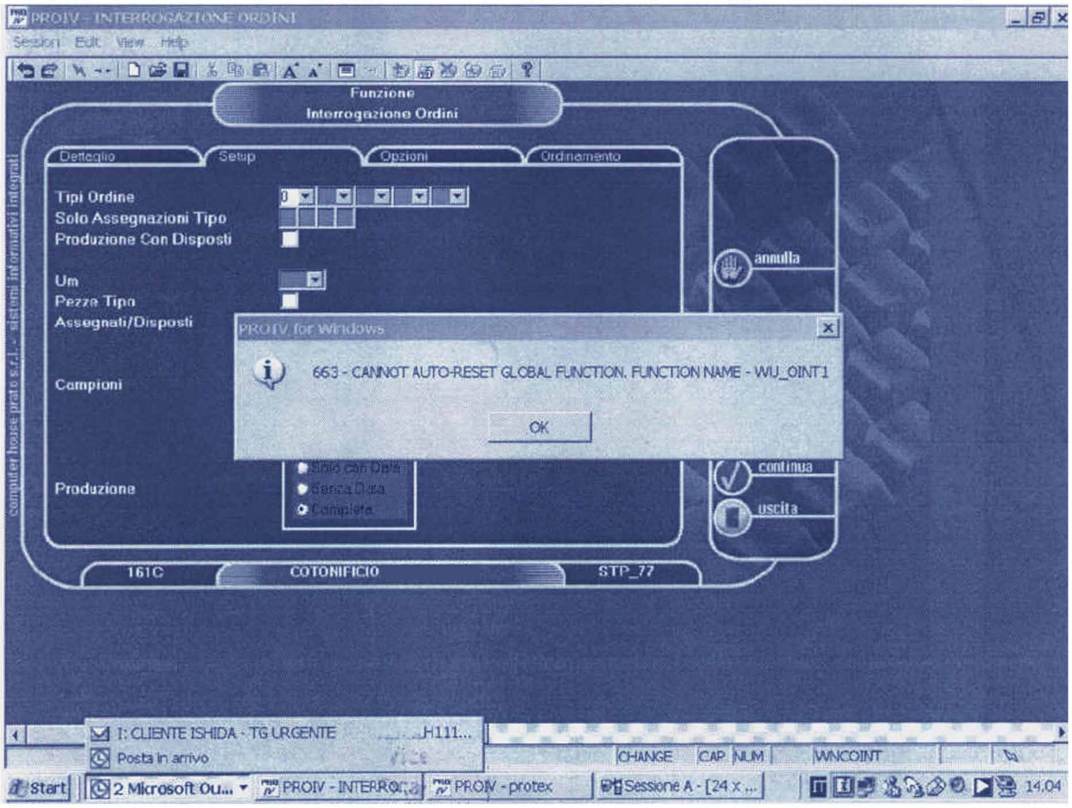
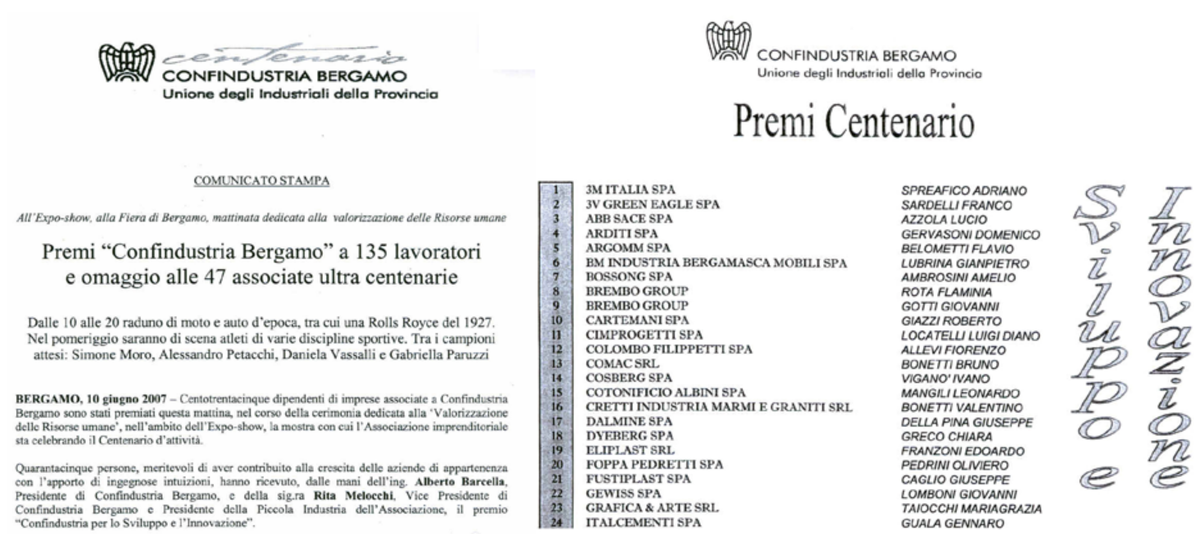


Figure 12. A management system for the textile industry which doesn't work but which has counted with resources from the European Social Fund. The main head of the setting in motion of the computer system is awarded by the local industrial union (section R&D), glossing over the severe human and financial damages brought about by that disastrous labour management. In short, a good example about the "parochialism" of the European textile firms.



centenario
CONFINDUSTRIA BERGAMO
Unione degli Industriali della Provincia

COMUNICATO STAMPA

All'Expo-show, alla Fiera di Bergamo, mattinata dedicata alla valorizzazione delle Risorse umane

Premi "Confindustria Bergamo" a 135 lavoratori
e omaggio alle 47 associate ultra centenarie

Dalle 10 alle 20 raduno di moto e auto d'epoca, tra cui una Rolls Royce del 1927. Nel pomeriggio saranno di scena atleti di varie discipline sportive. Tra i campioni attesi: Simone Moro, Alessandro Petacchi, Daniela Vassalli e Gabriella Paruzzi

BERGAMO, 10 giugno 2007 – Centotrentacinque dipendenti di imprese associate a Confindustria Bergamo sono stati premiati questa mattina, nel corso della cerimonia dedicata alla 'Valorizzazione delle Risorse umane', nell'ambito dell'Expo-show, la mostra con cui l'Associazione imprenditoriale sta celebrando il Centenario d'attività.

Quarantacinque persone, meritevoli di aver contribuito alla crescita delle aziende di appartenenza con l'apporto di ingegnose intuizioni, hanno ricevuto, dalle mani dell'ing. **Alberto Barcella**, Presidente di Confindustria Bergamo, e della sig.ra **Rita Melocchi**, Vice Presidente di Confindustria Bergamo e Presidente della Piccola Industria dell'Associazione, il premio "Confindustria per lo Sviluppo e l'Innovazione".

CONFINDUSTRIA BERGAMO
Unione degli Industriali della Provincia

Premi Centenario

1	3M ITALIA SPA	*SPREAFICO ADRIANO*
2	3V GREEN EAGLE SPA	*SARDELLI FRANCO*
3	ABB SACE SPA	*AZZOLA LUCIO*
4	ARDITI SPA	*GERVASONI DOMENICO*
5	ARGOMM SPA	*BELOMETTI FLAVIO*
6	BM INDUSTRIA BERGAMASCA MOBILI SPA	*LUBRINA GIANPIETRO*
7	BOSSONG SPA	*AMBROSINI AMELIO*
8	BREMBO GROUP	*ROTA FLAMINIA*
9	BREMBO GROUP	*GOTTI GIOVANNI*
10	CARTEMANI SPA	*GIAZZI ROBERTO*
11	CIMPROGETTI SPA	*LOCATELLI LUIGI DIANO*
12	COLOMBO FILIPPETTI SPA	*ALLEVI FIORENZO*
13	COMAC SRL	*BONETTI BRUNO*
14	COSBERG SPA	*VIGANO' IVANO*
15	COTONIFICIO ALBINI SPA	*MANGILI LEONARDO*
16	CRETTI INDUSTRIA MARMI E GRANITI SRL	*BONETTI VALENTINO*
17	DALMINE SPA	*DELLA PINA GIUSEPPE*
18	DYEBERG SPA	*GRECO CHIARA*
19	ELIPLAST SRL	*FRANZONI EDOARDO*
20	FOPPA PEDRETTI SPA	*PEDRINI OLIVIERO*
21	FUSTIPLAST SPA	*CAGLIO GIUSEPPE*
22	GEWISS SPA	*LOMBONI GIOVANNI*
23	GRAFICA & ARTE SRL	*TAIOCCHI MARIAGRAZIA*
24	ITALCEMENTI SPA	*GUALA GENNARO*

Sviluppo e Innovazione

- Search, transmission and communication of all truth.
- Honest dialogue.
- Charity and solidarity spirit.
- Academic excellence.
- Creative fostering of knowledge.

These are realities that beat science fiction by far. Evidently these are realities where the parochialism described by Saussure prevails (Saussure, 1990) and those responsible enjoy everlasting immunity, even legal, from the working point of view. One only needs to see the mobile publicity campaign (buses through the city where the university and those firms are) where the students are invited to enrol in textile engineering because they will have a creative future. Whereas the local reality is totally disastrous, since the industries dismantle the looms, and they take the production to countries where the cost of labour per hour doesn't reach 20 cents of US dollars and the parents of the potential textile engineering students are part of the dole. Besides, in it the lack of preparation of the internal staff, the lack of planning, the positive attitude of that who writes the message in assuming responsibilities totally alien to his/her knowledge with the purpose of preventing the paralysis of the firm, etc. are made apparent Perhaps a good summary is that which uses the author of it when he compares the heads of the project with the Paraguayan toucan (a big beak and little head). Of course the general manager was tricked into believing (Ramonet) that from a button in his computer keyboard he would have the whole reality of the industrial group in an interactive way and in less than a minute. Each one of those elements is hidden by the competent authorities, for instance, the trade unions. Or rather awarded by the academic authorities (dean or faculty deans) with textile specialization courses, when in fact we are in the face of the antimodels of European software engineering (Cipolla-Ficarra et al., 2011).

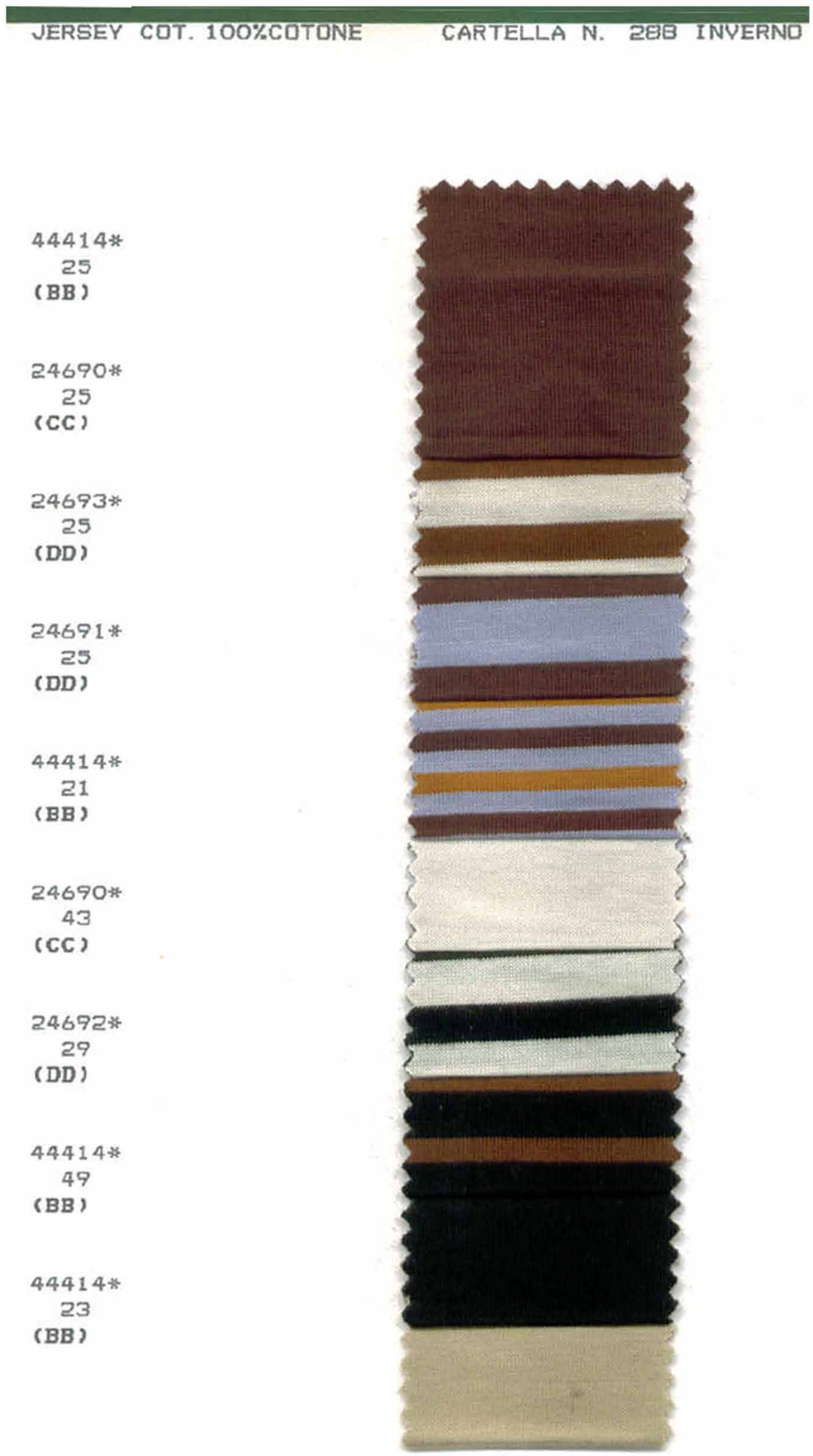
SOFTWARE ENGINEERING IN TEXTILE INDUSTRY: MODELS AND ANTIMODELS

The same as the advertisement which is constantly repeated in the different social media, that which generates profits without great changes is very positive for the coffers of a private or entrepreneurial activity. A golden rule which is also respected in each one of the statements which make up a textile industry structure. Not for nothing it is a productive sector where changes are introduced very slowly. That is, there is rather a gradual evolution in the long run than concentrated revolutions in a short period of time. The main reason is the software and the hardware inside the style department or design, from where the whole production process of the textile industry is born. In the narcissist businesses, it is possible to encounter a former mechanic, a musician, a baker, who do the job of designers of shirts, trousers, etc. drawing ideas out of English ties or searching in the centennial textile files belonging to bygone firms. In that context, the important thing is not to know, but being "trustworthy collaborators." They may well present the latest breakthroughs in computer design, that if those collaborators do not accept to have to study new functions of a CAD textile system, for instance, they will start the industrial sabotage process. However, these are human factors which currently escape the environment of software engineering and there are no qualitative metrics which determine the economic damage they generate in the short, middle and long term to the working institutions to which they are linked. Evidently, the previously mentioned examples are within the framework of the ICT (Information and Communications Technology) European antimodels, where the works made by some software scientists will never be able to wipe out that reality. Besides, the results of their works are ephemeral in the light of that reality, and unproductive, because they belong to the ivory tower of research. Scientific works which do not take into account extreme situations as those described above and which can only be detected with the communicability of the interactive systems, because they contradict the essential qualitative principles of software in the era of communicability expansion (Cipolla-Ficarra, 2010b).

DESTRUCTIVE STRATEGIES OF ICT BASED ON MARKETING

In this section we have examples where human factors are presented with the interaction of the simulation programmes of textile CAD. In geographical areas where parochialism prevails, at the moment of changing a CAD system because there is a change in the managerial system, it is necessary not only to demonstrate scientifically the breakthrough this will be for them, but also to detect those individuals who are a hindrance to technological advance, that is, the so-called "trustworthy collaborators". A pattern of behaviour which can not only affect the production, but even the sales turnover, that is millions of metres of tissues. One of the main problems of the textile sector is the sense of touch, since quality is tactile. Not for nothing in the design fairs where are presented the spring, summer, autumn and winter collections the sales agents are given small clothes books, so that the potential clients can touch them and make their orders. The traditional method consists in cutting a piece of the cloth and stick it in the order form. Evidently, the salesman who makes the sale through the iPod or the Tablet PC transfers telematically the order to the commercial department and from there towards stock or production in the case they didn't have that cloth in the store. One of the sectors which have more visual impact with the new technologies and in regard to the end client is the commercial department. They try to make a visual impact on foreign customers in the field of the latest technological breakthroughs. What those clients don't know is when the requested goods will reach them. The time factor is the reason why from the department and with the approval of the management it is decided to change the functioning systems of the firm, without evaluating at all the consequences in the design department. In the face of the threat of change and the need of keeping on producing, resistance to change inside the groups is generated. They are aware that they constitute the main link in the business food chain, that is why the printers where the clothes are simulated in 2D or 3D are the hobbyhorse between the cost department and the design or style department. Basically, this is due to the cost of the ink cartridges in the colour printers or the special paper they spend in the printing of the simulations, for instance. The ink cartridge printers are ideal for certain commercial software, for textile CAD and which work with images in the bitmap format for impression, most of them, or vectorial, to a lesser extent. From that moment the search for an economical solution is started by the head of the ICT, such as the colour laser printer to cheapen the costs, but then other human factors are added; technical-theoretical ignorance and the lack of responsibility in making decisions. In this way starts an endless loop in demonstrations and impression samples with different types of paper and printing to compare the shine of the printing, the quality of the colours, the simulation with special realism effects for the warp and weft in plain weaving, etc., attendance to the showroom of the main makers of international printers, because in their working philosophy it is the hardware that must adapt to the software and not the other way around, hiring of internal experts for specialized advice, reaching pseudo conclusions of the kind that there is no textile CAD that adjusts to the reality of the industrial group, etc. All of this generates a loss of time and increase of working costs which directly and indirectly have a repercussion on the production costs, when in fact they do not want to change their way of working, starting with the graphic design system for high range clothes for exclusive national and international customers.

Figure 13. Examples of presentation folders with real clothes aimed at the national and international commercialization. The buyers must touch the cloth before going on to the purchase of big bulks of cloth. This is the main and eternal limitation for e-commerce textile.



Now the images of the designs that are sent to production may make up an online catalogue for the potential customers. Those files with special clothes printers can be printed directly on cotton, linen, silk clothes, etc. Although in reality it doesn't work, and they are made with Egyptian cotton or from Sea Island (West Indian Sea Island), just to mention two types of high quality cotton. Even though we have the latest breakthroughs of interactive systems, the client always wants to have in his hands a sample of the real cloth. Consequently, the virtuality of the clothes inside the computer screens in 2D and/or 3D are only good to increase the realism of the computer animated.

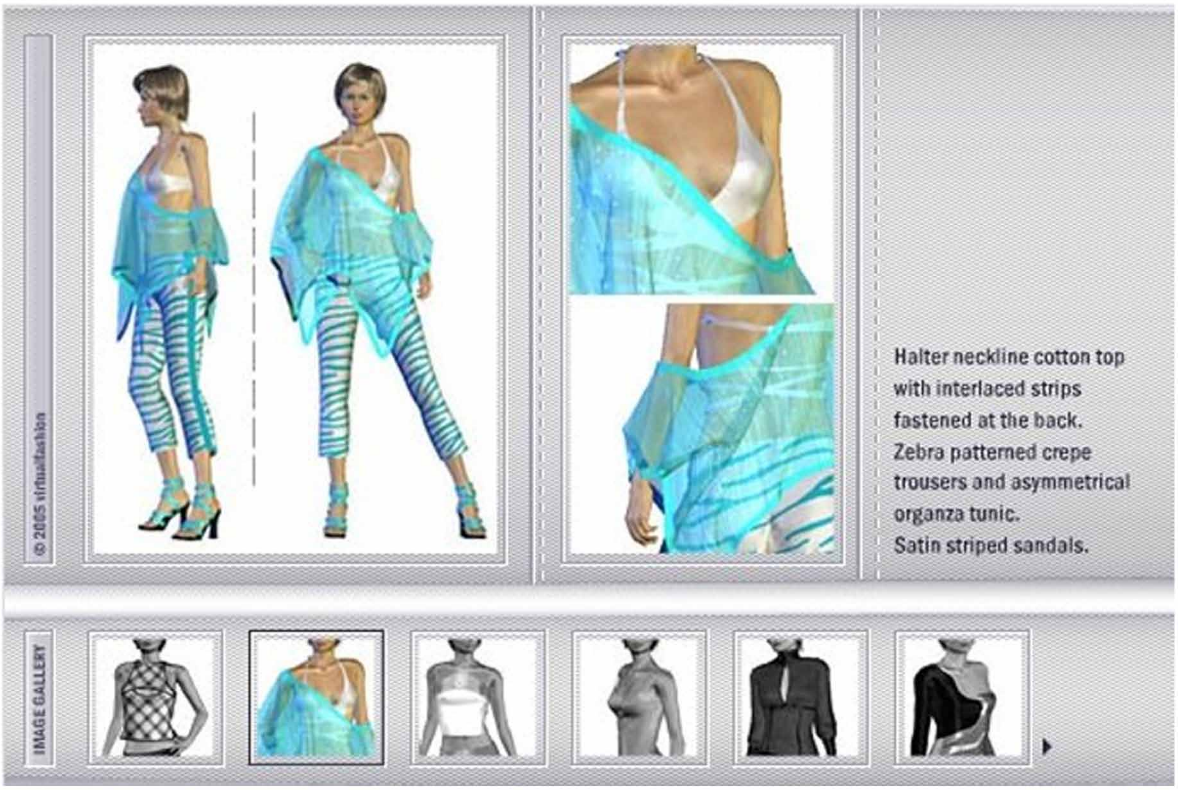
VIRTUAL PARADES

Virtual parades became fashionable in the last decade of the 20th century with the reduction of the prices of the software and hardware aimed at 3D (Carignan, Yang, Magnenat-Thalmann & Thalmann, 1992). In a personal computer and with graphic software it was possible to generate virtual parades of clothes, for instance. The commercial software 3D Studio allowed to work jointly with some free commercial textile applications (simcloth) or with contained cost (clothreyes). Aside from these economic differences, in the first the speed of the simulation of clothes was superior as compared to the second. Whereas in the Spanish application ClothReyes there are some options of realism stemming from the potentiality of the algorithms, since they can simulate even the tearing of the clothes. The problem in both cases lies in the fact that we are working with a plug-in, and therefore it slows down the rendering process. Evidently there are some strategies to solve these problems (Cordier & Magnenat-Thalmann, 2002; Vassilev, Spanlang & Chrysanthou, 2001; House & Breen, 2000; Pritchard & Heidrich, 2003; Ng & Grimsdale, 1996) but depending on the experience of the head to model and animate the virtual models. For instance, that the cloth is part of the tights of the body of the characters when we are working in the videogames environments, where action as a rule prevails over realism.

The first virtual models of the 90s were mannequins. The goal of this option is that of saving the production costs. The realism of the cloth is linked to the realism of the movements of the clothes while walking. They can also be linked to other atmospheric phenomena such as the wind or the rain, in the case of the flags, for instance, where there isn't only movement, but also the cloth's permeability factor. Here is where one can see whether the software has been developed with the technology of the firm that programs and markets it or whether there is a camouflaged transfer, from some sectors of R&D such as universities or public organizations (national, regional, local, etc.). Now realism on the bodies of the models was complicated at that time because of the software and hardware that was available, whether it is in the home context, as in the small firms of multimedia and/or graphic computing. The animation of the hairs, synchronization of the speech movements of the characters in the close range of the camera, the special effects that can be adjusted to the character who shows himself in a catwalk, etc., required many hours of final processing of the images. They required on top of that a prior analysis and solution of a myriad technical issues, through the incorporation of additional plug-ins, ad hoc. By that time the animators and programmers made real experimentation labs in order to look for solutions in the least possible time in 2D and 3D animation.

The realism of the cloth took a second place and only the textures applied to the characters could be seen from the editor of the materials of the commercial programmes related to 2D and 3D animation. Textures which were scanned with real tissues and introduced in the bookshops in bitmap or vector files. Other designs could stem from real designs made in stylists's paper or pictures of the real tissues. However, if we watch the children television series such as Musti,

Figure 14. An excellent 3D Spanish computer animation system for "virtual parades" (Cloth Reyes) made in the 90s where the high quality and low costs equation prevailed.



Nam-Gugu, Pororo, etc. and the animation films such as ToyStory, The Incredibles, Astro Boy, etc. (Cipolla-Ficarra, 2014), the textile issue is also left in the background.

Now textile CAD, by generating real simulation images which are used for the catalogues on-line of the marketing departments, may replace the obtainment techniques of clothes textures for the virtual characters. In this sense, the interested reader can look up the following bibliography where an interesting software is to be found.

Evidently, in the field of the centenary textile firm, where changing a managerial system entails 6 years per average, thus multiplying several times the initial budget, the lack of creativity prevented the setting in motion of virtual models for the marketing of its creations and clothes and only focused on placing catalogue textures in a vectorial format on shirts or trousers.

PECULIAR BUSINESSMEN FROM THE UNIVERSITY CLASSROOMS

In the 90s some Catalan university departments aimed at graphic computing and research subsidized by the EU used the small firms of friends and acquaintances to sell the works of students of the last courses of engineering and computer systems, software courses, etc. And also the doctoral thesis or the final projects submitted to get the masters in areas related to graphic computing and its wide range of uses: CAD, scientific visualization, mechanics, textile, etc. In this context textile was an issue that had to be developed by the college students because there were many local and international interests, to which the heads of the Catalan university departments had to respond, for instance. Departments could experience that research in the textile industry outside Catalonia. However, little by little, that centenary textile industry moved towards the north of Africa, and later on to the Asian tigers of the textile products. The reason is identical to the current one in the Lombardian textile sector and the rest of the EU, the lower cost of labour for the workers at the looms. Although the looms are automated to the utmost, the human factor is essential, as it is at the time of controlling visually with the human eye, each one of the tailored metres. It is a task where the human eye allows to maintain the high quality in those high range clothes in sewing and fashion.

Textile CAD is essential for the production of a textile industry (Dickerson, 1999; Hamilton, 1987; Cipolla-Ficarra & Ficarra, 2011). Here is the reason why the big industries are constantly interested in getting the latest breakthroughs in the matter of clothes simulation, especially on paper support for design or style. The algorithms of graphic computing successfully experienced from the Catalan public universities, for instance, and related to the hybrid lightning techniques, the solution of problems with the textures, the physical realism of animated objects, etc. Starting from these results which have been examined and counterchecked in real situations, among some members of the colleges and the small textile software firms. Between the two there is a kind of technological transfer with important profits for a part of the members of the whole environment of the development of graphic software. However, with a profit equal to zero to the university and remarkable costs, since they have put their facilities (software, hardware, spaces for the labs, etc.) and a pay equal to zero for those who have developed and verified the system with the graphic algorithms in real industries, that is, the students.

In those private firms they will take care of the marketing aspects of the product and they will have their network of distributors along the whole planet. The software will be updated in relation to the works the students make in the universities, but the students are totally unaware of this commercial dimension. The interesting thing would be to carry out in the future a diachronic and sociological analysis of the university environment in its peculiar Catalan context, since they succeed in selling those products to the world, including Lombardy, especially in the centenary businesses of the textile sector.

Those firms that serve as masks to the heads of the Catalan university labs start being just a small personal business of a friend under the formula of a limited partnership. Little by little, the pressure made from the think tanks of the traditional mass media, especially the newspapers with a big nationwide circulation, the specialized magazines, the national and regional TV stations, just to mention some examples, breed a bubble firm, controlled from the university. When said firm takes the focus of public attention, it is put up for sale. Once it is sold, the bubble bursts, since its products and services start to lose interest and nobody was really interested in what they market because they are partial solutions to complex problems, such as the textile CAD could be.

LESSONS LEARNED

The electronic marketing is influenced by a myriad human factors and the new technologies in the textile environment, especially in those industries known as centenary. It can be seen in them the lack of preparation or educational training of the members of the strategic sectors. A classical example is the style/design department or the calculation centre, made up by employees with professional training degrees or secondary school certificates in textile or computer science, for instance. The alleged solution of complex problems is in the hands of engineers or PhDs in engineering. They can do nothing to boost marketing on-line, for instance, due to the factors of resistance to change or industrial boycott. These are all human factors which are not currently considered in software engineering, especially in the quality issue. The distorting human factors are directly related to the parochialism that prevails in the mountain areas of Southern Europe, in our case the Pyrenees and the Alps. To such an extent that nobody is surprised by having a former mechanic without previous knowledge of the textile industry, copying or cloning the models of the English ties, former foremen of tire factories as manager of the department of design and marketing, ex-students of secondary school as heads of a calculation centre which keeps all the internal services of the intranet, extranet and internet through outsourcing. Realities which are also supported from the educational sector, since the deviations to the "trustworthy collaborators" are rewarded, and so they become a caste of hidden power inside the public and/or private institutions. It is them who decide whether the projects will abide by the established deadlines and also the success or lack of it in reaching the primary and secondary goals, in the times and costs that were agreed upon. The human factors of the textile sector in those geographic areas where the mountains prevail over the plains in the Southern Europe landscape will be the subject of future research from the point of view of social sciences.

CONCLUSION

The sale of textile products through the on-line hypermedia requires a series of new marketing strategies which little by little are being introduced in the graphic computing sector thanks to computer animations and the audiovisual culture. The textile marketing keeps on with the classical canon for sales, since the tactile factor is the stumbling block in the environment of the on-line hypermedia systems for the sale of clothes. The existing catalogues in some centenary firms only consist in putting up a 2D image of a textile product and inside it the different textures. That is, poor creativity and imagination solutions, in relation to the potentiality of the realism these images may have and the interest they may arouse in customers of the global village, especially in the era of communicability expansion.

However, we are facing a productive sector that is in itself slow to adapt to the new technologies because of a myriad factors which have been presented in the guidelines, which make up the first vademecum to better know the textile reality of the "Made in Italy" or "Style Italy". The origin of those problems is the educational context, added to the values and principles that should be respected especially in areas where parochialism and power castes inside and outside the centenary textile industries prevail. The listings of positive, negative, and neutral factors in the guidelines are an obvious example. A reality that will not be changed in the short term because it is cherished and boosted by the local educational environment, in the secondary as well as the professional and university institutions.

The economic situation brings about that the "Made in Italy" is being quickly replaced by the "Style Italy". That is, that the design or style is Italian, whereas the production hub may be in China, India, Turkey, etc. The weight of textile marketing in those peculiar industries falls not so much on the Internet, but rather in the centenary brands that have acquired their patents through the decades and have the licenses to product clothes under said patents (brands). Brands that are followed by the stylists, high level dressmakers, etc. and who constantly place clothes orders. The home market does not interest those centenary textile brands as much as the international scene. It is to the international market that they target their on-line and e-commerce marketing.

In few words, the invoice volume of the centenary textile brands in Southern Europe has stayed up because of international trade, the products are shown in international fairs of the textile sector, access to which is elitist, because it is restricted to the great customers only, the lack of university-trained staff is the common denominator, there are no real internal R&D labs, the mediocrity of the human factors makes the horizons be wider and jeopardize the "Style Italy, Spain, France, Germany, etc." ploy. In the current times of gaseous reality, even the centenary brands may succumb, as it happened to a myriad of real firms in the times of the virtual firms in the late 20th century and early 21st century. It is a shame they haven't developed research labs of cutting-edge technology or have staff with a high academic level, impervious to the destructive human factors of the so-called "trustworthy collaborators".

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KEY TERMS AND DEFINITIONS

Computer Graphics: Or graphic computing are graphics created using software and hardware. The use of a computer to produce and manipulate pictorial images on a video screen.

Computer-Aided Design (CAD): Is the use of computer systems to assist in the creation, modification, analysis, or optimization of a 2D and/or 3D design. A CAD system is a combination of software and hardware.

E-Commerce: Is trading in products and/or services using computer networks, such as the Internet, intranet and extranet.

Human Factors: Is a set of data and principles about human characteristics, capabilities, and limitations in relation to machines, jobs, and environments. It is a multidisciplinary field incorporating contributions from psychology, engineering, information design, industrial design, biomechanics, organizational psychology, social psychology, sociology, and physiology, for instance.

Interactive System: It is a computer device made up by a CPU and peripherals, whose functioning requires a constant interaction with the user. Currently these systems tend to their miniaturization, the mobility and wireless connectability among them.

Semiotics: The study or doctrine of signs, sometimes supposed to be a science of signs but not an engineering, for instance.

Software Engineering: Is the study and application of engineering to the design, development, and maintenance of software. Development of procedures and systematic applications that are used on electronic machines.

Textile Industry: The branch of industry involved in the manufacture of cloth. Traditionally, it is primarily concerned with the production of yarn, and cloth and the subsequent design or manufacture of clothing and their distribution. The raw material may be natural, or synthetic using products of the chemical industry. In short, it includes every business involved in growing or producing fibers, such as cotton growers and sheep farmers; those who make the fiber into thread; those who make the thread into cloth; and those who dye, bleach and finish the cloth.

Conclusion

We have started the transition between the era of the expansion of communicability towards the era of "quantic-nanotechnological-self-sufficient" communicability, in each passing minute the human being increases his dependence on the interactive systems in terms of daily business activities. In that process, the social networks have boosted the appearance of users who are unable to give the sufficient attention to the continuous reading of science fiction/geography/history/etc. the chapter of a book, or solving mentally simple arithmetic operations of addition, subtraction, multiplication and division. The latter are the real Achilles heel of many young users of the multimedia mobile systems, in terms of a last generation technological devices. Besides, the young users of the social networks prefer the photographic image to the text. Perhaps the theory of the minimal personal effort is what is intended to be promoted with certain interactive devices and contents. Many texts are organized in terms of a summed-up inverted pyramid of the late 90s with the expansion of the Internet, such as the audio communication, face to face, or through the voice, are replaced by the fragmented and manipulated image. The ultimate purpose is to narrate a delusional environment where the human being learns the use of the latest technologies and sets aside communicability. Usability and communicability are not synonymous in the online or off-line interactive systems.

These social facts lead us to the reality already told by Plato[1]: in the myth of the cave, in his 8th book from "The Republic." In it the Greek author explains his dual conception of the world and how a virtual man will be able to overcome the borders of all earthly things to reach the idea of the Good (in the social networks that should be the common good). However, as the same as with the slaves of the Platonic cave, those communicative distortions allow thousands and thousands of Internet users, allegedly to protect themselves in the anonymity of the networks for patterns of behaviour which go beyond sadism and fall inside the criminal field, the same being legally prosecutable offences in the legislation of many countries of Africa, America, Asia, Europe and Oceania. In others, even when a country is economically developed, true and full clarity communication shines though its absence, and many 'communicators' even have available informatics-legal services to erase the criminal deeds.

Now the term "alleged anonymity" is due to the fact that thanks to the new technologies of information and communication (NITC), even when a user erases a simple message from his mail square, he/she sends information to those who gather data about the potential clients of goods and services, for instance. In other words, it is possible to find out the timetable and days in which the user accedes his/her messages account, the daily frequency of those accesses, the messages read or directly wiped out, without reading them, and a long etcetera. It is not trivial, but with that simple information in the mail systems, one can already have a first profile of the users, to send them personalized publicity, without resorting to other channels or communication or computer science strategies (adware, pop-up, etc), such as the inclusion of his/her name in the social networks applications. Besides, a myriad of examples make apparent that belonging to certain virtual communities, apparently innocent, may be baleful consequences, because naively the door is opened to the cybernetic Trojan horse (patience).

In our days, billions of people interlink virtually among themselves through the applications of the social networks. These are applications born under the free software of computer programmers, distributed across our planet. The difference among them is that many lend their programming services for free. Others are paid through the private and/or public financial subventions, and/or with the R&D projects. Those subventions, like in the European case, which stem from the taxes paid, directly or indirectly, by millions of citizens who in our days are exponentially divided by the digital divide. That is, between those who can access the latest technological breakthroughs of the multimedia mobile phones and those who feel that they have enough merely with the traditional personal computers alone in the office or in the home, and who keep on using their personal agendas on paper support (more patience). Although a priori this last habit may seem prehistoric, it is the only and real way to protect yourself from the criminals of the international Garduña factor, for instance. That is to say, it is a choice aka; the non-participation in the social networks, as a measure of protection towards those people with whom there is a constant and a daily communication. Evidently, this means huge costs terms of non participation in the social networks. The same as with the computer viruses, the only way to avoid those viruses is not being physically connected to the net, whether it is intranet, extranet or Internet.

The same is great contradiction to the other technological advances, in the context of the communication and information of the social networks of the second decade of the new millennium. A contradiction which in our days (1960s-1990s) saw the final user as the controller of his decisions and in keeping with his free will, whilst travelling from the era of the expansion of communicability towards autonomous nanotechnology communicability, through the quanta computers. Currently there are other technological advances, which may lead millions of citizens to lose those freedoms that we all have until the present time enjoyed, such as can be inserting of video cameras or other devices into city drones (or flying spying cameras), so that a few, through the social networks and the quanta computers can control the daily activities of billions of people. In the history of human kind, the advances of the sciences are always very positive if the goal is the common good.

The problem lies in the authoritarian and mercantilist purpose of those who yearn to exert the power and control of said devices. In the chapters that make up the present compendium, it can be seen how its authors approach exceptionally and masterfully a diverse set of issues, all of them interrelated in a bidirectional way among themselves, when we refer to the social networks of the next decade. Lastly, a set of thoughts of thinkers for all those who work modestly and honestly whilst always guided by freedom: *It's a troublesome world. All the people who're in it, are troubled with troubles almost every minute. You ought to be thankful, a whole heaping lot, for the places and people you're lucky you're not.* (Theodor S. Geisel); *If a person offends, though you treat it light, and the quarrel you don't pursue, be on your guard and keep well alert, for whatever happens one thing's a cert: The person that's done you an evil turn will always talk bad of you* (Martin Fierro –José Hernandez), *If knowledge can create problems, it is not through ignorance that we can solve them (*Isaac Asimov); and *A little learning is a dangerous thing* (Alexander Pope).

ENDNOTE

Plato (2000). *The Republic*. Mineola: Dover Publications

Appendix 1: Social or Anti-Social Networking?

INTRODUCTION

Once again rhetoric serves to present some negative examples of the use of the net. Obviously, there are excellent examples from computer science, interactive design, HCI, etc. to social networking (i.e., Agarwal, et al, 2013; Billinghurst & Dunser, 2012; Hearst, 2011; Yin et al., 2012, Liu, Hansen & Tu, 2014; Morris, 2012; Roesner, Kohno, & Molnar, 2014), but in the examples that will be presented, all of them 100% true and stemming from the social networks, digital newspapers, entrepreneurial portals, personal messages or aimed at non-profit associations, among other modalities in which the files in ASCII format can be transmitted, make apparent the existence of negative patterns of behaviour in the era of the expansion of communicability (Cipolla-Ficarra et al., 2011). Although the data of the emitters of those destructive contents have been partially hidden, whether from the professional, economic point of view, etc., we are working on a methodology made up by a set of techniques where there is an interrelation between semiotics, computer science, digital photography, databases aimed at the online dynamic information, international juridical aspects, psychology and sociology mainly, in order to generate an automated listing of inclusion of those characters who should be excluded from the social networks, deriving from the detected patterns of behaviour. Now we submit some negative examples which will be included as universe of study and some recommendation for future researches.

BAD EXAMPLES

Banking Information

Financial companies who provide personal loans show a myriad of complaints in the social networks byin relation to the high costs of their services. However, inside the EU they use diverse commercial ploys such as change of name, although they belong to the same French banking group who keep (BNP Paribas –www.bnpparibas.com) own and control their mercantile activities (Figures 1 and 2).

Figure 1. Spanish portal which is called Cetelem (www.cetelem.es) and offers apparently a wide range of services to the consumers

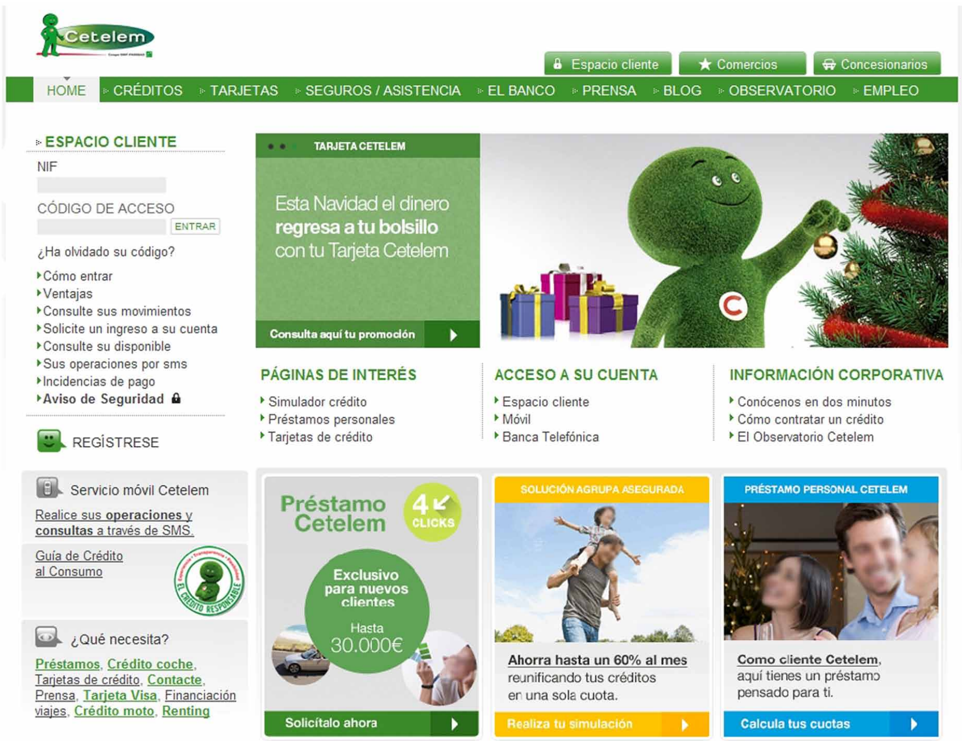

Figure 2. Italian portal (Findomestic –www.findomestic.it) where is promoted the use of credit cards which can turn into a constant source of usury to the customers

Digital Newspapers

The digital press resorts to the social networks to know the opinion of the readers and spread their contents. However, it is a manipulated circulation due to the topology of the different media of dynamic and static communication. For instance, in the figure a can be seen how a major scandal of political corruption is minimized by resorting to stars of international sports, and with the purpose of deviating the wrath of the readers (Figures 3 and 4).

Figure 3. The picture of a football star in Barcelona, Spain (Lionel Messi –right photography) accompanied by a Catalan policeman (Jordi Pujol i Soley –left photography) and tries to minimize the news of a multimillionaire fiscal fraud in Catalonia, Spain by an old ultra nationalist corrupt politician (www.elpais.es –07.28.2014)


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CAMBIOS EN LA MONARQUÍA »

El Rey prohíbe que la familia real trabaje para empresas privadas

NATALIA JUNQUERA | Madrid 262

Felipe VI encarga un código de conducta y una auditoría externa para La Zarzuela. Solicita también regular los regalos que reciben. Las medidas entrarán en vigor antes de fin de año

LA FORTUNA IRREGULAR DEL EXPRESIDENT »

Convergència anuncia una decisión sobre Jordi Pujol "en pocas horas"

MIQUEL NOGUER / MAIOL ROGER | Barcelona 88

ERC exige a la Generalitat que retire al expresidente todos sus privilegios, sumándose a la petición de Iniciativa y Ciutadans

Jordi Pujol, el pasado 26 de mayo. / QUIQUE GARCÍA (AFP)

La policía atribuye la fortuna de Pujol hijo a la "corrupción política"

J. GARCÍA / J. DUVA | Barcelona / Madrid 1070

Su riqueza no se justificaría en ingresos de la economía legal, sino en "el desempeño político de su entorno", asegura

El escándalo debilita al presidente

Lionel Messi en septiembre de 2013. / E. MORENATTI (AP)

El juez mantiene la imputación de Messi por fraude fiscal

REBECA CARRANCO | Barcelona

El magistrado afirma que el futbolista "podría haber conocido y consentido" el artificio para evadir

DEPORTES

El Atlético ficha a Griezmann

El club rojiblanco hace oficial la incorporación del atacante francés de la Real Sociedad

Mercedes apaga el fuego con gasolina

JOAN VILLADELPRAT

Hamilton no necesita una coartada para otorgarle un favoritismo a Rosberg

Charla con Oriol Puigdemont (En directo)

El francés más envidiado en julio

CARLOS ARRIBAS | París

Durante el Tour, Christian Prudhomme, su director, es el más poderoso

OPINIÓN

Rajoy y Mas

EDITORIAL

A la espera de comprobar el 'efecto Pujol', para evitar el fracaso hay que aplazar los desacuerdos

SÍGUENOS EN

EL PAÍS+

Ventajas para suscriptores

SUSCRÍBETE A EL PAÍS

INTERNACIONAL
ESPAÑA
Andalucía
Cataluña
C. Valenciana
Galicia
Madrid
País Vasco
Más comunidades
POLÍTICA
OPINIÓN
ECONOMÍA
TECNOLOGÍA
MOTOR
SOCIEDAD
DEPORTES
CULTURA
TELEVISIÓN

Figure 4. The chance to cast an opinion vote in the news through the comment and the effect it causes on the reader (I love it, I like it, It is the same to me, and it I anger me) as well as the option of spreading that news through Facebook, Twitter, etc. (www.lavoz.com.ar)

Digital Images

The use of the Flicker application to quickly insert photographies in the social networks, may have as a goal to disguise the acts of cyber terrorism where pseudo science and wild marketing have no boundaries. In these cases, such actions apply the old Spanish saying "dime con quien andas y te dire quien eres" (tell me who you go with and I will tell you who you are". In other words, the rest of the members of the group are naively integrated in the group of potential cyber destroyers (Figures 5 and 6).

Cyber Behaviour

Portals of an American association to inform about scientific news are used in the second decade of the new millennium by cyber terrorists with the purpose to destroy non-profit associations which work without any kind of prívate or public subsidy (Cipolla-Ficarra, 2012a; Cipolla-Ficarra, 2012b) (Figures 7 and 8).

Although the author issues a new communiqué in that same portal to leave theoretically without effect his previous message (we omit the message previously sent to the attorneys who follow this event) the damage can't be helped, since that same message is cyclically reused by other cyber terrorists in the social networks but in a private way (use of emails) to systematically destroy conferences (Cipolla-Ficarra, 2012a; Cipolla-Ficarra, 2012b) (Figures, 9, 10, 11, and 12).

Figure 5. A cyber destroyer/terrorist submits strategies to index R&D works in the scientific data bases

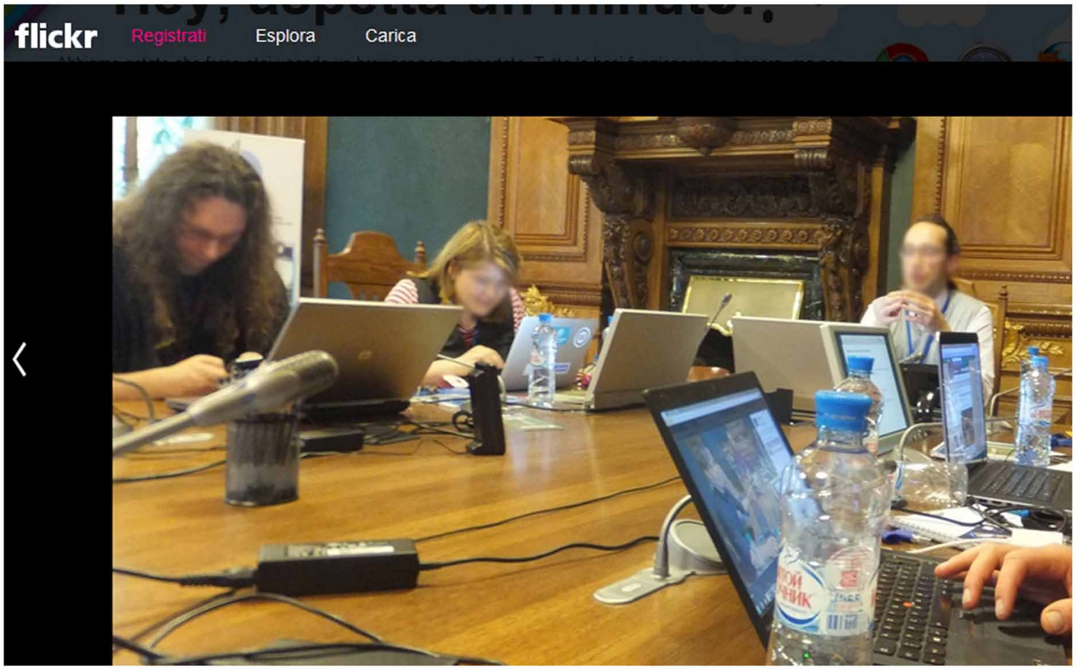


Figure 6. Constantly, the cyber destroyers see the evolution of the scientific data bases and the contents

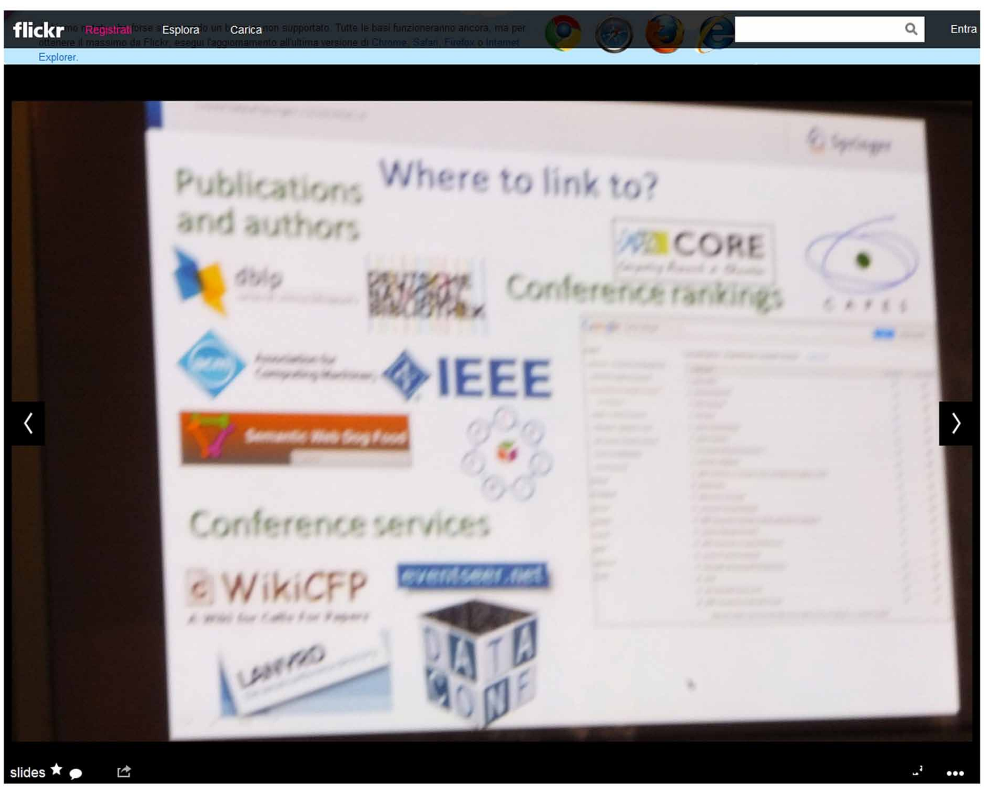
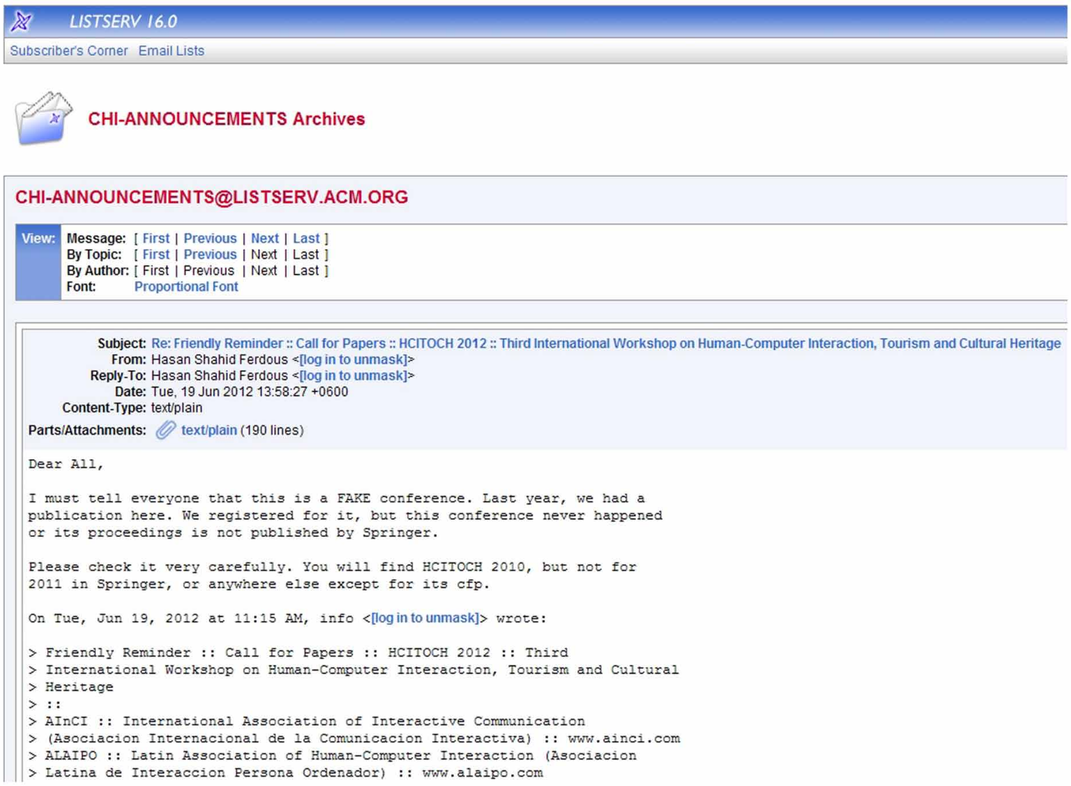


Figure 7. Smearing message of a student in the face of a "FAKE conference" (chi-announcements@ listserv.acm.org –06.12.2012). The work submitted to the alleged phantom event was published and indexed in the main scientific data bases.



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Subscriber's Corner Email Lists

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View: Message: [First | Previous | Next | Last]
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By Author: [First | Previous | Next | Last]
Font: Proportional Font

Subject: Re: Friendly Reminder :: Call for Papers :: HCITOCH 2012 :: Third International Workshop on Human-Computer Interaction, Tourism and Cultural Heritage
From: Hasan Shahid Ferdous <[log in to unmask]>
Reply-To: Hasan Shahid Ferdous <[log in to unmask]>
Date: Tue, 19 Jun 2012 13:58:27 +0600
Content-Type: text/plain
Parts/Attachments: text/plain (190 lines)

Dear All,

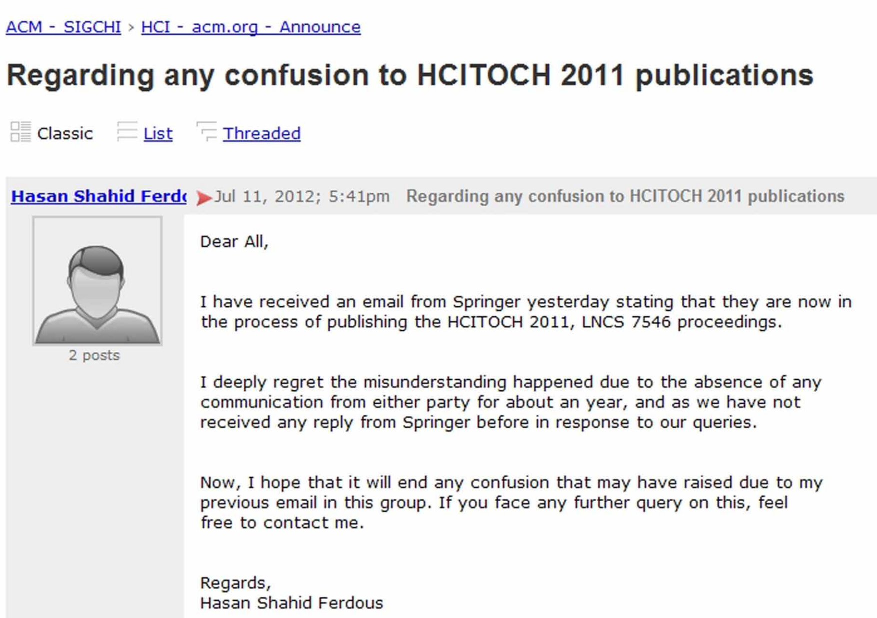
I must tell everyone that this is a FAKE conference. Last year, we had a publication here. We registered for it, but this conference never happened or its proceedings is not published by Springer.

Please check it very carefully. You will find HCITOCH 2010, but not for 2011 in Springer, or anywhere else except for its cfp.

On Tue, Jun 19, 2012 at 11:15 AM, info <[log in to unmask]> wrote:

> Friendly Reminder :: Call for Papers :: HCITOCH 2012 :: Third
> International Workshop on Human-Computer Interaction, Tourism and Cultural
> Heritage
> ::
> AInCI :: International Association of Interactive Communication
> (Asociacion Internacional de la Comunicacion Interactiva) :: www.ainci.com
> ALAIPO :: Latin Association of Human-Computer Interaction (Asociacion
> Latina de Interaccion Persona Ordenador) :: www.alaipo.com

Figure 8. A new message from the student, after the legal interventions



ACM - SIGCHI › HCI - acm.org - Announce

Regarding any confusion to HCITOCH 2011 publications

Classic List Threaded

Hasan Shahid Ferd Jul 11, 2012; 5:41pm Regarding any confusion to HCITOCH 2011 publications

2 posts

Dear All,

I have received an email from Springer yesterday stating that they are now in the process of publishing the HCITOCH 2011, LNCS 7546 proceedings.

I deeply regret the misunderstanding happened due to the absence of any communication from either party for about an year, and as we have not received any reply from Springer before in response to our queries.

Now, I hope that it will end any confusion that may have raised due to my previous email in this group. If you face any further query on this, feel free to contact me.

Regards,
Hasan Shahid Ferdous

Figure 9. A new example of the "Garduña Factor", which is not stopped because of the lack of legal systems in keeping with the damage they cause (08.12.2013)

Subject: Fake Conference in Maribor?
From: Keith Andrews <kandrews@iicm.edu>
Date: 8.12.2013 20:28
To:

Dear Borut,

Sorry we missed each other on Thu. I think my talk went down well, there were certainly plenty of questions.

I wanted to let you know about an upcoming conference in Maribor:

MSIVISM 2014
http://www.ainci.com/MSIVISM/MSIVISM.html

The web site carries the logos of both the University of Maribor and the faculty (FERI).

Unfortunately, I believe this might be a fake conference (search on google for "fake conference"), based on the following indicators:

o The list of topics covers pretty much the whole of computer science.

o Author notification is 7 days after the submission deadline (that is completely unrealistic for serious peer review).

o A similar conference by the same organisations (AInCI and ALAIPO) HCITOCH 2012 was apparently fake:
http://comments.gmane.org/gmane.comp.hci.acm-sigchi.announce/9317

You might want to check it out for yourself and reconsider any involvement.

Best regards,

Keith

--

Keith Andrews IICM, Graz University of Technology, Austria

http://www.iicm.tugraz.at/keith "No wild kangaroos in Austria"

Figure 10. Example of the irreparable damage with relation to other international events ADNTIIC 2012, HCITOCH 2012, SETECEC 2012, etc., by introducing the initials in Google, with the association of the negative promotion since the publisher

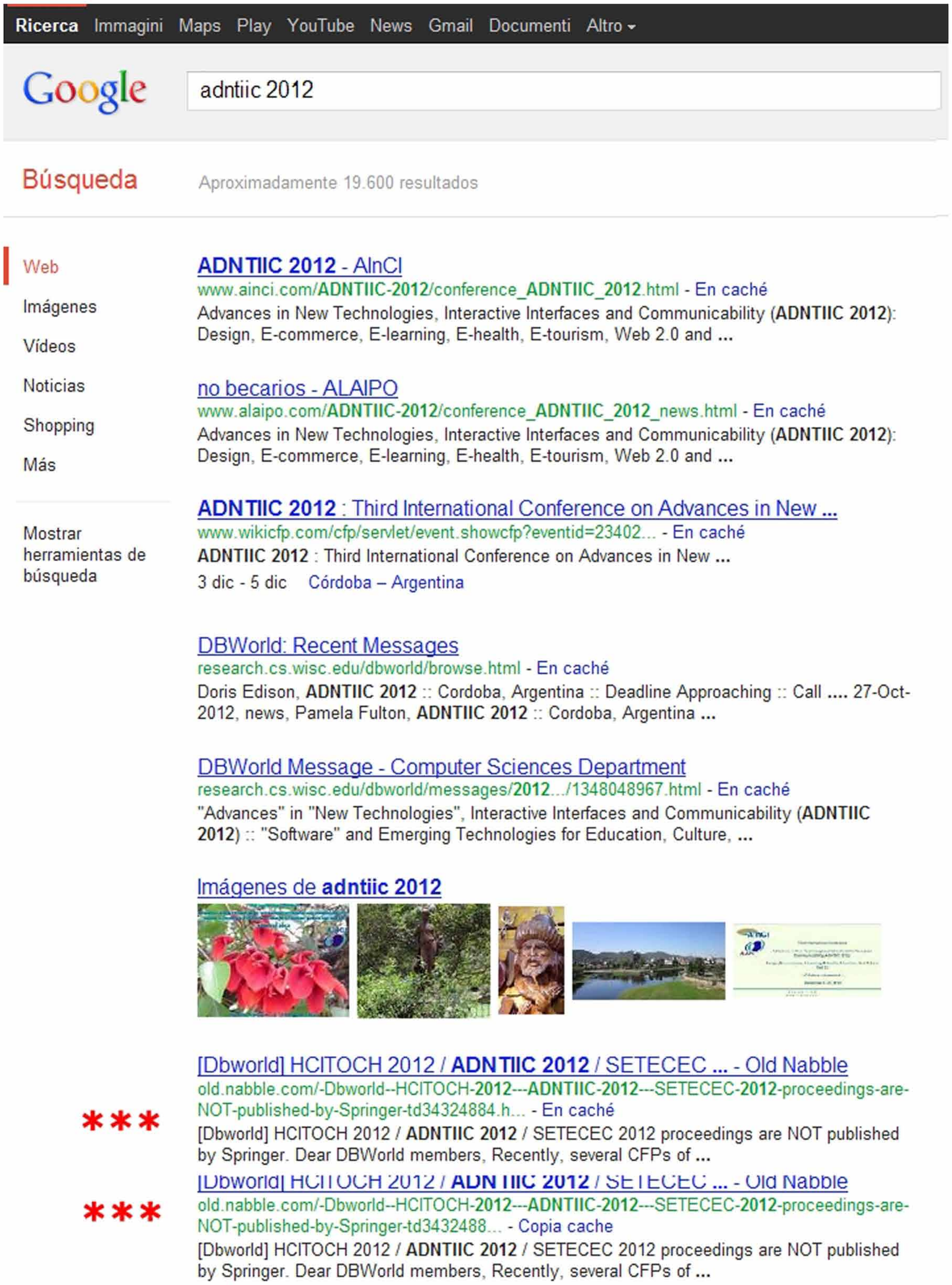


Figure 11. The asterisks indicate the association of images of the event to the destroying message

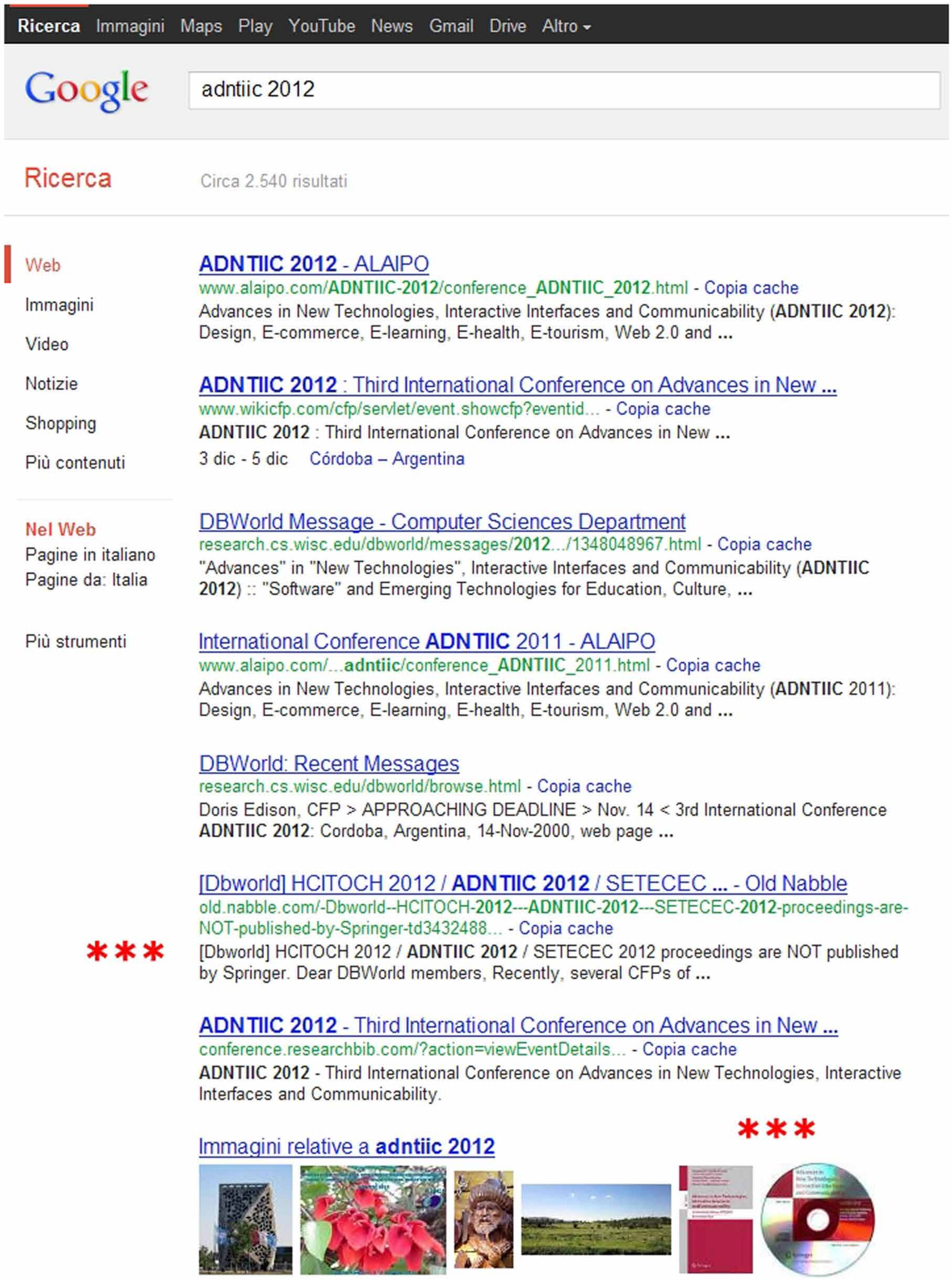


Figure 12. The logos of the institutions where the cyber destroyer allow them to establish a geographic map. In the example, there are interrelations between Catalonia (Spain), Lombardy, Trentino-Alto Adige/ Südtirol (Italy), etc

Partners

UNIVERSITÀ DEGLI STUDI DI TRENTO	University of Trento **(Project coordinator)**	Competences in knowledge management and assessment, software engineering, Web technologies.
Springer	Springer Verlag	One of the leading company in publishing scientific papers and books.
CSIC	Consejo Superior de Investigaciones Cientificas (CSIC)	Competences in social networks, trust and reputation.
Institut | Nicod	Jean Nicod Institute	Philosophers with competences in epistemology of IT.
	University of Fribourg	Competences in modeling and analyzing competing behaviors of scientists.
UNIVERSITY OF TARTU	University of Tartu	Competences in social network analysis.

Collaborations

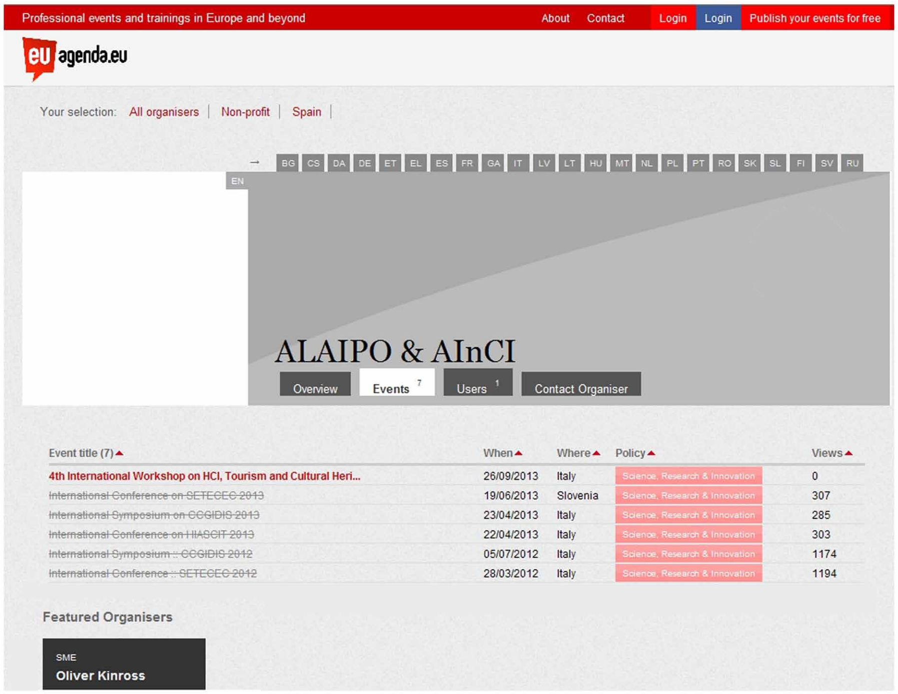
ICST.ORG	ICST	The Institute for Computer Sciences, Social Informatics and Telecommunications Engineering (ICST)
CREATE-NET	Create-Net	Center for REsearch And Telecommunication Experimentation for NETworked communities

Statistics and Information Access

The destroying effect of the social networks in the organization of international events can be grasped through the access statistics to the portals where there is an earnest control of the visitors. An aimed and well organized attack for the purpose of destroying modest and honest working groups in the context of the new technologies (Figure 13).

Some of the distortions of cybernetic behaviour can be detected in the counters. It is the increase of those counters that produce the dynamic persuaders or the spooling phenomenon in the social networks (Cipolla-Ficarra, 2011). We understand by spooling the generation of a wide network which in contrast to the spiders that produce it in nature the cyber destroyers only try to occupy the largest extension possible in the analogical and digital communication media in the least possible time and with costs equal to zero resorting to parochialism. From the university pressure is exerted so that the tests with disabled people or in religious bodies and that these activities are promoted in the press. This exercise pressure towards the analogical and digital press has been, is and will be the common denominator in universities where mercantilism prevails over education (Cipolla-Ficarra et al., 2012b). Studies carried out quite some time ago demonstrate that there are relationships between those centres of studies such as Pompeu Fabra University (Departament of ITC) in Barcelona (Spain), and/or University of Bergamo (Department of Human and Social Sciences) and IULM (University of Languages and Communication –Departament of Classics, Humanities and Geography) in Milan (Italy). The influence on the traditional social communication media is such that banal research projects in a news format can allegedly have more visitors

Figure 13. Drop of the total of potentially interested in the international events inside the European borders. For instance, in the International Conference on SETECEC 2012 (1,194 visitors) it has gone down to 307 (SETECEC 2013), which implies a 75% less. The authors of the online attacks are totally immune to the European laws.



than the main news of the day, in big newspapers like El País in Spain (Cipolla-Ficarra et al. 2011). The term alleged refers to the fact that there are groups of users who devote themselves to increasing the news counters akin to the interests of the information pressure group (Figures 14, 15, 16, 17, and 18).

The lack of university controls in Europe will reward such behaviour with the title of PhD. Evidently, these figures show how the social networks facilitate the falseness of the online information and increase the "Garduña Factor" (Cipolla-Ficarra, 2013) of their members in view of the eternal legal immunity.

Internet Search Engines

The searchers like Google may serve to the cyber destroyers to the purpose of associating criminal figures and information, totally alien and ignored by the victims, with the destroying purpose of the professional prestige in the global context and inside the social networks. Obviously, carrying out those links entails a previous online criminal work by the cyber destroyers (Figure 19).

Searching engines do not find the websites and in other cases they control automatically whether the portals are online or not (Figures 20 and 21).

Figure 14. A dynamic persuader who places visible counters (manipulated manually) and invisible for the users

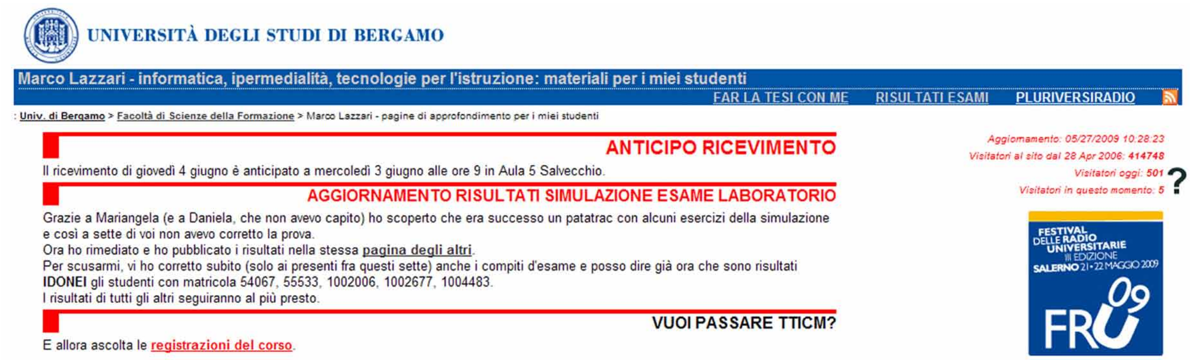


Figure 15. A follower of that dynamic persuader turns into a "spider for spooling" through a mini Project subsidized with social funds (Google, all the pages with the same people)

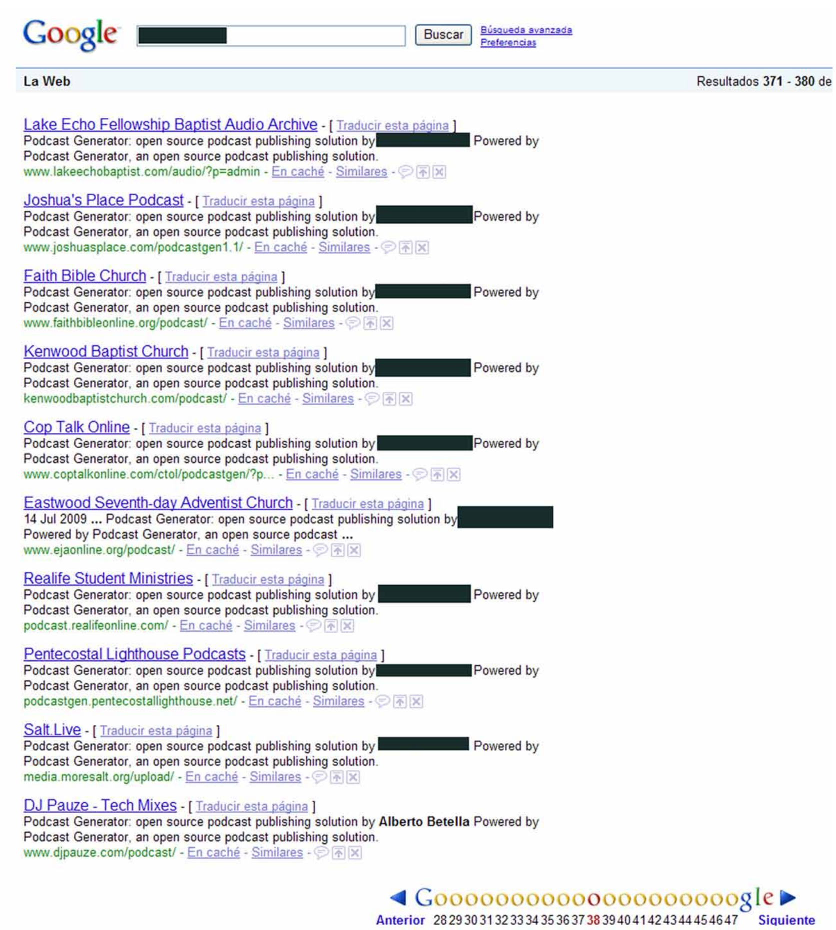


Figure 16. The student traditional mass media to the service of a dynamics persuaders for a social networking control (www.studenti.it –01.042007)

LA STORIA IL FATTO

PODCAST generation

Da Nord a Sud si moltiplicano le università che ***mettono a disposizione sul web le lezioni*** *per riascoltare ed integrare ciò che si è ascoltato o si è perso*

DI ROCCO ROSSITTO

La strada che sta lentamente portando all'uso del podcasting all'interno dell'università italiana passa anche attraverso piccoli episodi. Giustino Di Cunzolo è uno studente della facoltà di Architettura L.Quaroni di Roma, alunno del professore Antonino Saggio apripista del fenomeno in Italia. Giustino racconta che "durante la pausa tra la prima e la seconda parte di una lezione il professore di solito controlla che la registrazione esista e sia corretta. Una volta si stava già disperando per aver perso un'ora e mezza di lezione, ma fortunatamente una collega, pur non conoscendo questa peculiarità del corso, aveva l'abitudine di registrare le lezioni. Quindi la sua registrazione è andata a colmare quella mancante del professore".

Scene di quotidiana vita universitaria che raccontano come il fenomeno sia tutt'altro che sconosciuto allo sgangherato mondo dell'università italiana. Tanti sono infatti gli atenei in cui vengono messi a disposizione degli studenti dei servizi di podcasting, che, come lo definisce Wikipedia, "è un

Figure 17. The newspapers to the service of a dynamics persuaders –university endogamy) and the spooling spider (www.ecodibergamo.it –11.06.2014)

L'ECO DI BERGAMO.it

METEO OGGI DOMANI DOPODOMANI

BERGAMO CITTÀ | HINTERLAND | BASSA BERGAMASCA | ISOLA | LE VALLI | ANSA

HOMEPAGE | CRONACA | ECONOMIA | CULTURA E SPETTACOLI | SPORT | FOTO | VIDEO | RUBRICHE

L'Eco di Bergamo > Cronaca

CHI SIAMO | ABBONAMENTI | PUBBLICITÀ | NECROLOGI

[redacted] lascia l'Università Insegnerà allo Iulm di Milano

Mi piace Piace a 5 persone. Iscriviti per vedere cosa piace ai tuoi amici.

Tweet 0

6 novembre 2013 | Cronaca | Commenta

[redacted] ha lasciato l'Università di Bergamo per lo Iulm (Libera Università di Lingue e Comunicazione) di Milano. Un addio in sordina per uno dei docenti più noti e prestigiosi dell'ateneo orobico. Il professore – filosofo e teorico del Costruttivismo e del Pensiero complesso – ha dato un contributo importante alla nascita del polo umanistico di Sant'Agostino.

È stato prima preside della neonata Facoltà di Lettere e Filosofia dal 2001 al 2005 e poi alla guida della Facoltà di Scienze della Formazione dal 2005 al 2008. La notizia della sua partenza è giunta inattesa in ateneo solo pochi giorni fa.

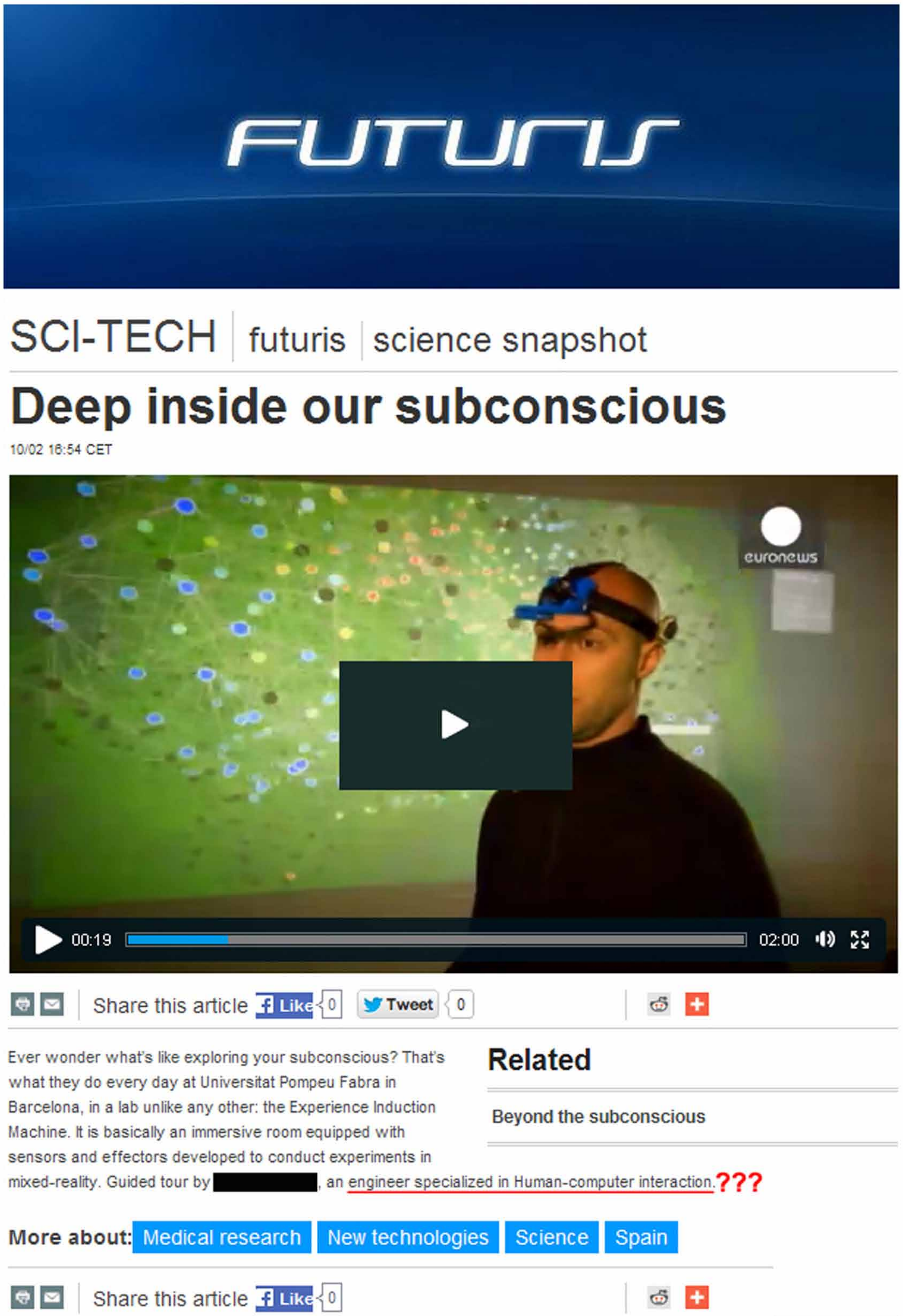
[redacted] senatore del Pd dal 2008 al 2013, era rientrato in Università lo scorso aprile a fine legislatura senza però dedicarsi all'insegnamento, in quanto l'anno accademico era già in corso. Sarebbe dovuto tornare in cattedra quest'anno come docente di Filosofia della Scienza nei

Oggi in Edicola

L'ECO DI BERGAMO

Che schiaffo all'Inter

Figure 18. The tops of the spooling spider is to reach the Paneuropean communication media such as the Euronews channel where he/she is presented with false academic titles, such as a HCI engineering when no centre of studies where he/she has worked has such a title



FUTURIS

SCI-TECH | futuris | science snapshot

Deep inside our subconscious

10/02 16:54 CET

euronews

00:19 02:00

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Ever wonder what's like exploring your subconscious? That's what they do every day at Universitat Pompeu Fabra in Barcelona, in a lab unlike any other: the Experience Induction Machine. It is basically an immersive room equipped with sensors and effectors developed to conduct experiments in mixed-reality. Guided tour by [redacted], an engineer specialized in Human-computer interaction.???

Related

Beyond the subconscious

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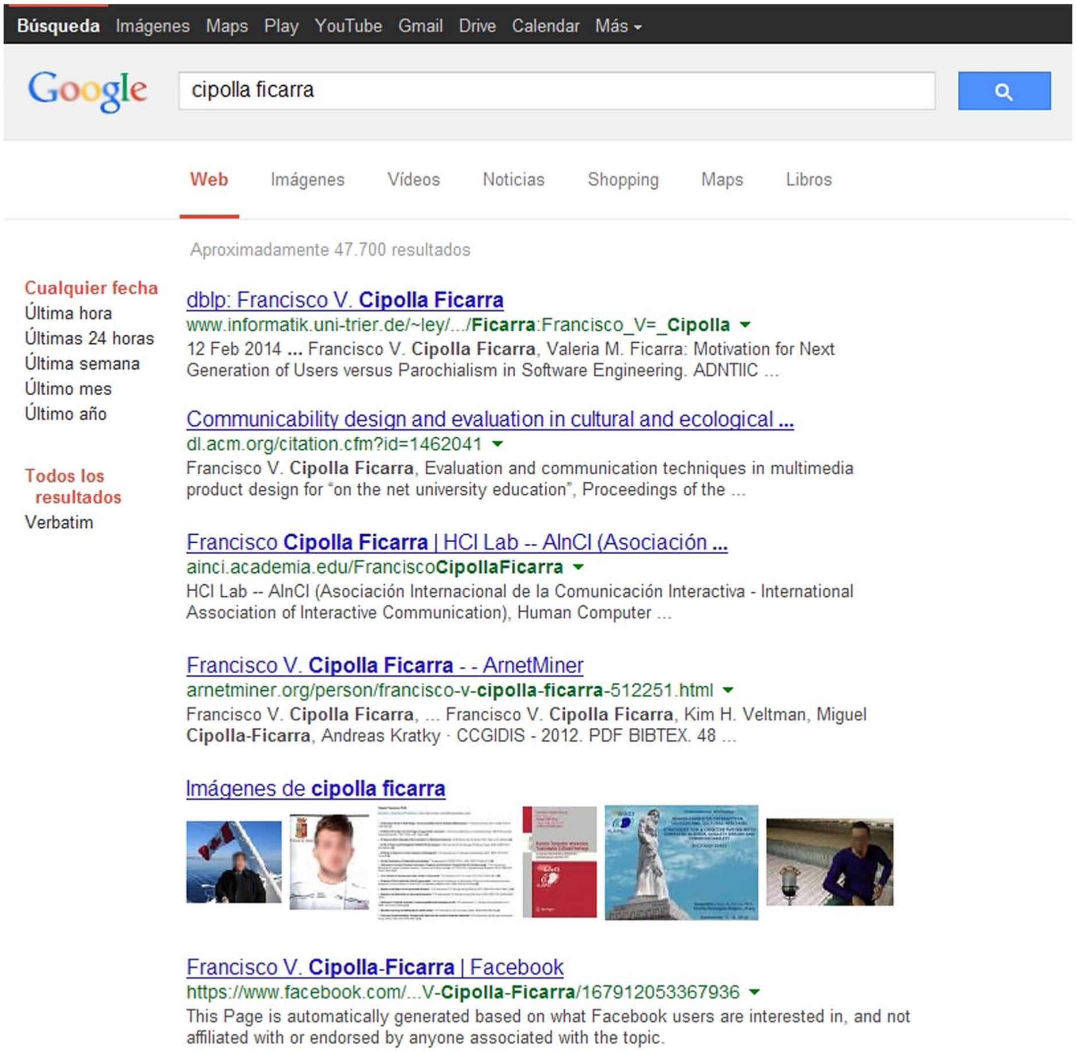
Figure 19. Incorporating the names and/or surnames of a person it is feasible to see how in the section of photographs that person is associated to other photographs of young people in the example of the figure, who have committed offences registered by the police where the victim usually resides.



International Events

Use of the social-scientific portals to issue the information of the smearing campaign against the organization of conferences in the USA. The serious accusations have forced (a first) the cancellation of the event (Figures 22, and 23).

Disguised war in the portals of diffusion of news of scientific events whose main topics are the interfaces, graphic computing, the networks, the databases, etc. to destroy events where the equation quality-price is exponentially superior to other similar events organized or fostered by foundations or universities. For instance, events where the participation can range between the 700-1000 euros when in fact they surpass in 100 or 200% the real costs (Figure 24).

Figure 20. Yahoo doesn't find the website

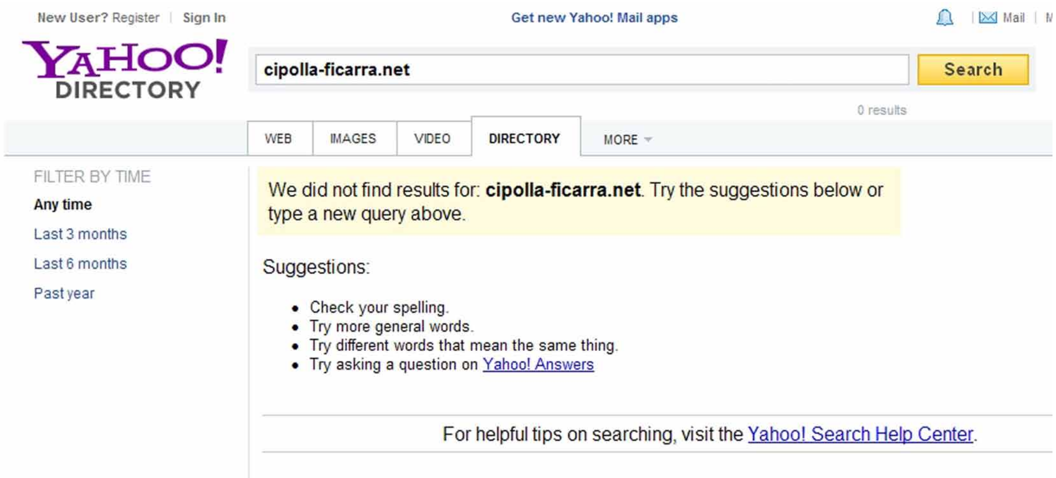


Figure 21. Automatic control of the activation of a website

Figure 22. News of the closure of the conference (https://research.cs.wisc.edu/dbworld)

Sent	Message Type	From	Subject	Deadline	Web Page
29-Jan-2013	conf. ann.	Paolo Missier	Call for Participation: BigPROV Workshop @EDBT'13: Managing and Querying Provenance Data at scale	22-Mar-2013	web page
29-Jan-2013	conf. ann.	Filip Zavoral	CfP - Intelligent Distributed Computing - IDC 2013, Sep 4-6, Prague	1-Mar-2013	web page
29-Jan-2013	conf. ann.	AMG Solo	World's Biggest Computer Conference WORLDCOMP is Canceled	1-Aug-2013	

Figure 23. Defaming message where underlies a wild and non-transparent commercial policy to draw potential customers at the moment of the publication of the proceedings

World's Biggest Computer Science Conference WORLDCOMP is Canceled

The world's biggest computer science conference WORLDCOMP is canceled after twelve successful years of service. Defamation campaign is going on WORLDCOMP:
https://sites.google.com/site/dumpconf or
http://dumpconference.ueuo.com or
https://sites.google.com/site/moneycomp1 or
http://weka.8497.n7.nabble.com/WORLDCOMP-World-s-Biggest-Bogus-Conference-is-Back-Again-td26681.html or
Google using the words worldcomp, fake or worldcomp, bogus.

We filed lawsuits in 2012 to stop this defamation but no use. Due to this, we are finding it highly difficult to get paper submissions, sponsors, etc. We are determined to solve this problem permanently through legal channels. We are focusing all our efforts on legal matters and that's why we canceled WORLDCOMP'13. We update WORLDCOMP's website also, once we complete some legal/technical formalities.

As ordered by the University of Georgia, Prof.Hamid Arabnia (http://www.cs.uga.edu/~hra WORLDCOMP coordinator) is refunding half the amount of the registration fee for all the registered authors of WORLDCOMP from 2005-2012. If you are a registered author and your physical address is changed then send an email to hra (AT) cs.uga.edu and CC to morehead (AT) uga.edu with your name, year, paper title, list of all co-authors of the paper, the amount of fee you paid, and the new mailing address for sending the refund check. The deadline to email this information is one week from now. Please forward this email to all your friends who have papers in previous WORLDCOMPs.

Sincerely,
AMG Solo (Ashu Solo)
https://www.jiscmail.ac.uk/cgi-bin/webadmin?A2=BIOFUSION;f9748581.0705
(WORLDCOMP publicity chair since 2005)

Figure 24. Events which are promoted in a bellicose way in the social networks because their costs surpass in around 100 or 200% the traditional prices (www.fbk.eu and/or/ iswc2014.semanticweb.org)

Figure 25. The author who appears in the figure doesn't have any official account in that application to avoid that the people who were linked to it were attacked

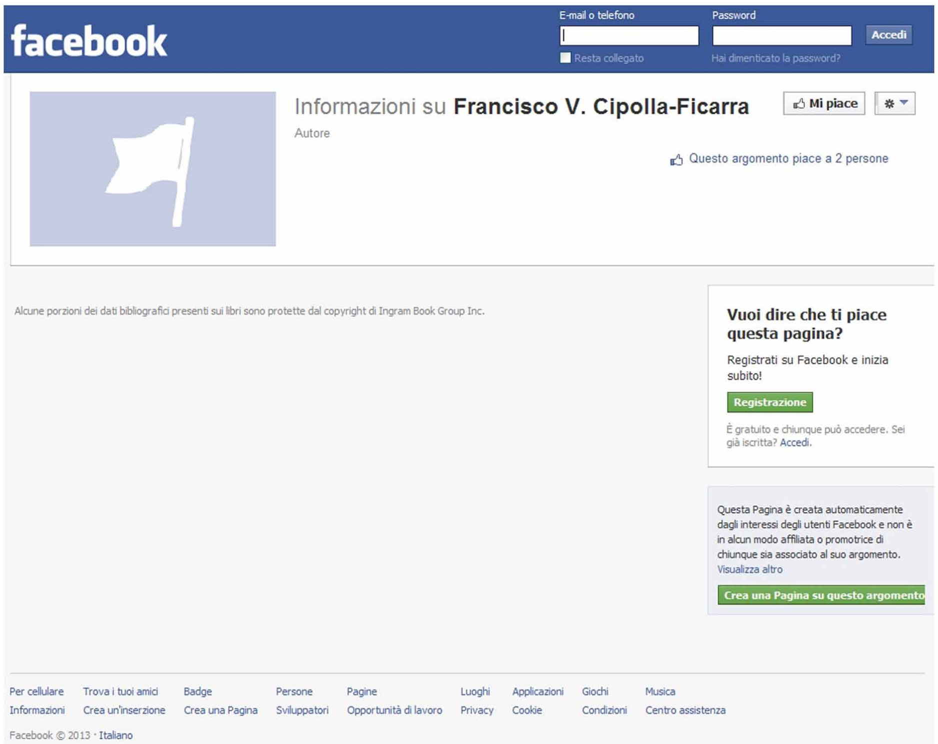


Figure 26. Web Architect & HCI Research

Social Web and Software Automatism

Automated generation of accounts in Facebook where are linked other people of the social networks (-) (Figure 25).

The reliability of the information in applications such as Linkedin can be equal to zero if the members keep on presenting themselves on line with false information in relation to their experience and/or training. Classical example of a spooling phenomenon belonging to parochialism since he constantly changes the main title of which he is allegedly an "expert" (Figures 26, and 27).

Figure 27. Solutions Architect & Research

Figure 28. Robin Williams' daughter Zelda, leaves Twitter and Instagram after vile abuse –www.washingtonpost.com (08.13.2014)

The Intersect

Robin Williams's daughter Zelda driven off Twitter by vicious trolls

287 More

By Caitlin Dewey August 13 at 10:38 AM Follow @caitlindewey

In yet another demonstration of the Internet's bottomless lows — and of Twitter's still-uncontrolled abuse problems — Robin Williams's daughter signed off Twitter for "a good long time" Tuesday night after receiving menacing messages from two trolls on the service.

Zelda Williams @zeldawilliams Follow

I'm sorry. I should've risen above. Deleting this from my devices for a good long time, maybe forever. Time will tell. Goodbye.

7:49 AM - 13 Aug 2014

1,824 RETWEETS 4,653 FAVORITES

The trolls' accounts, @PimpStory and @MrGoosebuster, have since been suspended by Twitter, but not before tweeting Photoshopped images of Williams that appeared to show him with bruises around his neck, as if he were in a morgue. @PimpStory also tweeted "look at what he ... did to himself because of you" and called Zelda a "heartless b****." That message was retweeted 21 times.

The examples presented denote how the dynamic persuaders (Cipolla-Ficarra, 2011) have evolved inside the context of the psychological bipolarity towards a phenomenon which can be defined as "Tri-phase" Disorder in the electronic context (Cipolla-Ficarra et al., 2014): belonging to a destructive group, perennial impunity in regard to the local and/or global legal systems and constantly being the central axis of attention, even if it entails breaking with the limits of ethics (figure 28) and aesthetics in computer sciences and all the disciplines interrelated with it and the excellent work in progress, results, research teams, etc. (Cipolla-Ficarra et al., 2012a; Cipolla-Ficarra et al. 2012b; Ewing, Gad & Ramakrishnan, 2013; Fan & Gordon, 2014; Holtzblatt, 2011; Teevan, Ringel-Morris, & Azenkot, 2014; Shahabi et al., 2007) (Figure 28).

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Appendix 2: A Set of the Good Online Information

INTRODUCTION

In the current annex are revealed a series of positive examples which turn the social networks into a unique phenomenon in interactive communication which will open new horizons in the next years, thanks to the advance of the hardware and the software (i.e., Fuchs, State & Bazin, 2014; Cook et al., 2013; Zhang, Hindle & German, 2014). A hardware which tends to the miniaturization and faster calculation speed, with a software that facilitates the autonomy of the devices (i.e., Akyildiz, Jornet & Pierobon, 2011; Faulkner et al., 2014; Johnson et al. 2012). Devices which from a technological point of view tend to increase the quality of life (George et al., 2013; Atias & Sharan, 2012; Parkes, Poupyrev & Ishii, 2008; Cipolla-Ficarra et al., 2011; Cipolla-Ficarra et al., 2012; Cipolla-Ficarra et al. 2013). However, in relation to the use of the human beings, they may have a non-positive finality. In this sense, and from the perspective of the social communication, it is easy to detect the use of the social networks to acquire quantitative popularity, such as can be the total number of links in applications such as as Linkedin, total of visitors in the blogs, amount of downloads of a movie or a text, etc. That is to say, the quantitative aspect prevails over the qualitative aspect of the hypermedia systems in the late 90s and early 2000s. In other words, there is a constant regression towards the use of the new interactive media and not towards the quality of the interactive communication.

Good Examples

Comics

The use of comic and statistics in the digital press to draw the attention to climate change. (Figure 1)

Figure 1. The average global temperature of the month of June 2014 has been the highest on earth and the sea since the measurements started in 1880 (www.elpais.es –07.28.2014)

E-voting

The possibility of voting online the candidates of certain associations (i.e., ACM –Association for Computing Machinery, or IEEE –Institute of Electrical and Electronic Engineers), knowing beforehand their professional and/or educational trajectory. (Figure 2)

Research and Interrelationship

Knowledge through a radil graphic of the relationships of a main author and his co-authors, through the Artneminer application. (Figure 3)

Mass Media Online

One of the advantages of the digital press is the possibility to compare news quickly and that public opinion can participate in the debates through the social networks such as can be news with xenophobic

Figure 2. ACM 2014 SIGGRAPH Election: Additional information in the networks with free access before casting an electronic vote

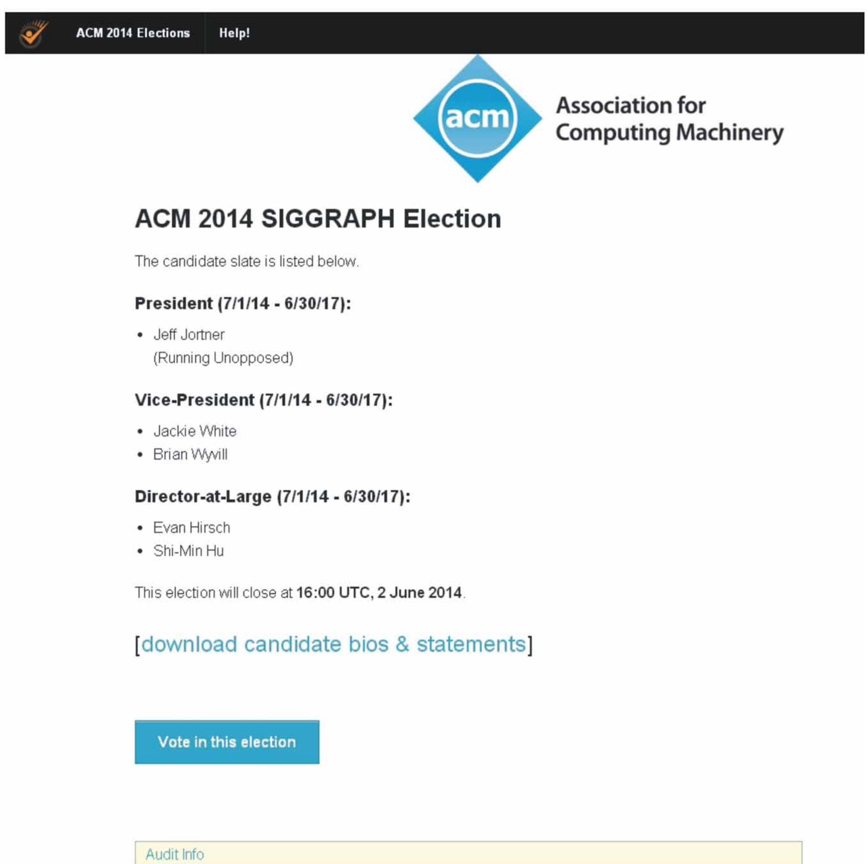
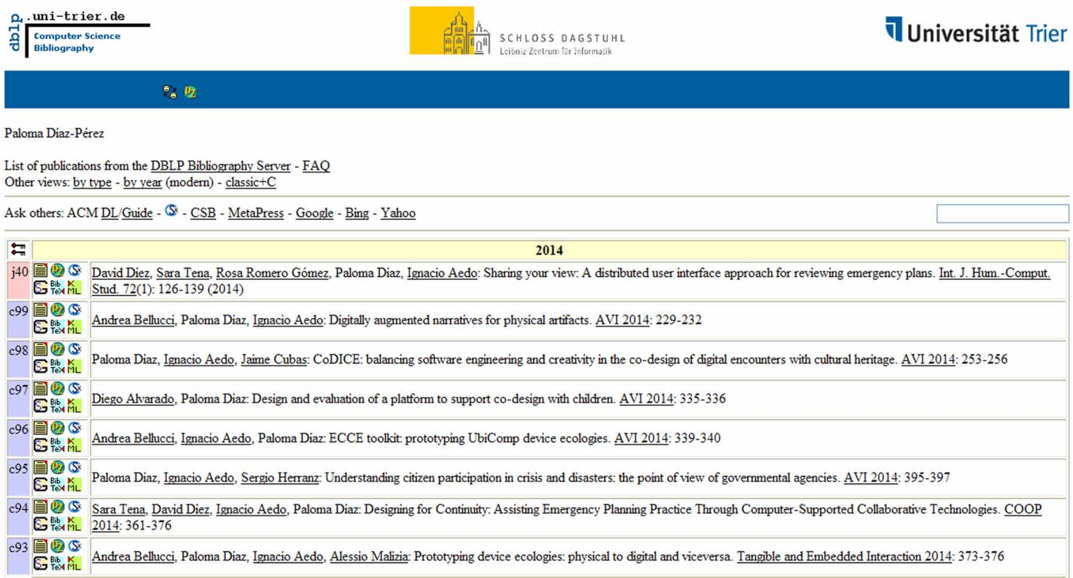


Figure 3. The main author occupies the centre and the rest of the authors are placed in a circular way in the outer part

Figure 4. Original publicity of the Microsoft firm (right photo) and modified picture in Poland (left photo). –www.20minutos.es (08.20.2009)

Appendix 2: A Set of the Good Online Information

Figure 5. Presence of university endogamy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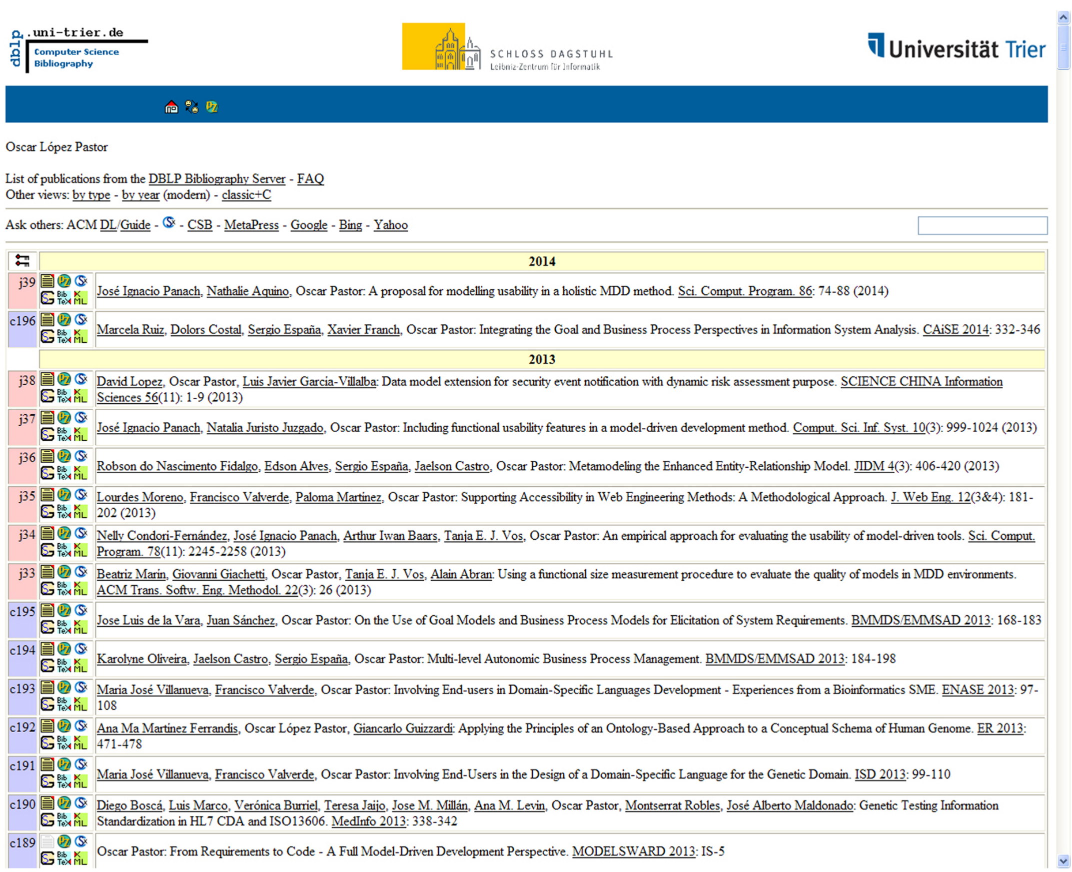
c99	Andrea Bellucci, Paloma Díaz, Ignacio Aedo: Digitally augmented narratives for physical artifacts. AVI 2014: 229-232
c98	Paloma Díaz, Ignacio Aedo, Jaime Cubas: CoDICE: balancing software engineering and creativity in the co-design of digital encounters with cultural heritage. AVI 2014: 253-256
c97	Diego Alvarado, Paloma Díaz: Design and evaluation of a platform to support co-design with children. AVI 2014: 335-336
c96	Andrea Bellucci, Ignacio Aedo, Paloma Díaz: ECCE toolkit: prototyping UbiComp device ecologies. AVI 2014: 339-340
c95	Paloma Díaz, Ignacio Aedo, Sergio Herranz: Understanding citizen participation in crisis and disasters: the point of view of governmental agencies. AVI 2014: 395-397
c94	Sara Tena, David Díez, Ignacio Aedo, Paloma Díaz: Designing for Continuity: Assisting Emergency Planning Practice Through Computer-Supported Collaborative Technologies. COOP 2014: 361-376
c93	Andrea Bellucci, Paloma Díaz, Ignacio Aedo, Alessio Malizia: Prototyping device ecologies: physical to digital and viceversa. Tangible and Embedded Interaction 2014: 373-376

Figure 6. Unrealistic number of research works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	2014
j39	José Ignacio Panach, Nathalie Aquino, Oscar Pastor: A proposal for modelling usability in a holistic MDD method. Sci. Comput. Program. 86: 74-88 (2014)
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c189	Oscar Pastor: From Requirements to Code - A Full Model-Driven Development Perspective. MODELSWARD 2013: IS-5

undertones. For instance: in the central picture of marketing campaign of the Microsoft firm a black person is replaced by a white in the Polish version. (Figure 4)

Internet Scientific Publications

Scientific works databases where it is easy to detect university endogamy as well as the presence of the spooling factor. The latter is due to the fact that it is humanely impossible to control career projects, masters, doctoral thesis, organize international events, participate in congresses and a long etcetera.

Photos and Tourism

The possibility of seeing pictures made by the users of the social networks boost tourism.The Google Map application is very positive in that sense.

In short, these examples have proven how the new generation of users of interactive systems will be in touch with the binary or digital communication in a natural way, in contrast to the adult users, experts or not, in the computer science context (Cipolla-Ficarra et al., 2013). Consequently, the analogical support of paper, for instance, will no longer be the main media of communication among users of the same age. Users who will value as a priority the connectivity attribute in certain moments, in view of the different categories that make up the interactive design (Cipolla-Ficarra et al., 2011).

Figure 7. Poor scientific production in Paraguay

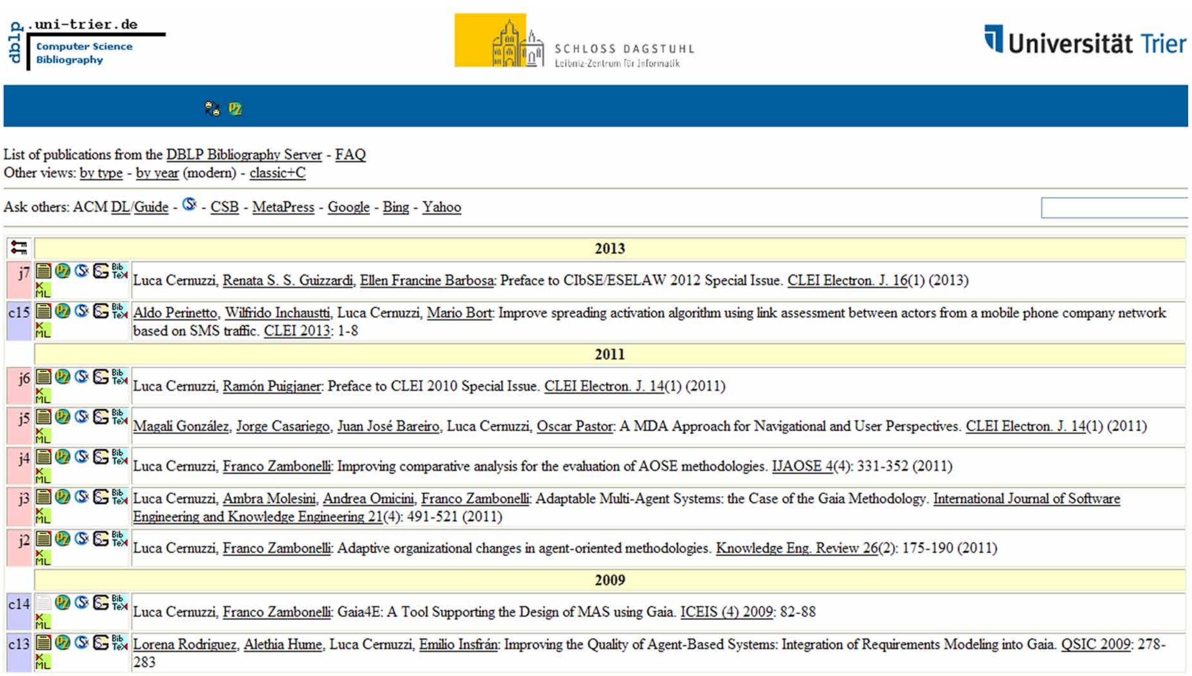


Figure 8. Poor scientific production for an Italian research

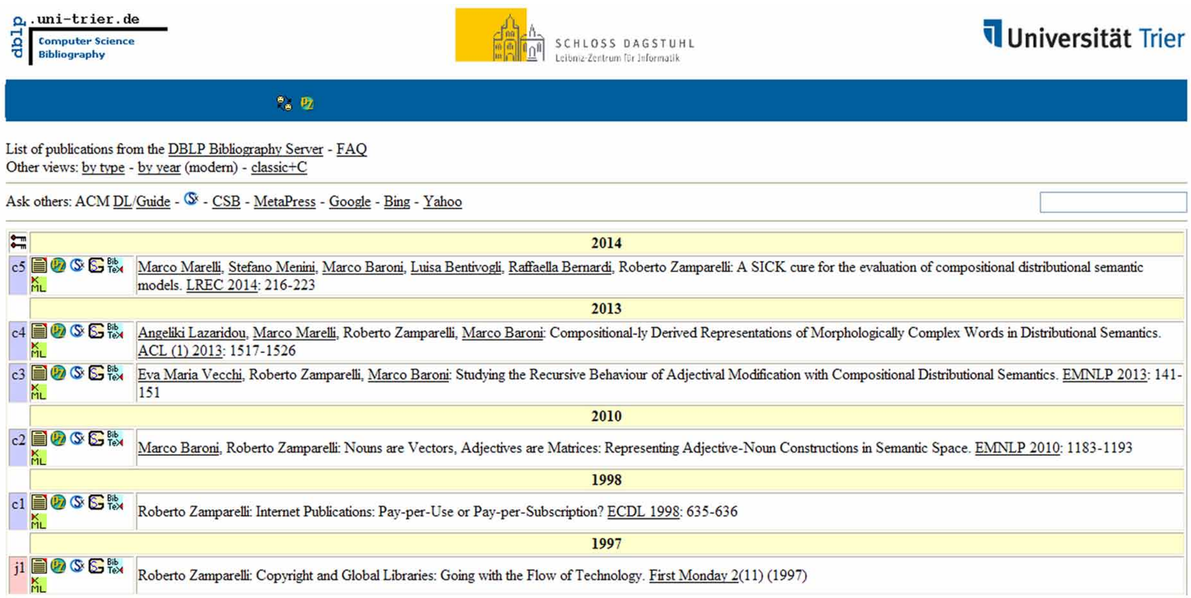


Figure 9. European map of photographs

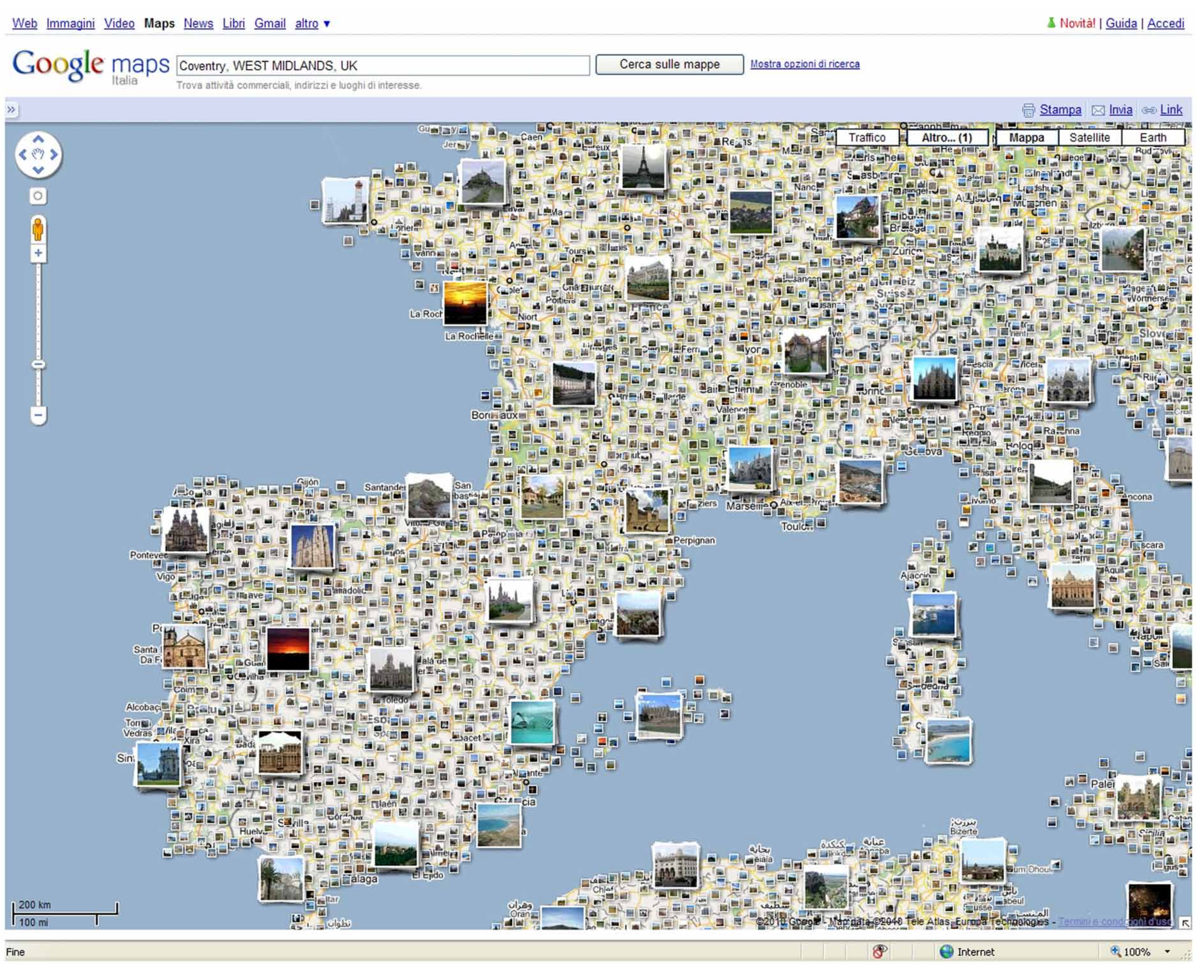
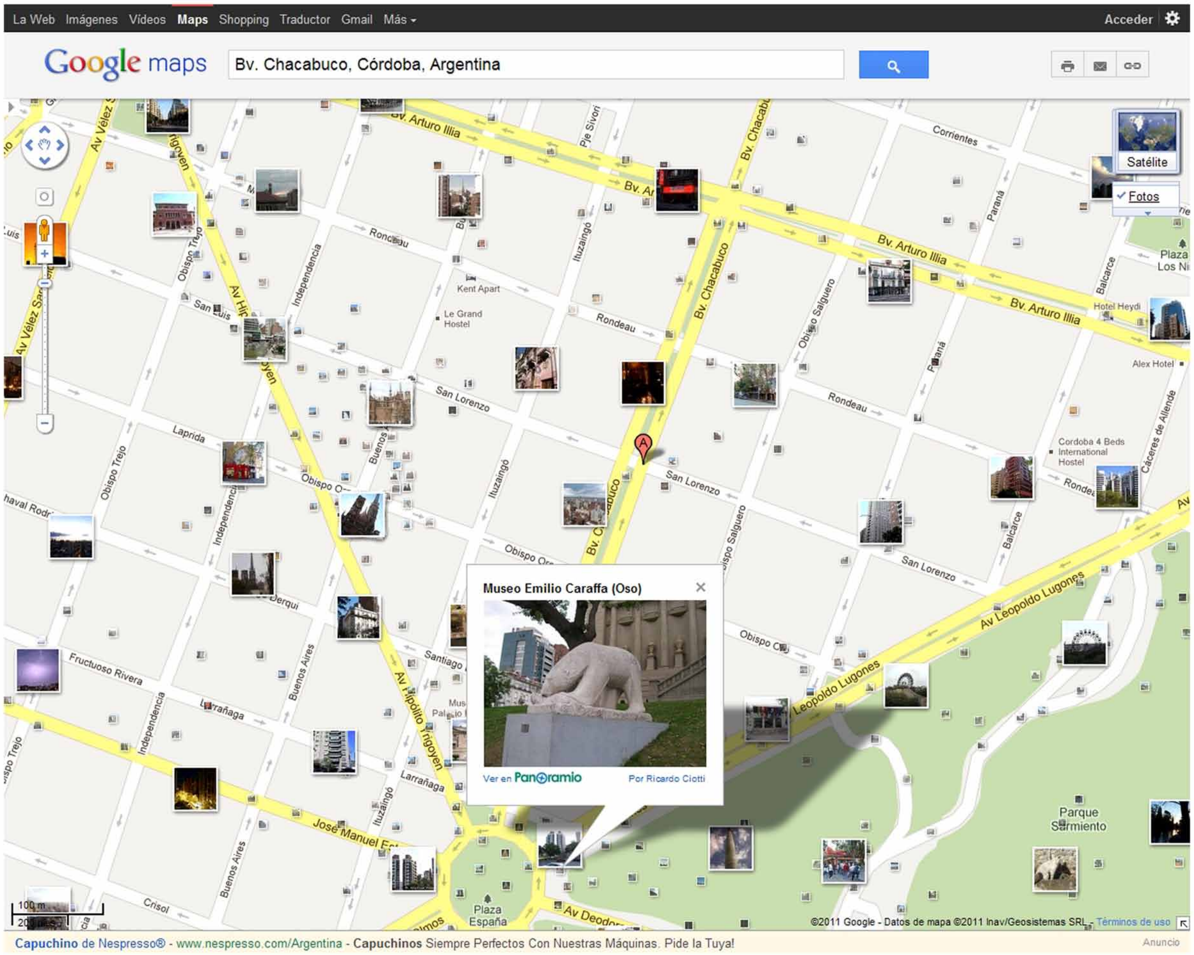


Figure 10. Sculpture which allows to detect quickly the entrance to a museum for that tourist who visits it for the first time



Works in Progress and Future Research

In this area and with this title we intend to sum up a series of research works directly related to the social networks and their application in medicine, education, human-computer interaction, the communications between the human being and the robots, software engineering, ITC, teleworking, social communication, etc. (i.e., Hooper & Dix, 2013; Kearns, 2012; Diallo et al., 2013; Mitra et al., 2014; Pfeifer, Lungarella & Iida, 2012; Raatikainen et al., 2012; Yiu, 2014). These works denote an excellent set of examples to be followed not only because of the results reached currently but also because of the wide range of potential investigations or future researches which can be obtained from these works.

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