iHCI 2011

IRISH HUMAN COMPUTER INTERACTION CONFERENCE

INTEGRATED PRACTICE INCLUSIVE DESIGN

8th - 9th September

Cork Institute of Technology

Conference Proceedings

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Proceedings of iHCI2011, the Fifth Irish Human Computer Interaction Conference
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A final version of this eBook with ISBN will be published after the conference by CIT Press.

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Posters

PREFACE

2011 marks the fifth year of the annual Irish Human Computer Interaction (iHCI) Conference. The conference theme for this year maintains the strands of interest that were established in the conferences since 2007 and places emphasis on 'inclusivity' both in practice and design. The field of HCI is largely characterised by a convergence of knowledge from different fields into research that is interesting in its process as much as in its practical or academic outcomes. In an increasingly competitive climate for all research the theme for the 2011 conference underlined a concern for innovation through 'integrated practice' and 'inclusivity in design'.

In many ways this resonated with previous conference themes that have reflected an interest in cultures of interaction, innovative HCI concepts, and transferable research while opening boundaries into novel or challenging spaces. While HCI is often seen to be grounded in the sciences the 2011 theme opened its call to research demonstrating innovative practice through an integration of disciplines that may include those residing in fields such as the arts, sciences, engineering, and humanities. While in practice this was the case in previous years it was made explicit in 2011. With respect to the implementation of technologies in and across society and cultures the call welcomed research designed to be inclusive; that is, work that seeks to improve technology for 'use' or extends the experience of technology to a wider scope of 'actors' in society.

The 2011 conference, hosted by the Media Communications Department in CIT, continues to promote the ethos of reaching out to new areas of practice with the aim of enriching the community with an inclusive scope of knowledge. While continuing the trend of expanding the iHCI community, it also endeavoured to match the high quality of organisation and standard of participation achieved by the organisers of in previous years.

The 'industry session', initiated in 2010, provided the space for Media Communications to invite speakers from the creative design industry who deal with interaction as an implicit primary concern in their practice. Such practitioners in the field generate innovative solutions as a matter of course and their commercial success depends on their ability to achieve novel solutions to design problems. As such the industry sessions organised this year enabled individuals and companies who may not otherwise choose to participate in a human computer interaction context to be involved. The sharing of knowledge and experience gleaned through their practice in the same forum as those from an academic research perspective is a useful method of initiating and reinforcing collaborations between industry and education.

The invitations issued result in five participants presenting over two sessions, one on each day of the conference. On day one Elie Lakin from Jason Bruges Studio opens with a presentation around interactive architecture and raises the possibility to discuss issues about how multidisciplinary teams of architects, designers and engineers work together to address design problems that emerge on large scale public building projects. Aaron Marcus of Aaron Marcus and Associates(AM+A), Berkeley, CA, USA, addresses cross-cultural user-experience design as a critical factor in the branding and development of products for international distribution. Aaron goes beyond the linguistic and visual issues traditionally associated with the globalisation of brands and addresses the cultural as a key factor which influence the successful 'use' of interfaces across cultures. On day two the industry session carried three presentations from Ireland. Mark Campbell from eMedia, Gabriela Avram on the recent activities of the Interaction Design Association (IxDA), and Kieran Delaney on HCI at the Nimbus research Centre in Cork.

The 'industry session' has therefore been successful in providing a way of augmenting the range of HCI topics that naturally come through the CFP. As such it offers an opening to include disciplines that have, in relative terms and for various reasons, not shared the same level of academic research.

The CFP this year resulted in the selection of 17 papers and 7 posters. Contributions came from those with affiliations with Trinity College Dublin, University College Cork, Dublin City University, Cork Institute of Technology, the NIMBUS Research Centre, Dundalk Institute of Technology, Galway-Mayo Institute of Technology, Institute of Technology Blanchardstown, National University of Ireland (Galway), University of Strathclyde, University of Dundee, Universitat Pompeu Fabra, Aalborg University, North Karelia University of Applied Sciences, Politecnico di Milano, National Technical University of Athens, Lancaster University, University of Limerick, Logitech, Waterford Institute of Technology, Lake Communications, and University of Madeira.

As with any meeting of people with shared interests the Fifth Irish Human Interaction Conference should be judged on the conversations and future collaborations that may be spawned by the presentations selected and organised by both the program and internal committees. The proceedings will be formally published in an eBook form after the conference and made available through the conference website. We hope you enjoy the proceedings over the two days and that the conference goes some way in helping to support your current and future research interests.

ACKNOWLEDGEMENTS

The conference this year is sponsored by Cork Institute of Technology and the event was hosted by the Department Media Communications. The internal organisation includes participation from a range of departments within the institute which include the Department of Computing, DEIS, and the CIT Crawford School of Art and Design. Contributions towards the organisation of the event was supported by an internal committee that involved senior management, researchers, and lecturers.

The committee is very grateful for the help extended to it by the staff at the Nimbus Centre.

Program Chair

Paul J. Green, Media Communications (CIT)

Conference Chairs

Emmett Coffey, Media Communications (CIT)

Paul J. Green, Media Communications (CIT)

Trevor Hogan, Media Communications (CIT)

Gearoid OSuilleabhain, DEIS (CIT)

Ian Pitt, Computer Science Department (UCC)

Paul Rothwell, Computing (CIT)

Internal Organisation Committee

Joey Campbell, Media Communications (CIT)

Orla Flynn (Head of School, CCAD)

Paul J. Green, Media Communications (CIT)

Trevor Hogan, Media Communications (CIT)

Rose McGrath, Head of Department, Media Communications (CIT)

Jim O'Dwyer, Head of Department, Computing (CIT)

Gearoid OSuilleabhain, DEIS (CIT)

Paul Rothwell, Computing (CIT)

Niall Smith, Head of Research (CIT)

Paul Walsh, Computing (CIT)

Program Committee

The peer review process was conducted by an international program committee some of whom have continued to support the conference since its inception in 2007. The committee this year was comprise of the following:

Gabriela Avram, University of Limerick, Ireland

Liam Bannon, University of Limerick, Ireland

Mike Bennett, Stanford University, USA

Daragh Byrne, Dublin City University, Ireland

Joan Cahill, Trinity College Dublin, Ireland

Joey Campbell, Cork Institute of Technology, Ireland

Luigina Ciolfi, University of Limerick, Ireland

Michael Cooke, Trinity College Dublin, Ireland

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Chris Speed, Edinburgh College of Art, Scotland

Arnd Steinmetz, University of Applied Sciences, Darmstadt, Germany

Ielka van der Sluis, Trinity College Dublin, Ireland

Ingo Stengel, University of Applied Sciences, Darmstadt, Germany

John Vines, Northumbria University, UK

Paul Walsh, Cork Institute of Technology, Ireland

Judith Wusteman, University College Dublin, Ireland

KEYNOTE

The keynote speaker for iHCI 2011 is Paul Adams.

Paul is a Product Manager at Facebook, where he works on the design and development of new advertising products. He is recognized as a leading thinker on designing social interactions. Paul worked for a number of companies prior to assuming the role of Product Manager/Researcher at Facebook.

From 2007 - 2010 he was a Senior UX Researcher with Google and lead researcher for 'Social', working on web applications and mobile. He conducted research in the US, UK, India, China and Japan and worked on Gmail, Latitude, YouTube and much more under wraps. He conducted field and lab research to help product and engineering teams build things that people love.

Before Google he worked at Flow as a Lead UX Consultant engaging clients with all parts of the product development process. He led projects for the BBC, The Guardian, Vodafone, Betfair, London Underground and UK Government.

With Dyson from 2003 - 2004 he worked as a Product Designer on the small teams that designed Japan's best selling vacuum and the first Dyson slimline upright. He pioneered user research as part of the design and development process and led Dyson's first field research to test new concepts.

Prior to this he also worked with Perfix on projects for Vodafone and O2 and with Faurecia he worked on new concepts for automotive seating.

Currently Paul is at Facebook and is concerned with figuring out better ways for businesses and people to communicate and interact, and for people to communicate with each other about businesses, products and brands.

He writes a popular blog at ThinkOutsideIn.com where he discusses issues about how humans relationships influence design. Some of these concepts provide the basis for a new book to be published this coming November.

In his keynote address Paul will talk about how the web is being rebuilt around people and how businesses will need to adapt to this change. He will also discuss how UX/HCI practitioners are best placed to help businesses navigate this change.

INDUSTRY SESSIONS

There were five industry based industry organised into two sessions over the two days of the conference. On the first day Elie Lakin from the prestigious Jason Bruges Studios in London and Aaron Marcus of Amanda, Berkeley California will make presentations on Interactive Architecture and Cross-Cultural User-Experience Design respectively. On the second day there are three presentations from the Irish Industry, the first by Mark Campbell of eMedia, Galway, the second by Gabriela Avram organiser of the Limerick Chapter of the IxDA, and finally Kieran Delaney talks about HCI at the Nimbus Research Centre which interfaces third level research with industry partnerships.

Interactive Architecture by Jason Bruges Studio, London, UK

presented by Elie Lakin

"Founded by Jason Bruges in 2001, the studio comprises an experienced team of architects, lighting designers, specialists in interaction and industrial design and project managers. They create interactive spaces and surfaces that sit between the worlds of architecture, interaction design and site-specific installation art. Our projects range from large-scale building facades and public art to interactive interior environments and products."

http://www.jasonbruges.com

Cross-Cultural User-Experience Design by Aaron Marcus and Associates (AM+A), Ca., USA

presented by Aaron Marcus

"For ten years, AM+A concentrated on R+D projects for major corporations and the federal government. In the early 1990s, anticipating ubiquitous computing and the emerging Internet, AM+A shifted its emphasis to the design of market-driven projects for both large organizations and smaller start-up companies.

AM+A finds that the challenges of fundamental visual communication reappear with each new generation of products. Our pioneering and rigorous approach, grounded in proven principles of visual communication, information design, and human factors, has contributed to the evolution of every generation of user interfaces."

http://www.amanda.com

eMedia: Bringing Science to Life by Mark Campbell, Founder of eMedia (creators of PocketAnatomy.com)

presented by Mark Campbell

"eMedia is an award winning Medical Multi-Media Software Design Company specialising in 3D medical animations, 3D medical learning software, and 3D medical apps for iPhone and iPad. Our web, mobile and widescreen solutions […]bring Science to Life".

http://www.emedia.ie

IxDA

presented by Gabriela Avram, University of Limerick

"The IxDA is a global network dedicated to the professional practice of Interaction Design. With the help of more than 20,000 members since 2004, the IxDA network provides an online forum for the discussion of interaction design issues and other opportunities and platforms for people who are passionate about interaction design to gather and advance the discipline."

Gabriela Avram was instrumental in establishing the Limerick Chapter of the IxDA and organises meetings that regularly feature important contributors to the field of interaction design.

http://www.ixda.org

The NIMBUS and HCI

presented by Kieran Delaney, Nimbus Research Centre, Cork

The NIMBUS Centre is Ireland's only research centre devoted to the field of embedded electronic systems. It brings together CIT's existing Centre for Adaptive Wireless Systems (CAWS), the Smart Systems Integration Group (SSIG) and the Technologies for Embedded Computing (TEC) Centre.

NIMBUS, and its sixty five researchers and engineers, is managed by CIT staff with extensive international research, teaching and industry collaboration experience. Research focuses on hardware, systems integration and networking in application fields such as energy, security, user interfaces, health, manufacturing and in particular on the technologies that will underpin the emerging Internet of Things.

http://nimbus.cit.ie/

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research papers

The Human Computer Interaction issues associated with the creation of personalized role playing simulations

Eileen O' Donnell, Catherine Mulwa, Mary Sharp and Vincent Wade
Knowledge and Data Engineering Group,
School of Computer Science and Statistics,
Trinity College Dublin,
Ireland.
00353 01 8961335
odonnee@scss.tcd.ie mulwac@scss.tcd.ie mary.sharp@scss.tcd.ie vincent.wade@scss.tcd.ie

ABSTRACT
The human computer interaction issues associated with the creation of personalized role playing simulations are discussed in this paper. This paper is aimed at those who are interested in building authoring applications which enable educators to build role playing simulated e-learning resources to use with their students. One of the main issues which have come to our attention is that many learning designers and educators do not understand what exactly it is we are trying to achieve by creating personalized role playing simulations. Also, how to gauge the pedagogic merits which can be achieved by using these e-learning resources. Potential users require guidance on the most appropriate uses for this authoring application. The provision of exemplars of use of such personalized e-learning activities would assist potential users in creating their own role playing simulations. Other issues which are to be addressed in authoring applications for creating personalized e-learning activities are: documentation; training materials; preview mechanisms; integration; usability; and the use of clear and relevant terminology. Human acceptance is paramount to the effective use of educational software which is designed to facilitate the creation of personalized e-learning resources. In conclusion, if the realization of an authoring application for creating personalized role playing simulations is to be achieved the following issues must be resolved: relevance to the learning experience; efficiency in production; and improvements in the human computer interaction.

Categories and Subject Descriptors
C.0 Computer System Organization: software interface

H.5.2 User Interfaces: Training, help and documentation; user-centred design.

General Terms
Documentation, Design, Human Factors, Language

Keywords
Personalized learning activities, role playing, simulations, human computer interaction, learning, training, e-learning, technology enhanced learning, usability, evaluation.

1. INTRODUCTION
This research reports on early user evaluations of an authoring application for creating role playing simulations and the human computer interaction issues associated with the use of these authoring applications. The objective of this research is to design a human computer interface to facilitate effective interaction by non-technical authors when creating personalized role playing simulations for use by their students. Sonwalkar [16] claims that personalized learning resources are required to increase the effectiveness of technology enhanced learning. Role playing simulations are suitable for use when teaching students, training workers and other groups in society who wish to learn new skills. For example, role playing simulations would be suitable for teaching the card game of Bridge to elderly or retired people. These simulations could also be used in the training of non-technically competent people in the use of mobile devices.

2. METHODOLOGY
The research and development of an authoring application to enable the creation of adaptive simulations was undertaken as part of GRAPPLE which was an EU FP7 STREP funded project [8] part of which was conducted in the Knowledge and Data Engineering Group, Trinity College Dublin. The evaluation of the authoring application was conducted by a research member of the same group who was not involved in the development of the application. Participants feedback on the human computer interaction issues observed with this application are reported in this paper. And, some suggestions are proposed with respect to improving the human computer interaction of this authoring application.

Prior to the evaluation taking place two seminars of a half hour duration each were provided, firstly, to introduce the functionality of the application and secondly to discuss the pedagogical rationale. Subsequently, each participant spent two hours in total testing, evaluating the application, and answering the questionnaire provided. The questionnaire is available as part of the GRAPPLE deliverable: Refinement and Improvement of Evaluation Guidelines [17]. Ten participants evaluated the authoring application six of these had teaching experience.

3. MOTIVATION
Role playing simulations provide educators with an alternative teaching resource for presenting course material to students in a non-life threatening and safe environment. The motivation for this study is to create a user friendly interface for educators to create role playing simulations by identifying the human computer interaction issues associated with the creation of role playing simulations in order to improve the usability and

effectiveness of such authoring applications. Følstad and Knutsen [6] claim that the early involvement of potential users in the design stage of an application can alleviate the requirement for costly redesign and redevelopment. Gena and Weibeizahl [7] suggest evaluation can provide useful feedback for subsequent redesigns.

Virvou and Manos [18] claim human acceptance is an important factor in the successful use of educational software. Foss and Cristea [5] suggest that improved functionality and usability of authoring applications for creating personalized learning experiences is necessary to promote user acceptance. Nikoukaran et al. [12] suggest that quality and ease of use should be considered when evaluating an application.

Koshy [11] suggests that action research methodology facilitates evaluation and reflection. Hence, participants involved in the evaluation of an authoring application were invited to contribute their views and reflections on usability prior to any further development. Bargas-Avila et al. [1] mention the importance of user feedback when assessing the usability of online applications.

Bennet and Bennet [2] suggest that the use of technology in education facilitates self-directed experiential learning. Sonwalkar [16] suggests that the current use of learning management systems are predominantly used for the exchange of information rather than the provision of learning content which is supported by pedagogic rationale.

Parrish [14] concluded that learning design should encompass pedagogical intent and not just a pleasant interface to learning resources. An authoring application for creating personalized role playing simulations would enable authors to create re-usable e-learning resources with a view to enhancing students' retention of specific concepts and improvement in learning. Hockemeyer and Albert [9] recommend that personalized technology enhanced learning resources would effectively enable reusability.

4. PERSONALIZED ROLE PLAYING SIMULATIONS

4.1 Personalized role playing simulations

Personalized role playing simulations are suitable for use across disciplines. This application is suitable for use in every discipline which presents students with e-learning resources suitable to their prior experience or level of knowledge. Brusilovsky et al. [3] state that one of the problems yet to be resolved: is how to adequately assess a student's current knowledge when details of this knowledge exist in various different incompatible systems. Authors can select the personalized settings they wish to use in each e-learning resource. Chalfoun and Frasson [4] suggests that a smart interface for learning should be able to personalize learning resources to suit a user's evolving needs.

The objective of this research is to create authoring applications to be used by e-learning designers and educators in the creation of role playing simulations. Such role playing simulations can be used to enhance the learning experience of society in general by providing pedagogically sound e-learning activities which can be experienced rather than read or talked about. Parrish [14] suggests that by producing meaningful personalized learning experiences for students learning designers are adding quality to the learning resources created to engage students' attention. Raybourn et al. [15] suggest that complex problem solving and novel strategies are best learned experientially.

Følstad and Knutsen [6] stress the importance of discerning the difference between useful and non useful user feedback. The onus is on the evaluator to distinguish which feedback from participants is beneficial to improving the application and which user feedback can be ignored. While evaluating an authoring application for creating personalized role playing simulations, participants provided the following feedback with respect to the human computer interaction with the application:

- Exemplars of use should be available
- A training module should be appended to the package
- Documentation should be available
- The language used should be clearly understood
- A preview mechanism should be available to see the students view of the learning activity being created

4.2 Integrated Practice

Authoring application for creating personalized role playing simulations when complete will be integrated with existing learning management systems or e-learning platforms to provide learning designers, teachers and trainers with an alternative medium for presenting course material to students in a format that can be experienced by students.

Kalyuga and Sweller [10] found that personalized learning resources proved to be more effective than non-personalized learning resources. Personalized role playing simulations could be used to facilitate the learning needs of the elderly in our society. Other groups in society could also benefit from personalized e-learning resources, for example, learning mandatory skills (health and safety or manual handling) required for the workplace.

4.3 Simulations for Mobile Phone use

Role playing simulations created for using mobile phones could facilitate inclusivity for the aged in our society by making freely available easy to follow simulations of how to effectively use mobile devices (Figure 1).

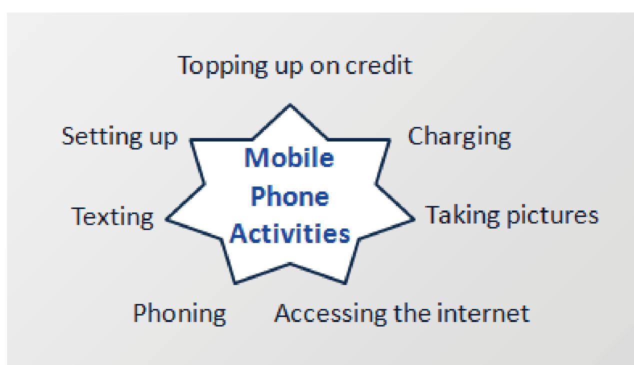

Figure 1: Mobile Phone Activities

Users do not have to use all the options available in the application, but users should be aware of the functionality of the available options, to assist them in selecting the combination of options best suited to their needs. Norman [13] recommends that the full range of functionality be clearly visible to the user, although the user is not expected to use all the available functionality of any application.

This proposed authoring application could be utilized by a range of users from different disciplines, including: lecturers; teachers; trainers; demonstrators; and instructors (Figure 2).

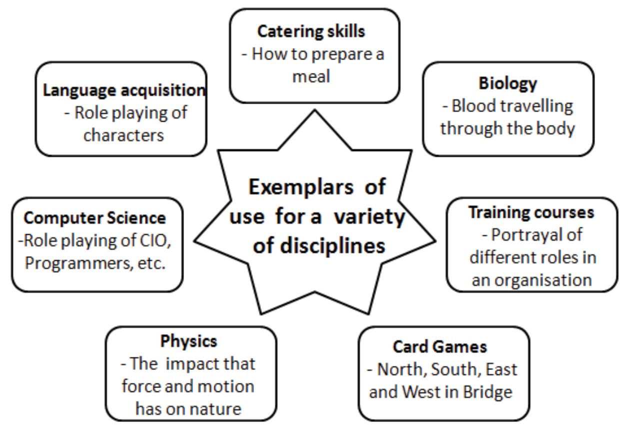

Figure 2: Exemplars of use

5. HUMAN COMPUTER INTERACTION

The human computer interaction involved in engaging with an authoring application which effectively enables non-technical learning designers and educators to create role playing simulations has to be clearly understood before such an interface can be created.

Potential users have to be inspired to use the authoring application, therefore exemplars of use should be created using the authoring application to show potential users the benefits to be gained by engaging students with role playing simulations. Documentation must be provided to assist potential users in effectively using this authoring application. Training materials provided should be sufficient to show potential users how to create role playing simulations on their own. A preview mechanism should be available to users to see at a glance the student view and test the student engagement with the role playing simulations created. The terminology or language used in the authoring application should be clearly understood by all, the use of technical language will deter potential users from engaging with the authoring application.

5.1 Exemplars of use

Exemplars of use are required to show potential users examples of where role playing simulations are relevant and beneficial to the students learning experience. The objective is to create exemplars of use that will inspire learning designers and lecturers sufficiently to make them wish to engage with creating some role playing simulations of their own. The exemplars of use should clearly portray how the flow of the units of learning would work together to make up a learning resource which would enable the students or learners to experience the intended learning outcomes sought by the learning designer or educator. Figure 2 portrays a list of suitable scenarios which could lend themselves to role playing simulations which students could experience.

5.2 Documentation

Explain how the authoring works in detail by providing comprehensive online documentation to assist users at every step of the process in creating role playing simulations. The use of a contextual hover would provide users with the necessary documentation which is relevant to the specific functionality the user is using when the request for documentation/or clarification is sought (Figure 3).

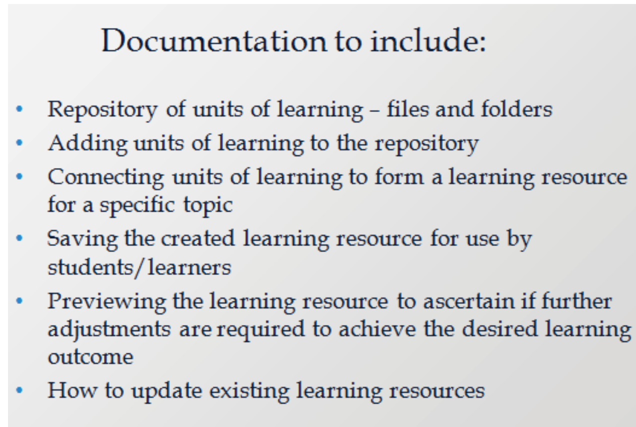

Figure 3: Documentation Samples

5.3 Training

The training material provided for learning designers and educators to follow should clearly explain to potential users the purpose and value of the learning resources which will be created during the training provided.

Training could be provided in the form of a flash movie or an interactive tutorial. The flash movie should be designed to portray the correct use of the authoring application. An interactive tutorial could also be used to ensure that the authors understand how to design and create e-learning resources which enable students and learners to experience activities in the guise of many roles. The units of learning selected to form the e-learning resource to teach learners a specific topic must be pedagogically selected to enhance the learning experience.

5.4 Provide a Preview Mechanism

By providing a preview mechanism, e-learning designers or educators can at any stage during the creation of role playing simulations see and test the learning resources which they are creating, observe mistakes or opportunities for improvements and amend accordingly.

5.5 Terminology or Use of Language

The technical terms used to create and deploy authoring applications for creating role playing simulations should be left in the background of the application and should not be visible to confuse and put potential users off using the authoring application. All the terminology used in the human computer interface of the authoring applications should be clearly understood by learning designers and educators across all disciplines.

These authoring applications are expensive and time consuming to create, but, when developed they should provide e-learning designers and educators with an authoring application which is freely available to enable learning designers and educators to cheaply and quickly create role playing simulations to use with their students.

Depicted in (Figure 4) is the interface for the GRAPPLE [8] authoring application which was evaluated by participants.

Figure 4: Interface for GRAPPLE authoring tool

Depicted in (Figure 5) is an amended human computer interface for a proposed authoring application for creating personalized role playing simulations. The proposed interface has yet to be developed.

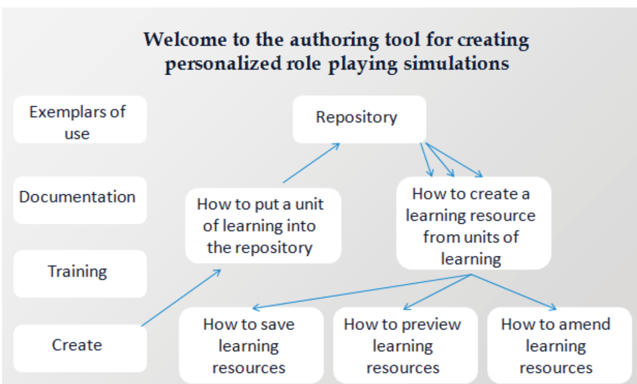

Figure 5: Proposed interface for authoring application

6. CONCLUSION

This paper discussed some of the relevant human computer interaction issues associated with the effective creation of personalized role playing simulations which should be considered by computer programmers prior to embarking on designing and implementing applications for creating role playing simulations. This study aims at providing designers of the human computer interface of authoring applications with some useful guidelines to ensure that the authoring applications are more effective, efficient and user friendly.

The human computer interaction with such authoring applications is significantly important. Learning Designers and educators will only engage with such authoring applications if they realize the benefits that students can get by engaging with role playing simulations, and are able to create these simulated learning experiences: cheaply; quickly; and with ease.

This paper was written to assist designers and developers of authoring applications to improve the human computer interaction with the applications they are developing.

The complete findings, based on participants' feedback with respect to the design and development of the GRAPPLE [8] authoring application, are available at: http://www.grapple-project.org/public-files/deliverables/D9.5-WP9-FinalEvaluation-v1.0.pdf/view. Thus closing the evaluation loop by enabling future developers to incorporate the user feedback gathered in the GRAPPLE evaluation process [8] outlined above into the design and development of future authoring applications.

7. FUTURE RESEARCH DIRECTIONS

This scope of this paper was limited to a discussion of participants' feedback on their human computer interaction with an authoring application for creating personalized role playing simulations. The pedagogical issues and concerns connected with the use of role playing simulations are separate issues which would be interesting to pursue as future research topics. Further research and improvements are required in the development of personalized authoring applications if widespread use is to be achieved.

8. ACKNOWLEDGEMENTS

We wish to acknowledge with thanks the feedback provided by participants who were involved in the evaluation of the GRAPPLE authoring application for creating personalized role playing simulations in Trinity College Dublin.

This research is in part based on works supported by the Science Foundation Ireland (Grant Number 07/CE/I1142) as part of the Centre for Next Generation Localisation (www.cngl.ie).

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Cross-cultural aspects of ICT use by older people: preliminary results of a four-country ethnographical study

Josep Blat
Interactive Technologies Group
Universitat Pompeu Fabra,
Barcelona, Spain
josep.blat@upf.edu

Sergio Sayago
Digital Media Access Group
School of Computing, University of Dundee, Dundee,Scotland
sergiosayago@computing.dundee.ac.uk

Mirja Kälviäinen
D'ART Design Resource Centre
North Karelia University of Applied Sciences, Joensuu, Finland
Mirja.Kalviainen@pkamk.fi

Francesca Rizzo
INDACO Department,
Politecnico di Milano, Milan, Italy
francesca.rizzo@polimi.it

Nicola Morelli
School of Architecture and Design
Aalborg University, Aalborg, Denmark
nmor@aod.aau.dk

ABSTRACT
Culture is crucial in understanding how people use technologies and designing better ones. However, very little is known about cross-cultural aspects of Information and Communication Technologies (ICT) use by older people (60+), despite the heterogeneity of this user group. This short paper addresses this issue by drawing on an ethnographical study of ICT use conducted with over 120 people, aged 67-71, in four European countries: Finland, Denmark, Italy and Spain, over a 6-month period. The preliminary results show that making a social, independent and worth use of ICT are common aspects across the four countries, despite the so-called heterogeneity of older people as ICT users. This short paper also touches on two key aspects which emerged from the study, engaging older people in research and the evolution of some barriers to technology use.

Categories and Subject Descriptors
H.1.1 [**Models and Principles**]: User/Machine Systems – *human factors.* H4.3 [**Information systems applications**]: Communications applications; H5.2 [**Information interfaces and presentation**]: User interfaces. K.4.2 [**Computing Milieux**]: Computers and Society – *Assistive technologies for persons with disabilities*

General Terms
Human Factors

Keywords
Older people, ethnography, culture, ICT

1. INTRODUCTION
Whereas there is growing interest in culture in human-computer interaction research [7], very little is known about cross-cultural aspects of Information and Communication Technologies (ICT) use in out-of-laboratory conditions by older people (60+). However, the heterogeneity of older people as user group [3], an increasing ageing population, and the importance of understanding people's interactions with ICT in out-of-laboratory conditions in order to design better technologies [9], suggest that exploring cultural aspects of real-life ICT use by older people is worthwhile.

This short paper discusses preliminary differences and similarities in everyday ICT use by older people, aged 67-71, in four European countries (Finland, Denmark, Italy and Spain). We do this by drawing upon an ethnographical study we have conducted with around 120 older people over a 6-month period within the context of the *Life 2.0* project [8]. We also discuss aspects of user engagement and barriers to technology use that have emerged from the ethnographical study, and that we plan to explore thoroughly during the project.

2. LIFE 2.0 AND PREVIOUS HCI
Life 2.0, partially funded by the EU, aims to make the network of social interactions more visible to older people by providing them with an accessible platform, which will consist of several technologies (e.g. mobile phones, social networking sites, advanced multimedia content distribution systems – e.g. IPTV), and should enable them to track, locate and communicate with relevant members of their social networks (i.e. relatives, friends and caregivers).

Whereas most of the technologies addressed in Life2.0 already exist in the market, and over 140 EU-projects have been funded in the area of accessible and assistive ICT [2], what distinguishes Life 2.0 from these projects is the integration of available ICT into an online platform that will (i) offer accessible services to older people and their social circles based on geo-positioning ICT in four European countries, and (ii) allow all of them to produce and use digital content in public and private settings.

Some of the technologies addressed in Life 2.0 have received attention in previous human-computer interaction research with older people, such as iTV [11] and social networking sites [4], whereas other technologies related to geo-positioning, such as Google Maps, have received much less attention [12].

ICT are increasingly global and studies are looking into cultural aspects of our interactions with them. For instance, [16] focused on international usability in a controlled study with Indian participants, finding that more usability problems are found when an interviewer is a member of the same (Indian) culture than when it is not (Anglo-American). Yet, cultural differences and similarities in older people's everyday ICT use have been largely overlooked. An exception is the three-countries quantitative case study of older people's browsing conducted by Sa-nga-ngam and Kurniawan [14]. In this study, older people in Thailand were, contrary to stereotypes, fairly familiar with ICT, despite not embracing online shopping as much as older people in the UK and US do.

Ethnography is an important element of the second and current wave of human-computer interaction [1, 17, 6] and some studies with older people are supported by ethnographical interviews, such as [13] on a home-based communication system for older Mexican people, and also combine interviews with in situ observation, such as [4] on assistive robotics for older people's independent living. However, studies involving ethnography with older people tend to be short-term, despite the important role of time in HCI [6]. An exception is [15], wherein a 3-year ethnographical research was conducted in an adult educational center with around 400 older people in Barcelona. Key results of this study were that socialization, independence, and inclusion are crucial in older people's real-life e-mailing.

In this paper, we explore everyday ICT use by older people in four European countries. We do this by conducting ethnographical research that can be labeled as 'quick-and-dirty' [10], due to time and budget constraints associated to an R&D project. We describe the ethnographical research next.

3. ETHNOGRAPHICAL RESEARCH

The ethnographical research in Life 2.0 aims to guide the design and evaluation of the platform to be developed in the project by understanding the everyday interactions of older people with contemporary ICTs and devising future scenarios of technology use.

Over 6 months, we have conducted, in each country, first-hand observations of older people interacting with ICTs and talked to them about their experiences of and opinions about using them. The conversations have been informal (e.g. chats while using the technology) and formal, mostly adopting the form of focus groups and workshops - as these research methods fostered more socialization than individual interviews. We recorded the conversations by using technologies that increased social inclusion in the different contexts, such as paper-based notes. Diaries were designed to help our participants to record their daily life situations, and they were asked to fill them in during a week. Questionnaires were aimed at gathering personal data and at collecting preliminary information about hobbies, activities, and technologies used. We have also interviewed some members of their social circles who are relevant for the project, such as social care assistants. The ICTs addressed have ranged from Google Maps and Social Networking Sites to mobile phones and the Apple iPad. Table 1 summarizes the main ethnographical activities.

Country	Participants	Research methods	Technologies
Spain (Barcelona)	75 - 51 female - 24 male	In-situ observations and conversations in computer courses, interview with social care workers, diaries	Google Maps, Facebook, Blogger, document processing tools
Finland (Joensuu)	8 - 5 female - 3 male	Diaries, interviews and observation of technology use in the homes of the participants	Apple iPad, computers, mobile phones
Italy (Milano)	30 - 17 female - 13 male	Questionnaires, diaries, contextual interviews in the homes of the participants	Online browsing, document processing tools
Denmark (Aalborg)	13 - 8 female - 5 male	Workshop to explore hobbies, daily activities and familiarity with ICT	Mobile phones with GPS, computers

Table 1: Overview of the four-country ethnographical study

4. CULTURAL DIFFERENCES AND SIMILARITIES IN TECHNOLOGY USE

4.1 Social rather than individual use

All our participants make or aspire to make a social use of ICT in order to avoid being or feeling isolated. Regardless of culture, they consider that using ICTs should never replace face-to-face contact. We have observed, and participants reported, that this social use of ICT involves physical contact (e.g. using computers in a group) or, when this is not the case, ICT foster and increase communication with relevant members of their social circles (e.g. receiving an e-mail from children).

The cultural differences we have found in the four countries highlight the relevance of socialization as a key element of the use of current, and probably, future ICT, by older people living in them. For instance, socialization is very important in Finland because older people spend a lot of time alone in their houses, which are kilometers away from the city centre, and the weather, especially in the long winter, plays havoc with travel and increases safety concerns. By contrast, the milder weather in Spain and Italy encourages outdoor activities, which results in 'physical' socialization.

4.2 Being independent and achieving independence

Independence (i.e. not relying on anyone else to use ICT) is also a common and key element of ICT use across the four countries. All our participants reported that peer-to-peer support is crucial in achieving the goal of being independent ICT users. The support they need to master these technologies is seldom provided by close relatives, such as grandchildren or children, regardless of their proximity to them. Instead, our participants reported that they found this support in community centers, and that they preferred the human contact they find in these centers to reading books or tutorials.

The cultural differences in the four countries we have found both reinforce and contextualize the importance of independence. Whilst in Finland independence is essential for good, safe and meaningful everyday (harsh winter, living far away from the city centre), in Italy, Denmark and Spain, independence is much more related to improving the perceived quality of life of older people. Peer-to-peer support is more difficult to provide to older people living in Joensuu than those living in Barcelona and Milano, however. Few older Finnish people own cars, public transport is not as reliable as it could be, and they also need to travel long distances to reach the city centre, which is especially treacherous in the winter. By contrast, in Barcelona, Aalborg and Milano, traveling is not such an important barrier for going to community centers.

4.3 Not for the sake of it! Worthwhile use

Contrary to stereotypes of older people 'killing time' or 'don't knowing what to use ICT for', all our participants use ICTs to carefully plan their activities, which are numerous, ranging from holiday trips and taking care of grandchildren and ill partners to meeting up their friends in community centers. Thus, older people do not use ICT for the sake of using them. Instead, they use ICT *only* for conducting worthwhile activities, which are related to their interests and hobbies, and those that allow them to help relevant members of their social circles (e.g. children). It is worth noting that this worthwhile use of ICT concurs with the importance of socialisation and independence.

5. ENGAGEMENT AND BARRIERS

5.1 Engaging older people in research

User participation at all the stages of technology development is a hallmark of HCI research. However, how do we engage older people in a long-term project that deals with current and future ICT? Although the number of older people who are using ICT is increasing, most of today's older people have largely been excluded from research and technical activities related to the development of (novel) ICT. Moreover, older people might be reluctant to be at the centre of research activities, due to, for instance, a perceived lack of contribution to research activities, lack of experience with ICT and involvement in research activities, and low levels of education.

The strategy adopted in Life 2.0 has focused on establishing human contact with older people and on creating *proxy* groups, consisting of older people with whom the researchers and institutions had established contact before[1]. These older people have helped us contact and engage other older people in the local communities, providing a trust situation for a deep study of the participants' everyday life and meanings in it.

Whereas other strategies, which are widely used in studies of HCI with older people, such as advertising projects and research activities in local newspapers and sending letters or cards by mail, might be very effective for conducting laboratory-based studies, establishing human contact and working with proxies has turned out to be very effective for: setting up a user group in four countries, developing ethnographical research with them over 6 months, and engaging them in other ongoing activities of the Life 2.0 project, such as Geocaching in Aalborg (Denmark), training activities in Barcelona (Spain), and workshops for devising scenarios of future technology use in the four countries (see Section 6).

5.2 Evolution of barriers to technology uptake

In the course of devising new services/technologies, understanding the barriers to technology uptake and forecasting their evolution is very important. The cost of technology is one of the barriers for technology uptake amongst the older population, and we found this barrier in our ethnographical study. For instance, when exploring the use of the Apple iPad in Joensuu, older people reported that the device was very expensive. All the participants in the four countries own standard (i.e. not designed for older people) mobile phones – not smartphones, which are much more expensive. They also reported that their children passed their discarded or 'old' mobile phones on to them.

This practice of technology transfer raises the question of the evolution of the cost of technology as a barrier to its use. If this practice continues, and there are no evident reasons for thinking it will not, especially considering the rapid technological evolution, older people in few years time (or even months) will probably use the smartphones and tablet PCs of their children. Thus, the cost of technology, as a barrier to technology uptake, is likely to be temporal, and should be better understood, for instance, within the context of technology transfer in families, and over time.

The Apple iPAD also presented older people in Finland with some interaction difficulties. Trembling hands hindered considerably the interaction with it, providing an example of another type of barrier to technology uptake: lack of accessible design. However, it might well happen that, just as older people put their reading glasses on to use their 'small' mobile phones, they develop their own strategies to use tablet PCs and therefore, overcome accessibility barriers which, of course, should be considered and addressed while designing the technology. Unlike Finland, in Denmark, older people used the Apple iPad with few problems, despite considering the technology far from their capability. We plan to address this combination of human and technological barriers throughout the lifespan of Life 2.0.

6. DISCUSSION AND FUTURE WORK

We considered that adopting an ethnographical approach, in this case, quick-and-dirty rather than classical ethnography, due to time constraints, could help us identify cross-cultural aspects of ICT use by older people in different countries. The results seem to confirm it.

Rather than limiting the research methods and activities in the ethnographical research conducted in every country to a common and rigid research framework, which might have improved the consistency of the research and results, we opted for maintaining the core elements of ethnography, first-hand observations and conversations. These aspects have provided the basis of the research reported in this paper, and kept the study open to the rich and different (cultural) backgrounds and expertise of the partners, which provides wider, and at the same time, deeper results.

Despite stereotypes and heterogeneity of older people as ICT users [3], our research has allowed us to identify some differences within strikingly similar core issues in ICT use across different cultures. We have explored ICT which have already received some attention, and others having been mostly overlooked, pushing research forward by looking at different users of them in different countries.

We have also addressed user engagement within a relatively new context in human-computer interaction research with older people, a long-term R&D project involving ethnography where older people are producers and users of the technology, and discussed different human or technological barriers to technology use. Both aspects reinforce the value of ethnography in HCI with older people, and contribute to better understanding it.

Whereas part of the cultural aspects of ICT use can be somewhat quick to understand by building upon a previous and extended work in Joensuu and Barcelona, and we feel confident about the relative validity of the findings, new results which have emerged from the preliminary analysis of the quick-and-dirty ethnography conducted, demand more ethnographical data and analysis. Thus, in order to do justice with our participants and maintain

[1] In Joensuu and Barcelona, the relationship with the user group had been established prior to Life 2.0 as a result of collaborating with them in other projects and activities, Barcelona preferring direct contact without proxy. In Aalborg and Milano the proxy group has been set up in this project.

ethnographical research rigor, we have not included any extracts of our conversations with them, despite being commonplace in ethnographical papers, in this short paper.

We are currently gathering and analyzing more ethnographical data. We expect to involve participants' relatives in the study in an attempt to deepen our understanding of the social practice of ICT use amongst the older population. We are also defining and validating service scenarios, drawing on the data gathered so far, with the user group. These scenarios will inform the design of the Life 2.0 platform.

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Participative User Research and Evaluation Methodologies for Pervasive Communities

Edel Jennings, Edel Madden
TSSG,
Waterford Institute of Technology,
Waterford,
Ireland
{ejennings, emadden}@tssg.org

Mark Roddy
Lake Communications,
Sligo,
Ireland
mark.roddy@lakecommunications.com

Ioanna Roussaki,
ICCS, NTUA,
Athens,
Greece
ioanna.roussaki@cn.ntua.gr

ABSTRACT
We describe user research and user evaluation methodologies devised to resolve the challenge of engaging three distinct groups of users, who are not strong stakeholders, to participate in a cooperative user-centric development process for novel pervasive and social networking systems, proposed by the EU FP7 funded Information and Communication Technologies (ICT) project SOCIETIES. These methodologies provided wide-ranging data sources from behavioral to attitudinal, using natural, de-contextualized and hybrid settings. The paper gives an overview of how the range of techniques selected were flexibly employed and the resulting findings integrated across two different stages in the project's early development process.

Categories and Subject Descriptors
H.5.3 [**Group and Organization Interfaces**]: Computer-supported cooperative work, Collaborative Computing, Evaluation/methodology.

General Terms
Human Factors.

Keywords
Ethnography, online survey, participatory workshop, storyboards, pervasive communities, ubiquitous computing, social networking.

1. INTRODUCTION
SOCIETIES[1] is an EU FP7 funded ICT integrated project that has undertaken to consult with a broad group of users in the development of its ambitious and novel technologies, which combine the technologies of ubiquitous computing and the world of widely adopted social networking services. The core concept in SOCIETIES is that of pervasive communities. Individuals in pervasive communities use their own suite of social and pervasive technologies, known as a Cooperating Smart Space (CSS), to engage with other CSSs, which could belong to other people or pervasively attuned entities, in Community Interaction Spaces (CIS). Individuals may belong to any number of pervasive communities, and thus CISs, simultaneously. Individuals may also interact with other individuals without using CSSs through more traditional mechanisms. CISs can be formed on an ad-hoc basis or be planned and more permanent; they also have the ability to merge with other CISs, or splinter to form sub-communities.

The SOCIETIES consortium comprises sixteen partners from industry and academia across the European Union. It has identified three distinctive user groups, to represent a broad range of potential users, namely: the student group, the enterprise group and the disaster management group. In all three cases the groups have been selected so that they can participate throughout the life of the SOCIETIES project, from requirements gathering, to consultation and involvement in the design and development of the system. To date, users have been involved in user research and user evaluation activities via the diverse range of techniques overviewed in this paper. The primary Student Group is comprised of first year students from Heriot-Watt University in Scotland. (A secondary student group from ICCS in Athens was also engaged in the survey activities for comparison purposes.) The enterprise group is composed from people based in Intel's Innovation Open Lab in Leixlip, Ireland. The disaster management group is formed from assessment experts at the Assessment Mission Courses (AMC) of the European Civil Protection Mechanism, which take place in Cyprus.

However, SOCIETIES researchers' engagement with the groups is constrained by distance, time and user motivation. Whilst participative engagement including all stakeholders is desirable, for the most part the user groups, while willing to participate, were constrained by other commitments and their time available to participate was limited. Given this, it is challenging to devise suitable methodologies for user research and user evaluation. In particular, the methodologies had to be extremely flexible to provide users with multiple points for potential engagement based on their availability, and to adapt to the limits of distance between diversely located researchers and users. Furthermore, as the concept of community is so important to SOCIETIES, we felt that it would also be significant to capture both individual and group responses with each methodology.

In the paper we outline the triangulation of methods selected for the project's initial user research and employed to gather user requirements: observation via ethnographic methods, self-reporting via online surveys, and participatory workshops with scenarios, as presented in section 2. It also sketches how the scenarios devised from early participatory sessions with developers and potential users developed into early low-fidelity prototypes. These prototypes, which took shape in the forms of storyboards impregnated with questions for each user group and in one case, the student group a Wizard of Oz experiment, were employed for user evaluations, as described in section 3.

[1] http://www.ict-societies.eu

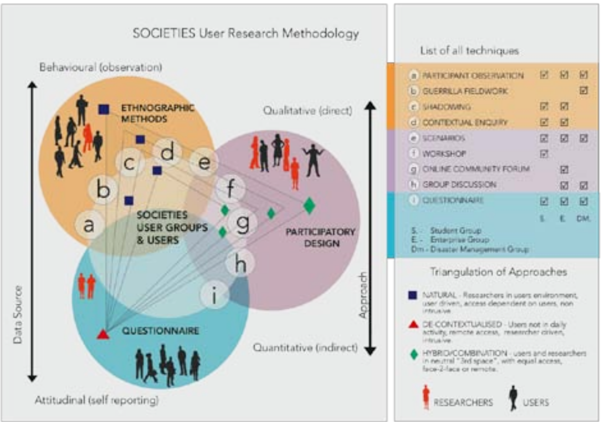

Figure 1: User Research Methodology.

2. User Research Methodology

The user research methodology, depicted in Fig. 1., was required to meet with the following objectives: 1) introduce users to the SOCIETIES novel technologies and concepts as imagined by the project researchers; 2) motivate users to participate through engaging with manifestations of project visions that are meaningful to them; 3) yield requirements from user research that would be initially informative to project development, 4) enable researchers to have some useful and empathetic insight into the lives, interests, and concerns of potential users; 5) utilize research activities that could be conducted in a minimal amount of time with little effort or disruption to the lives of the users; and 6) facilitate equal access interaction between the stakeholders of user groups and researchers with malleable project scenarios.

Initial scenarios for each group were devised from consortium brainstorming sessions. The student scenario was based in a campus and included creation of several CIS to facilitate services such as navigation, lesson reminders, and study groups. The enterprise scenario was based around organizing agendas, sharing information and making relevant contacts at a conference event. The disaster management scenario is created around an assessment mission for an earthquake disaster situation.

A triangulation of methods was employed which could feasibly be conducted over three to four days in direct contact with users, which included: observation via ethnographic methods, self-reporting via online surveys, and scenario led participatory workshops. In the case of each group the approaches used varied according to location, environment, user access and availability. Results from the three different approaches of user research were presented as ethnographic vignettes, statistical analysis, and updated scenarios.

2.1 Rapid Ethnographic Methods

SOCIETIES researchers engaged in rapid ethnographic techniques, such as participant observation, contextual enquiry, shadowing and guerilla fieldwork to gain insight and understanding of the everyday worlds of users. This research focused mostly on closely observing one or two individuals in their natural environment, and making some further 'wide-angled' observations. The results of this research were presented as ethnographic vignettes. The student observations include references to students' frustrations with access to expert support during laboratory times, their need for contact with family and friends, and their goals of obtaining part-time work. The enterprise ethnographic work took place at a conference, where attendees were noted to use a wide range of technology tools simultaneously, yet they were dependent on printed agendas for navigation. They often made efforts to stay connected to the office, and update colleagues. An objective of attending conferences was recognizing new opportunities and contacts, yet attendees found this to be serendipitous, as it was difficult to discern whom those most relevant new connections might be amongst the crowd. Users from the disaster management group were observed to be working under high pressure in training scenarios, simulating assessment activities in disaster affected areas with many unknowns, which could include capability of communications networks. They required access to reliable updated maps and multi-lingual information, and were prepared to use whatever technology was functional, reliable and feasible.

2.2 Online Questionnaire

An online questionnaire was devised collectively by the SOCIETIES consortium and sent to sample users from each group. The online survey had different sections: general demographics, technical audit, social networking audit, and community audit, as well as a section with questions specific to each group. The survey approach was de-contextualized and required users to extract themselves from their daily lives to take time to read, and answer; responses were anonymized. The statistical results make differences in users' approaches to using technologies for different social functions more apparent.

2.3 Participatory Design (PD) Workshops

Participatory Design workshops were chosen as a democratic, collaborative approach, to enable creative, cooperative development of SOCIETIES concepts; involving all the stakeholders. Scenarios were chosen as a key tool for the PD sessions as they function both, as a creative process for visioning exercises and as an empathetic narrative conduit for complex ideas and information. Initial scenarios demonstrating possible uses of SOCIETIES systems in the context of student, enterprise and disaster management situations were created in brainstorming sessions with researchers. These initial scenarios were introduced to users in the neutral creative third space of PD workshops [1], where users reacted to, altered, advanced these scenarios and often created new scenarios of their own. Techniques used varied in each workshop. For example, the student PD workshop employed brainwriting, brainstorming, and body storming, whereas the enterprise PD sessions took place in small groups and continued in an online discussion forum in a proprietry social network. The disaster management PD workshop took place over lunch as a more casual but focussed group discussion. The PD workshops brought researchers and users together to share ideas and forge creative understandings [2], which otherwise might not have been possible, through which visions of how pervasive communities could function in each groups's social setting were sketched. These new updated scenarios were presented as the results of the the participatory design workshops.

3. User Evaluation Methodology

The user evaluation methodology had similar, but different, goals: 1) it needed to demonstrate scenarios refined from the user research stage, filtered through the technical and market requirements, as malleable low-fidelity prototypes; 2) Those prototypes were expected to reflect the world of the users back to them so that users could recognize their contributions were effective and that their requirements were being addressed; and 3) to facilitate communication between designers, developers and users for applications of ubiquitous technologies that may not have purely functional or screen-based use cases.

A first user evaluation trial was planned to record user feedback to early low-fidelity prototypes, to take place in March and April 2011. The conclusions and updated scenarios from the user research conducted along with work done regarding technical and market requirements by project partners informed the prototypes. Ubiquitous computing has a strong requirement for contextual storytelling, in early evaluations [3]. This combined with the limited access to users, pointed us towards the use of storyboards.

3.1 Storyboards

Storyboards allowed researchers give consideration to the situations, emotions, interactions and context in relation to the artifact's intended use [4]. The storyboard creation and evaluation process that we used had several stages, described as follows.

An analysis phase where scripts were written and created based on earlier scenario work, and populated by characters or personas based on user research results. Scripts were validated against user requirements, and edited accordingly.

The second stage was the synthesis and prototyping stage, where concepts are formed into visual narratives, showing example applications of pervasive communities in each of our three user group environments, imagined over time. We chose to use Prezi, an animated zooming presentation tool to make the storyboards. Images, and text were placed within a storyline arc. Questions were generated and placed directly within the storyboards.

The third phase was the simulation phase, which dealt with representation of the SOCIETIES pervasive and social system in the storyboards and making the storyboards interactive. How to represent the SOCIETIES system in the storyboards was problematic because it is an innovative system, still in the process of being conceived and defined. We could not say with certainty which devices and pervasive technologies would be used or whether users would interact with the system through existing social networks or novel interfaces. We analyzed interaction patterns between users and the proposed system, guided by each specific script. We utilized basic unbranded interface elements, alongside familiar technologies such as mobiles and laptops, and novel devices utilizing motion detection sensors, location sensors, biosensors, remote video capture or unmanned aerial vehicles. Plain text was used to gauge the efficacy of pervasive social recommendations.

The fourth stage was evaluation. A closed social network was established with an area for each of the projects' three user groups. Each storyboard was presented on pages in the relevant group area, where researchers and users could comment or discuss the topics raised.

Users were invited to attend short workshops where the storyboards were presented. They recorded their individual answers to questions posed within the storyboards on paper questionnaires. In the case of the enterprise and disaster management groups, lively discussions followed, where users were given the opportunity to express their reactions, hopes, disappointments, fears and concerns in relation to how the proposed systems were represented in the storyboards.

The fifth stage is the integration of feedback back into the prototypes. This work will be undertaken by SOCIETIES in the development of further prototypes and user evaluations are planned within the project lifecycle.

3.2 Wizard of Oz Experiment

A secondary method for user evaluation that was used in the case of the student group only, is the Wizard of Oz (WOO). A WOO experiment immerses the trial participant in an environment that appears to them to do advanced things, but is actually controlled by a third party. The environment is intended to mimic the outcome of the project that the trial is being done for; hence for the SOCIETIES Wizard of Oz student trial, the environment is supposed to be a pervasive CSS/CIS driven one, set in a university campus. While the trial participant sees impressive displays that are taken at face-value as pervasive, all these things are in fact controlled by someone else using non-pervasive networking programs. The WOO trial could only validate a small number of user requirements, but offered users a more direct experience of the proposed systems than storyboards. It included trialing a novel interaction device – augmented reality glasses. The responses to questions posed to participants were in general more accepting of the proposed automated services and personalized pervasive communities demonstrated in WOO than in the storyboards.

4. Conclusion

The constraints imposed by limited and remote access to users and the small allocations of time allowed for user research for requirements gathering, and user evaluation of early prototypes necessitated an adaptive and flexible approach. However, using a suite of methodologies for user research, which included ethnographic methods, online surveys, and scenario based participatory sessions for user research, has afforded researchers with an in-depth understanding of user requirements, which in turn enriched prototypes generated for the first user evaluation exercises. An egalitarian analysis of envisioned future scenarios, has been made possible, for researchers and users, through the techniques of storyboards and Wizard of Oz. This has led users to question key aspects related to the project's proposed ubiquitous and social technologies, such as automation, privacy and trust in the system. The results from such varied methodologies, diverse opinions and ideas, are demanding to integrate back into the project; as they are not uniform, homogenized or simple. The findings are pushing researchers to explore unexpected directions in the project's development. While there is considerable effort required to engage with users about novel technologies, which they do not yet consider significant to their everyday environments, the potential impact of such systems on users' lives is such that it is essential to do so. Two further user evaluation trials are planned within the lifespan of the SOCIETIES project, as more advanced prototypes are developed, which will give potential end-users more scope to participate in the project.

5. ACKNOWLEDGMENTS

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Visualising and Interacting with a CAVE using Real-World Sensor Data

Carl Flynn
CASALA Research Centre
Dundalk Institute of Technology
Dundalk, Co. Louth
carl.flynn@casala.ie

Hyowon Lee
CLARITY: Centre for Sensor Web Technologies
Dublin City University
Dublin 9
hlee@computing.dcu.ie

Noel E. O'Connor
CLARITY: Centre for Sensor Web Technologies
Dublin City University
Dublin 9
noel.oconnor@dcu.ie

ABSTRACT

A CAVE (Cave Automatic Virtual Environment) is a 3D interactive environment that enables a user to be fully immersed in a virtual world and offers a unique way to visualise and interact with digital information. In this paper we build a foundation of CAVE interaction design by characterising generic affordances of such an environment and enumerating currently conceivable/implementable interaction mechanisms. In particular, we focus on how different aspects of the CAVE affordances relate to virtual worlds that are generated for the purpose of visualising and interacting with real-world sensor data. In support of this we present a case study which explores how the CAVE can be used to visualise and better understand data from 16 residential apartments where we have been collecting daily home usage information for the past year. We summarise our on-going work by demonstrating how the unique characteristics of the CAVE can be used to visualise this large quantity of heterogeneous data, which provides more novel possibilities than traditional data visualisation and interaction methods.

Categories and Subject Descriptors

H.5.1 [**Multimedia Information Systems**]: [Artificial, augmented, and virtual realities]; H.5.2 [**User Interfaces**]: [Input devices and strategies]

General Terms

Design, Human Factors, Experimentation

Keywords

CAVE, Ambient Assisted Living, Interaction Design, Visualisation, Sensor Data, Virtual Reality

1. INTRODUCTION

The Centre for Affective Solutions for Ambient Living Awareness (CASALA) is an advanced research centre based at the Dundalk Institute of Technology, with the primary focus of investigating novel Ambient Assisted Living (AAL)[1] technologies. As the demographics of the developed world shift towards longer life expectancy and older populations, AAL technologies offer us many possibilities to cope with the challenges ahead and improve the quality of life for older people [13]. As part of our AAL research programme, we are working directly with the elderly residents of the Great Northern Haven (GNH) apartments in Dundalk, Co. Louth, which is made up of 16 high-tech purpose-built two bedroom apartments. The building contains thousands of sensors and actuators as well as other interactive technologies. For example, sensors detect when a resident opens a window, starts a kettle, goes to a bedroom, etc. Our objective is to use the real-world data generated from these devices to develop new ways to promote greater levels of independence and well-being for older people. The data is also being used to develop behavioural models to promote early interventions and help decrease the rate of cognitive and physical decline as well as, ultimately, better enabling older people to monitor and manage their own health. To date, we have collected over 83 million records worth of daily usage information from the 16 apartments.

As part of this research we use a CAVE, an immersive virtual reality system, to develop and test new technological, environmental and architectural concepts and designs. The CAVE is a cube shaped room which offers a multi-person, multi-screen, high-resolution 3D video and audio interactive environment. The users enter the CAVE wearing 3D glasses and as they move and interact within the display boundaries, the correct 3D perspective is displayed in real-time to achieve a fully immersive experience. Using the CAVE we are able to virtually recreate the GNH apartments to-scale and in full 3D. The users can then navigate around the environment as if being there using different control methods and devices. Not only does this allow us to investigate different scenarios and sensors before they are implemented in the real world, it also allows us to feed the sensor data from the apartments directly into the CAVE. As we navigate around the environment we can visualise both the sensors and the data in a format that is most suitable to our needs.

This paper is organised as follows. In the next section, we briefly review ongoing CAVE related research. In Section 3,

[1] An integration of stand-alone assistive technologies, with elements of smart homes, and telehealth services

we describe a set of essential components that make up a typical CAVE setting, leading to Section 4 that lists methods and techniques to enhance the usability of the CAVE environment. Section 5 then goes on to describe various ways in which a CAVE user can interact with the environment. In Section 6 we summarise a case study where these design considerations are used to explore different ways to visualise and interact with GNH sensor data. Finally Section 7 concludes the paper with our plans and future work.

2. RELATED WORK

Since the creation of the CAVE in the early 90's by Carolina Cruz-Neira, Thomas A. DeFanti and Daniel J. Sandin [7], the Electronic Visualisation Laboratory based at the University of Illinois Chicago has remained at the forefront of CAVE and virtual reality research. Intriguingly, in spite of all the advances in technology over the last twenty years, it is surprising how little CAVEs have changed since they were originally shown to the world at SIGGRAPH'92. Other laboratories such as the 3DI lab at Virginia Tech University under the direction of Doug A. Bowman are carrying out exciting research in the area of virtual environments and particularly in relation to how we interact with them [2, 1, 3]. Their research into the area of 3D user interfaces is particularly relevant not just for CAVE environments but also the re-emergence of interactive 3DTV and other 3D enabled devices today. Increasingly important in this context is Microsoft's Kinect[2]. While Microsoft did not set out to develop a technology for CAVE interactions, their Kinect technology is creating fascinating new ways to interact with virtual worlds. Similarly, the emergence of Google's liquid galaxy project[3] is likely to have an impact on CAVE-based research. The Virtual Reality Applications Center at Iowa State University is another laboratory which is highly influential in the field of virtual reality and immersive environments. They have been prolific in both their research and ability to create spin-off companies related to the VR field, one of which, Mechdyne[4], is a leader in the set-up and development of CAVEs such as the one used at CASALA. For all the research into CAVE environments, however, there is significant scope for more research into the area of visualisation strategies and interaction techniques within a CAVE [4]. Exhibiting very different affordances to conventional desktop interaction or more recent mobile interaction, the currently available design knowledge base for the CAVE is limited. In this context it is clear that understanding the special characteristics and affordances of CAVE interaction will be the key to successfully exploiting the benefits of such a platform.

In terms of how virtual environments are being used for AAL research, pan-european projects such as VAALID[5] provide us with an interesting insight into how virtual reality simulation tools are being integrated into the development cycle to enable the rapid prototyping of accessible and usable AAL technologies [9]. VAALID is a promising if rare example of how virtual environments are attempting to drive the development of AAL technologies.

[2]http://www.xbox.com/en-IE/kinect
[3]http://code.google.com/p/liquid-galaxy
[4]http://www.mechdyne.com
[5]http://www.vaalid-project.org

Figure 1: The CAVE in operation

3. CHARACTERISING THE CAVE

The typical CAVE build is made up of 4 screens laid out similar to Figure 1 with each screen measuring between 2 to 3 metres in both width and height [6]. Each of the 3 vertical walls is a projectable screen with a projector sitting some distance behind it (perhaps up to 10 metres or more). Placing the projectors behind the screens prevents shadows being cast by users or other objects onto the image being displayed. The use of rear projectors means that CAVE setups generally require significant amounts of space in which to be housed, usually many times greater than the space of the user interaction area itself. These distances, however, can be reduced through the use of mirrors. The floor screen is made up of a down projection screen which can be walked upon by the user. Due to the distance required to project onto the screens, the floor projector is generally attached to the CAVE frame and uses a mirror to project down onto the floor. This is the typical physical structure of a CAVE, however, CAVE builds can be made up of more or less screens up to a maximum of six screens, such as the one implemented by the Virtual Reality Applications Center (VRAC)[6] at Iowa State University.

Of course, a key aspect of the CAVE is the ability to display full stereographic 3D images. This is typically provided through the use of stereoscopic 120Hz projectors, 3D shutter glasses worn by users and Infrared (IR) emitters to synchronize the glasses and screens. However, a similar effect can be achieved through the use of passive projectors and polarized glasses. Related to this, an important factor is ensuring that the CAVE is configured to display images across the screens as if on one large screen. This can be achieved through the use of a range of different software applications which are specifically developed for CAVE environments. These applications generally look after all aspects of the screen management as well as handling the virtual world object models and interaction, object tracking integration, controller integration and management of the different computing hardware involved.

Another key component of a CAVE is the use of head tracking in order to adjust the image displayed across the screens based on the position of the user's head in the CAVE. To

[6]http://www.vrac.iastate.edu/

demonstrate this, imagine standing in the centre of the CAVE looking at an image of a wall that is shoulder height on the screen in front of you. Behind the wall some distance away is the image of a tree. In the real world if we hunker down behind a wall, the trees behind it will be hidden from view. In the CAVE the head tracking replicates this scenario so as the user hunkers down in the CAVE the view will descend lower to the ground and the tree will no longer be visible behind the wall. In order to achieve this, our CAVE uses 10 IR cameras placed around the top edge of the 3 vertical screens. These are able to detect the exact position of 3 reflective balls that are placed on the user's 3D glasses providing the x, y and z co-ordinates of the user's head within the CAVE space. This is a widely used object tracking set-up, however, technologies such as Microsoft's Xbox Kinect potentially provide an interesting and much lower cost alternative to traditional tracking implementations.

All CAVEs require a method of interacting with their virtual worlds. This is something we will address in greater detail in Section 5. However, to date, joystick or gamepad style controllers similar to those used by many popular videogame consoles, as well as interactive gloves, are the most common devices for interaction.

Finally, all CAVEs require the necessary processing power to produce smooth and graphically detailed virtual worlds and enable the users to interact with them in a usable and meaningful way. There is no standard implementation, but our CAVE uses 5 Xeon quad core workstations each possessing 16GB of RAM and an NVIDIA Quadro video card, as well as a standard desktop PC to handle the object tracking.

4. ENHANCING IMMERSION

The objective of a CAVE environment is to provide as *immersive* an experience as possible into a virtual world [12]. In other words it is about trying to create an environment that absorbs the user so that they become unaware of the physical CAVE and its surrounds and fully experience and "believe" the three dimensional world that is generated for them. This is mainly achieved by the typical CAVE set-up as described in Section 3, but the following key elements can be used to further enhance the immersive experience:

Photorealism. In the context of the paragraph above, one could be forgiven for assuming that the level of immersion generated in a CAVE is all about the level of photorealism [8] but in reality it is more to do with the sense of depth and space that the virtual world conveys. A cartoon or abstract world can be just as immersive as one that is photorealistic. Techniques such as ambient lighting or global illumination [10] within a 3D world can have a significant impact on the sense of depth and space conveyed to the user.

Reduced Ambient Light. Not to be confused with the use of ambient lighting within a 3D scene, the ambient light we are referring to here is any light that is not generated by light thrown on to the screens by the projectors. The more ambient light there is the more the user notices the physical CAVE surrounds and the less immersive the experience. Ideally CAVEs should be set-up in windowless rooms and where any artificial lighting can be fully controlled.

3D Projectors. Projectors that are capable of displaying crisp and clear stereo 3D images are one of the most important aspects in enhancing the immersive effect of the CAVE. It is the 3D projections that provide the overriding illusion of depth in the virtual world. The resolution provided by the projectors can also help to support that effect with higher resolutions providing more defined images.

3D Glasses. Flicker-free 3D shutter glasses or high quality polarized glasses ensure the illusion of depth is effective.

Screens and Seams. The number of screens in a CAVE environment impacts the level of immersion felt by the user. A standard 4 screen CAVE provides a high level of immersion, particularly when a user is facing the centre screen. This ensures that the user's entire horizontal field of view (which is generally anywhere between 160 to 180 degrees) will be fully covered by the CAVE's 3 vertical screens. It is only if the user positions their head a significant angle facing away from the centre screen or up towards the ceiling that there is a break in the screen coverage. CAVEs with 6 screens can provide complete coverage.

Another important aspect to the level of immersion is the way in which CAVE screens are linked together. Any material other than the projection screen itself will interfere with the 3D illusion, particularly in the low ambient light conditions used in CAVEs. Many CAVE environments do not use visible seams and instead join the seams behind the screens outside the path of a projector's beam of light.

Audio Set-up. Depending on the type of 3D world the user is interacting with, the type of audio set-up may be of greater or lesser importance to the user. Assume we have a 3D world which is designed to assess a user's ability to identify and locate traffic sounds. Having multiple speakers placed at different points behind the CAVE screen would allow for the generation of traffic noise from multiple points and help users to correctly identify which direction a vehicle is coming from before they see it just as in the real world.

Hardware and Software Specifications. Ensuring that CAVE hardware and software can handle the 3D world to be experienced is essential. A 3D world that jitters and struggles to keep up with the user's movements will not provide for a usable immersive experience.

Object Tracking. Object tracking can add to the immersive experience in different ways. Most often object tracking is used to determine the positional co-ordinates of a user's head within the CAVE. This data is then used to adjust the image that the user sees on the screen as outlined in the earlier example of hunkering down in front of a wall with a tree behind it.

CAVE Floor Area. One of the limitations of a CAVE is the fact that its usable area is generally only $2m^2$ to $3m^2$. This means that a user's movements are significantly restricted. Ironically, due to the highly convincing immersive effect of most CAVEs, this can sometimes lead to users wandering towards the screens and becoming disorientated.

Interaction Methods. In addition to the key elements listed in this section, the mechanisms as to how a user interacts with the CAVEs virtual environments impacts on the level of immersion the user experiences which we detail in the next section.

5. INTERACTION IN THE CAVE

The methods we use to interact with CAVE environments is an extremely important and topical issue for many CAVE researchers [14, 11]. Study into the interaction strategies for CAVE environments is important because it can fundamentally change how a user engages with the virtual world they are presented with and topical because new advances in technology such as Microsoft's Xbox Kinect and Google's Liquid Galaxy project open up a whole new range of possibilities. In this section we enumerate currently available or conceivable interaction methods in the CAVE and their characteristics. Before doing so, it is worth highlighting some key questions that should be answered to help assess which methods of interaction would be most suitable for a particular scenario:

- What is the purpose of the virtual world?
- Who is that world created for?
- What type of world is being generated?
- What level of interaction is required?

So, for example, if the purpose of the virtual world is to assess a user's natural movements within a scene then perhaps we need to ensure that the interaction method is a very natural one; if the world is specific to older people perhaps the necessary interaction method would be different than that for a young adult; if the world being generated is an abstract environment such as a data model then perhaps we should provide the user with a more sophisticated navigation control for 6 Degrees of Freedom (DoF); if we want to allow the user to manipulate objects in a scene then perhaps this will require a specific interaction method that provides features to point, select, drag and stretch in some way. Depending on the envisaged usage scenarios the ideal type of interaction strategies for the CAVE will be different. So what are the interaction methods options available to CAVE users? The following are some of the main options available but are by no means exclusive:

Gamepad/Playstation-style controller. Gamepad controllers are already a familiar device for video gamers, typically the user holds the device with both hands and a number of push buttons and thumbsticks are conveniently accessible under thumbs and forefingers. While these controllers tend to prove very effective for those accustomed to them in both high DoF and low Dof situations, they can appear overly cluttered and non-intuitive to first-time users.

3D mouse. A 3D mouse is held freely in the hand and uses a trackball and buttons similar to a traditional mouse. It is typically compatible with tracking software giving it the possibility of 6DoF simply by turning, twisting and tilting the device. The simple design of a 3D mouse may prove more intuitive to some users than a gamepad controller and is particularly suitable for interacting with abstract worlds where significant degrees of freedom are required.

Fixed position joystick. An integrated joystick and stand (with perhaps one or two trigger buttons) provides an excellent method for interacting with a virtual world, particularly if it is a built environment scene where only a few degrees of freedom are required. Its fixed position helps users to focus on the virtual environment and eliminates the need to hold and carry a cumbersome controller. However, this may limit its usefulness in many situations and the fact that the joystick is placed on a stand will also block some of the user's view of the floor screen and may cast additional shadows.

Dance pad/floor sensor. A dance pad is a flat electronic controller that is placed on the ground and provides the user with interaction through the placement of feet on specific areas of the pad. Dance pads are typically used at home and in games arcades for dance based videogames and can be easily replicated through the use of floor sensors attached to a microcontroller. The advantage of a dance pad in the CAVE is that it does not require the use of a hand-held or on-body controller and it has the potential for a simple and intuitive interaction. However, interacting using foot placement alone may be restrictive and tends to force the user to concentrate on their foot movements rather than the virtual environment.

Interactive glove. Interactive gloves often use a finite number of sensors to detect the bending or stretching of joints and the pressure applied to fingertips. This, combined with a tracking mechanism, enables the user to simulate their hand position in a virtual world. Using hand gestures the user can then navigate through the world and manipulate and interact with objects. Anyone who has seen the movie Minority Report[7] can realise the potential. Unfortunately, most current glove controllers do not have the level of functionality, accuracy and sensitivity required for commanding generic functions such as pointing and selecting a button or manipulating a virtual object. In spite of this, it is worth noting that interactive gloves are still widely used in CAVEs.

Wand controllers. Wand controller is a somewhat generic term to define a particular style of controller device (of which there are many), here referring to devices such as the Playstation Move, Nintendo Wii-mote and Nintendo Wii Nunchuck. While each of these is quite different they also have key similarities: (i) they are all held or gripped in a similar way in one hand, (ii) they all contain accelerometers in order to determine the movement and rotation of the devices, and (iii) they all feature trigger buttons. While different devices have different additional features, they all have the potential to be used in a CAVE. We are able to integrate a Wii Nunchuck into our CAVE through the use of an Arduino[8] microcontroller. The advantage of the Wii Nunchuck is that it provides a very simple alternative to a standard gamepad with just one analog thumbstick and 2 trigger buttons. Yet it allows for the possibility of 6DoF, meaning that it has the ability to be useful in both built environment and abstract data interactions (see Section 6.1

[7]Minority Report (Steven Spielberg, 2002), DreamWorks and 20th Century Fox

[8]Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It is intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments.

for more detail).

Voice control. Using voice commands to control specific aspects of a virtual world adds a natural and intuitive interaction modality suitable for CAVE environments. Through the use of voice recognition software which can recognise words and sentences and then convert them into actions we have the possibility to better integrate users into the CAVE. Although voice control is generally not considered a primary interaction method it provides huge potential when combined with other natural interaction methods such as controller-free gesture recognition or haptic/aural feedback.

Phone and tablet apps integration. In certain situations the use of a smartphone or tablet device could be a useful way to interact with a CAVE. Using custom-built apps, the device can be used to interact with a built environment situation in real-time in the CAVE. So, for example, we could use the device to simulate a home automation control panel (e.g. turning lights on or off, activating an alarm or opening and closing blinds). This would give us the ability to easily simulate and test potential real-world scenarios. In terms of interacting with abstract data visualisation the device could also be used to feed data directly back into the CAVE and adjust the data in real-time rather than through a computer placed outside of the CAVE space.

Body sensor-based recognition. The possibility of being able to interact with a CAVE environment by thought alone is an exciting prospect. Devices such as Emotiv Systems EPOC neuroheadset[9] offer the promise of thought based interaction via neuro-signal information which is collected from multiple sensors placed on the users head. Unfortunately, there remains a big question mark over the accuracy and usability of such devices.

There are many other types of body sensors (e.g. sensors for monitoring heart rate, body temperature, fall detection, etc.) which also offer the possibility of interacting with CAVE environments. So, for example, we may want to use a body sensor in the CAVE to help simulate a real-world scenario (such as a fall) which when detected activates an alarm in the virtual home.

Computer vision-based gesture recognition. An alternative way of recognising human gesture in the CAVE environment is by using computer vision techniques to provide "controller-free" interaction whereby the user does not have to hold any physical device or sensor. In this regard, the Microsoft Xbox Kinect offers probably the most exciting new method of interaction for CAVE environments. The Kinect has already been successfully integrated into our CAVE and allows its users to interact with virtual environments using body gestures alone[10]. The Kinect is able to detect multiple large objects such as people's bodies and their exact position within a space, but also fine details such as individual finger movements at specific ranges. Using FAAST(Flexible Action and Articulated Skeleton Toolkit) we are able to generate a simple skeleton over a user's body image. Once this is done we can configure FAAST to detect specific skeletal movements and tolerances (i.e. clearly detect detailed body actions) and translate them into actions in the virtual environment. All this is achieved through the low cost Kinect device which uses nothing more than an RGB camera, infrared depth sensor and microphone array.

Object tracking. When we think of object tracking we often think of head tracking which adjusts the image we see on the screens based on our head position. However, because we know the exact positional co-ordinates of our head or any other object that is being tracked within the CAVE space, we can also use this information to interact with the CAVE in other ways. One way is to use object tracking to generate a virtual pointer from a controller device allowing the user to select, move and manipulate objects and menus in the virtual world. Another way would be to trigger certain actions when a tracked object is within specific co-ordinate positions within a CAVE space. So, for example, we could trigger a light being switched on in a virtual room when our tracked object was below a certain height (this could simulate the scenario of a light being switched on if someone fell to the ground at night).

6. CASE STUDY: THE GREAT NORTHERN HAVEN SENSOR DATA

6.1 Data Visualisation in the CAVE

The core of CASALA's research is based around the real-world data being generated at the 16 apartments that make up the GNH complex in Dundalk, Co Louth. With thousands of sensors gathering vast amounts of data on all aspects of the apartments 24/7, we are in the enviable position of having access to information that is not only immense in quantity and detail but which is generated by real people living real lives. The entire building contains a total of 2,240 sensors and actuators with 100+ in each individual apartment in addition to other interactive technologies (such as internet televisions and touch screen tablets). The sensors include door and window contact sensors, presence sensors, temperature sensors, light sensors as well as water, heating and electricity usage sensors. Every time a sensor is triggered the data is instantly recorded in our central database. With this data we can better understand the day to day actions and activities of the older people living in the apartments and in the process help to develop, implement and better utilise AAL technologies. It is through these technologies that we hope to add tangible benefits to the overall health and well-being of older people and help them to live longer and more independently in their home of choice. The work is being developed in close partnership with the residents of the GNH to ensure that the technologies being developed and implemented provide a real benefit to them.

The CAVE provides us with the ability to work with the data gathered from the GNH and visualise and interact with it in very unique ways. Through the CAVE we have the potential to better understand and interpret the data being collected as well as replicate potential scenarios or even interact with or feed data back to residents in real time.

In terms of visualisation, our key focus in this paper is on how we view real-world sensor data in a CAVE environment. In this context we have concentrated on two approaches.

[9]http://www.emotiv.com/
[10]See a video demonstrating this at:
http://www.youtube.com/watch?v=fxnMMVy9tFU

The first, termed *Built Environment Data Integration Visualisation*, concerns how we can present data in a 3D representation of a real world environment. The second, termed *Abstract Data Visualisation* investigates how we can present data in an abstract way that provides us with useful and important information that we cannot obtain from standard two dimensional graphs and charts. To demonstrate each of these methods of visualisation leading to our apartment data, we give a simple example of how each of these might be implemented:

6.2 Built Environment Data Integration Visualisation

Imagine that a user is standing in the CAVE in the middle of a 3D model of a kitchen containing all the usual kitchen appliances such as fridge, cooker, kettle, toaster, microwave etc. Now let's assume that each of these electrical appliances represents an appliance in a real-world kitchen and each of these electrical appliances is connected to a sensor which monitors usage. Using the data collected from the real-world kitchen we can feed that information directly into our 3D model where we might for example see a label with each appliance informing us of its usage details or perhaps use heat mapping to indicate the appliances that are used most (or which use the most electricity). Perhaps we might even use the information to indicate movement and usage around a home which could be represented by an avatar moving from appliance to appliance. In each case we are feeding data directly into the 3D representation of the real world enabling us to interpret the data in completely different ways.

In this scenario we generate a three dimensional model or representation of one of the GNH apartments in the CAVE in full stereo 3D. This allows CAVE users to immerse themselves in the virtual apartment. Using one of the many interaction methods discussed in Section 5 we can then start to navigate and explore that world as if we were walking around the real apartment. This scenario on its own provides an excellent way to assess the suitability of building design for specific requirements. We have already engaged older volunteers to assess the GNH apartments where issues such as counter heights, shelf heights and turning cycles for wheelchair access were some of the specific topics identified and discussed. Once a particular issue is identified then the virtual model can be quickly modified and re-assessed.

The next step we have taken is to integrate sensor objects, sensor data, trigger points and actions within the virtual apartment. In this case we highlight different sensors throughout the virtual apartment with a red marking to make them easily visible. If a user navigates close to one of the markings it will trigger the generation of a clock plot graph using data from a real apartment. This will provide the user with a visual representation of sensor activity over a defined period of time (see Figures 2 and 3). Using this method the user can identify a sensor in its proper context and instantly view the data in a clearly interpretable and understandable way.

This Clock plot can be easily deciphered once we comprehend the elements that constitute it. Firstly, we need to realise that each colour marking on the clock plot represents a point in time when the sensor has been triggered (remember this clock plot is showing information for just one sensor in the home). Next we need to view the plot similar to how one would read a traditional clock face. In this case, however, a full 360 degree rotation of our "imaginary" hour hand represents 24 hours instead of 12. This allows us to visualise the activity of a sensor in a 24 hour period in a very clear manner. The next element that makes up the clock plot is the layering of these 24 hour rings starting from the centre point of the circle with each new ring wrapping itself around the outer edge of the last one. This allows us to view the activity of the sensor over a period of many months rather than just one day and enables us to identify and compare patterns of behaviour. Finally, we can use additional colour codings within the plot to further identify specific elements. In this case we have separated weekday and weekend data using blue and green colour markings.

Once we understand these elements we can start to see clear patterns of activity where the sensor is being triggered. So,

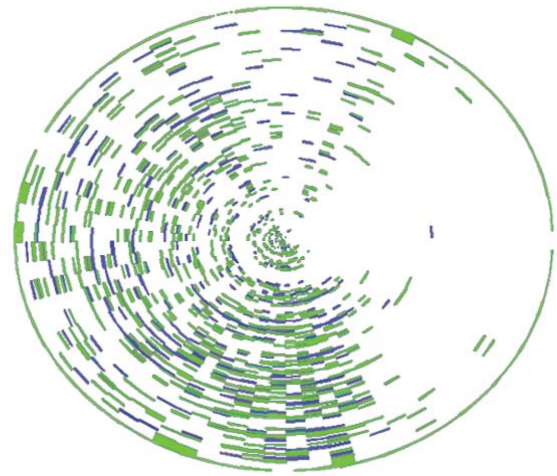

Figure 2: Clock plot displaying data from one individual sensor at the Great Northern Haven

Figure 3: Displaying Great Northern Haven PIR sensor data using a clock plot within the CAVE

in the case of the clock plot as illustrated in Figure 2, we can easily identify that the left-hand side of the clock face has a lot more activity than the right-hand side. The activity on the right-hand side of the plot relates to night time activity and the left-hand side relates to day-time activity. We also start to identify clear lines and clusters of data demonstrating particular activity periods as well as what appears to be a difference in patterns of behaviour between weekdays and weekends. This is just one example of how integrated clock plots can be a powerful and effective tool in helping us to understand and interpret large quantities of sensor data.

Now that we have the sensor data within the CAVE we can use different methods to learn even more about the activities within a particular apartment. Using heat mapping we have the ability to apply different colours to specific zones where sensors are being used. The more a sensor is being triggered, the hotter (or redder) that zone becomes. This allows complex sensor activity data to be displayed in a way that can be easily visualised by the CAVE user. Generating heat mapping on a model in a time lapsed manner could help in identifying interesting behaviours or patterns within an apartment.

Keeping in mind the idea of generating a time lapse sequence, the CAVE also offers us the possibility of playing back actions and activities of a particular apartment over varying time frames and speeds. So, for example, we can use an avatar to represent a person triggering sensors within an apartment and simulate any resulting actions such as doors and windows opening and closing, lights turning on and off, or any other identifiable electrical appliance being switched on or off at the same time that we ourselves are immersed in the environment observing it all happening. Integrating the temporal aspect within the spatially-oriented world can be designed in such a way as to explain and narrate a set of phenomena or stories in a coherent way, ultimately turning into a 3D CAVE version of a "visual confection", an assembly of many visual events, selected from various streams of story then brought together and juxtaposed [15].

Finally, we are able to integrate live video feeds into the virtual worlds generated within the CAVE. This opens up the possibility to do what can best be described as a "reverse augmented reality" i.e. superimposing a real world image onto a user's view of a computer-generated CAVE world. This means we have the potential to immerse ourselves in the CAVE and at the same time engage in a live video and audio feed with one of the residents in their home at the GNH.

6.3 Abstract Data Visualisation

Using the same example of collecting data from the electrical appliances of a real world kitchen, instead of using a 3D representation of the kitchen in the CAVE to view that data, this time we generate three dimensional charts using the data. Let's assume we wish to monitor the usage of a kettle every day for a period of one month. A standard two dimensional graph can easily provide us with that information. However, using the CAVE we can now add depth to the data and transform this graph in to a three dimensional graph allowing us to show not only an x and y plane but also a z plane and in full stereo 3D. This means that

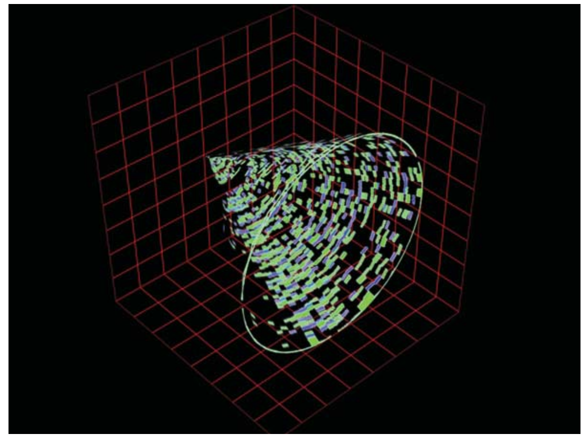

Figure 4: Three dimensional clock plot

we can now map the usage data to the x plane, the daily time data to the y plane and the monthly time data to the z plane producing something similar to a terrain map. Although this is a relatively simple example, the CAVE offers us the potential to visualise vastly more complex data and perhaps more clearly identify patterns within it. Due to the almost complete immersion provided by the CAVE we also have the ability to visualise and compare vast numbers of complex datasets set side by side, layer by layer in a way which would not be possible using traditional monitors or screens.

Although still at an early stage of our CAVE development, one of the first steps we have taken is to gather data from the apartment sensors and generate three dimensional versions of our two dimensional clock plots within the CAVE (see Figure 4). For example, if we take data from a living room presence sensor we are able to generate a three dimensional cone that shows us every time that sensor was triggered within a 24-hour period. This is then enhanced by presenting that data over a period of 6 months represented by colour markings positioned along the depth of the cone. Individual colour markings can then also highlight specific days of the week or a simple weekday/weekend mix. All this information displayed within an immersive three dimensional cone helps to better illustrate and interpret the breakdown of the resident's activity within the living room during the specified time.

Three dimensional clock plots are one of the primary methods we are currently using to visualise our data but we are also looking at many other suitable methods such as 3D surface maps, 3D scatter plots, 3D bar charts, etc. They all have the ability to teach us something new about the data within the immersive setting of the CAVE. 3D scatter plots using data from multiple sensors and which are colour-coded have the potential to provide us with similar information to heat maps within a built environment model but without the need to model a representation of the apartment where the sensors are installed.

Because the CAVE can generate what appears to be an in-finite expanse to its users, we can display large numbers of three dimensional charts, plots and graphs at any one time and in any position within a three dimensional space. This allows users to easily compare and interact with large numbers of different datasets at any one time. We are currently working on a number of combinations of these while identifying and recording various visualisation and interaction issues arising from applying each of these to our CAVE environment.

7. CONCLUSION

Visualising and interacting with real-world sensor data in a CAVE can be a powerful tool in a research environment. It has the ability to immerse users and present data in truly unique ways. The oft-used phrase "it has to be seen to be believed" still has some merit in relation to the CAVE. Its ability to mix virtual and real-world elements in such an immersive way can be both fascinating and highly informative.

For this paper we have focused on a specific aspect of CAVE use. However, new technological developments such as the Google Liquid Galaxy project (which enables us to view Google Earth and Street View across screens), Xbox Kinect integration (which offers controller-free interaction) and the latest synchronizable WebGL browsers (enabling plugin free 3D) offer us many exciting new avenues for CAVE research.

While there is no doubt that CAVEs can be extremely beneficial, they are costly (particularly in terms of the initial financial investment required), even if there are exceptions to the rule [5]. They also require a significant investment of time in order to be able to generate useful and valuable results. Challenges in terms of its usability include motion sickness and fatigue when used intensively or for an extended period of time, user training for the modalities and controllers provided, and the lack of current usage resulting in difficulty to find more practical but novel use scenarios today, all of which provide directions for future research.

We have been able to use sensor data in new ways that enhance our understanding of the lives of the GNH residents. This has been possible because of the unique data that CASALA has available to it and the unique resources such as the CAVE that the research team has at its disposal. Through the visualisation and interaction of real-world sensor data in the CAVE we are able to interpret information in entirely new ways and in the future better understand how we can use AAL technology to improve levels of independence and well-being for older people.

8. ACKNOWLEDGEMENTS

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Usability in Mobile Learning: Results from a study of learning under varying levels of extraneous cognitive load.

Robin Deegan
Cork Institute of Technology
Cork city
Co. Cork
IRELAND
robin.deegan@mycit.ie

Paul Rothwell
Cork Institute of Technology
Cork city
Co. Cork
IRELAND
Paul.Rothwell@cit.ie

ABSTRACT
In this paper we present the findings of an experiment carried out to measure the effect of environmental factors on the usability of mobile devices used for learning. We draw on current research on 'cognitive load theory' to inform the experiment design. Learners, when using a mobile device, are subject to three types of demand on their cognitive resources: one due to the intrinsic complexity of the material being learned, another due to the cognitive demands of the learning activity itself, and finally a demand that is extraneous to these and due to a combination of the use of the physical device itself (the hardware and software interfaces) and the distractions of the environment. This study indicates that using a mobile device while travelling through a changing environment can result in approximately 12% increase in Cognitive load, 3.9% decrease in performance and 4.5% decrease in learning. These effects persist once the environment stabilises. A model of this extraneous cognitive load can be developed and presented that, when applied, can inform future developers of mobile applications on the effects of the environmental distractions that occur when a user is operating a mobile device.

Author Keywords
Mobile usability, Mobile HCI, m-learning, cognitive load.

ACM Classification Keywords
H.1.2 [User/Machine Systems] Human factors, Human information processing, Software psychology.

General Terms
Measurement, Performance, Experimentation, Human Factors, Standardization, Theory.

INTRODUCTION
Mobile devices are used both by a user on the move through changing environments (whilst walking, travelling on a bus, etc.) and by stationary users in a variety of environments (a park bench, cinema lobby, etc). Both scenarios present difficulties for users because of the distracting effect of the uncontrollable environments.

Recent research into the usability of mobile devices focuses heavily on the interaction between the user and the device itself. The design of the software and hardware are the predominate foci. However, little research exists that focuses on the effect that multiple environments have on our cognitive performance. How does the environment affect our cognitive processing as we use mobile devices?

Cognitive load theory [2] attempts to inform the design of instructional material by providing an understanding of the demands of the various cognitive activities involved in learning. In earlier work we have outlined how research in 'cognitive load theory', can be applied to the investigation of the usability of mobile learning (mLearning) applications. [3]

The goal of this paper is to present the results of a study into the effects of changing environments on learners using mobile devices and help suggest a model of cognitive load that can be considered by application designers to counteract these challenges.

Currently application designers will use HCI / usability design guidelines such as usability heuristics [17] to help design suitable applications. It's hoped that this work could help inform similar heuristics specifically related to cognitive load that could add to existing usability heuristics and could be used by the application designers.

This paper reports on research carried out with a view to exploring the effect that multiple and changing environments have on our cognitive performance when using mLearning applications. Here we begin with a brief outline of mobile learning and cognitive load theory and go on to describe and discuss an experiment designed to attempt to measure the effect of environmental factors on cognitive performance when using an mLearning application.

MOBILE LEARNING
Mobile learning is a cognitively demanding task [8]. Technological advances in mobile computing and the ubiquitous use of mobile devices have further led to the challenges presented both to learning with the use of mobile devices and to the development of mobile learning applications. Learning can be a difficult activity and as learners use more mobile technology to assist learning, application developers should consider using that same technology to help recognise and limit the effect of distractions (context aware computing).

Sharples, for example, points to the need for learners to control the pace and style of learning when in a mobile environment. He also highlights the need for technology to share control with the learner [5].

COGNITIVE LOAD THEORY
'Cognitive load' refers to demand placed on the resources of working memory in the performance of cognitive tasks. Because working memory has a limited capacity, our capacity to handle cognitive load is limited [1, 2].

Cognitive load theory is predicated on a model of cognitive architecture, outlined by Baddeley [15], where working memory and long-term memory co-operate in conscious cognitive activity. Working memory has a limited capacity such that it can only deal with about seven 'elements' at a time, the more complex these elements, the more complex the cognitive tasks that can be handled. Complex elements are supplied as 'schemas' by long-term memory. Schemas are built by working memory and encapsulate learned knowledge that is stored in long term memory.

Types of cognitive load

Sweller *et al*, [2] describe cognitive load as consisting of 3 parts:

1 – Intrinsic Cognitive Load: The load associated with the inherent difficulty of the task;

2 – Extraneous Cognitive Load: The load associated with all mental activity not directly associated with the task.

3 – Germane Cognitive Load: The load associated with schema creation, essentially it is the load necessary to process the intrinsic cognitive load i.e. to learn [4].

Sweller argues that intrinsic cognitive load (ICL) cannot be changed by any means other than changing the task or the knowledge of the participant [4]. As the participant progresses through the task and 'learns', their knowledge increases and so intrinsic load decreases. This is because working memory has access to more complex elements through the schemas created.

Extraneous cognitive load (ECL) is the demand placed on mental resources due to cognitive activity not directly associated with the task. Dealing with aspects such as unnecessary/redundant information, interpretation and navigation of the instructional design and user interface, etc. all contribute to extraneous cognitive load. Also external elements, such as ambient noise or light, beyond the control of the user/task designer can add to extraneous cognitive load.

Germane cognitive load (GCL) is the demand placed on mental resources due to the necessary cognitive activities of schema creation associated with learning [4]. GCL is also responsible for the interpretation, processing, and automation of schemas. Basically GCL is the load applied to working memory that converts data interpreted by our senses into long term memory, and is fundamental to the process of learning.

Changing load

As we learn, both ICL and GCL will change (with knowledge learned) but ECL should remain static (assuming that the environment, equipment and task remain the same). This makes measuring the individual loads quite difficult as we cannot differentiate between extraneous, intrinsic and germane loads [3]. All we can do is measure the total cognitive load.

The challenge to measure ECL and develop a predictive model of ECL became the goal of the experiment. It was decided that a predictive model for extraneous cognitive load should be considered so that a mobile device could identify any potential increases in extraneous load allowing developers to try to adjust the learning content to suit. Essentially a context aware learning application, when aware of the environment, could change the learning content to suit the level of predicted cognitive load that the user is experiencing.

METHODS

In previous work, strategies for measuring and managing cognitive load were explored [3] and CL assessment methods for the experiment were chosen based on this work. Participants in the current study completed a task, within the application Brain Challenge Lite[1], on an apple iTouch.

The experiment participants were organised into three groups. Each member of each group completed three sessions with the application. The three groups were subjected to a different sequence of environments for their three sessions.

The 'Control' group completed all three sessions in a quiet office-like environment. The other two groups completed their first and last sessions in the same office-like environment but had their second session environment manipulated. The 'Simulated' group were subjected to a session two environment created by the experiment designers (the lights were turned low and a distracting video was played in the background[2]). The 'Natural' group were subjected to a normal everyday session two environment where they were required to walk through the college corridors and canteen area (Table 1). After each session each participant completed a NASA TLX[3] questionnaire. The NASA TLX is a widely used subjective tool that is used to give an approximation of cognitive load.

	Control	Simulated	Natural
Session 1	Application use in office-like environment. Complete TLX	Application use in office-like environment. Complete TLX	Application use in office-like environment. Complete TLX
Session 2	Application use in office-like environment Complete TLX	Application use in office-like environment with artificial environmental Stimuli. Complete TLX	Application used while walking with natural environmental Stimuli. Complete TLX
Session 3	Application use in office-like environment. Complete TLX	Application use in office-like environment. Complete TLX	Application use in office-like environment. Complete TLX

Table 1 - Test groups and sessions

Participants

An *a priori* power analysis was completed to determine an appropriate sample size. The significance criterion was set at the conventional value $\alpha = 0.05$. To achieve the statistical power of 0.80 ($1-\beta = 0.80$) the effect size was defined as large. It was determined that each group should have a minimum of 21 participants [6].

72 people took part in the experiment. No demographic data was recorded. All participants were either students or lecturers. All participants were randomly distributed to one of the 3 groups.

[1] http://www.gameloft.com/mobile/brain-challenge/
[2] http://www.youtube.com/watch?v=gPxPC3ZFt4g
[3] http://humansystems.arc.nasa.gov/groups/TLX/

Design and Procedure

Five iPod Touches were used so that five participants could complete the experiment concurrently. To motivate participants to participate each was entered in a draw for an iPod Touch.

Gonzalez *et al.* conducted a review of cognitive games for the aging [7]. Based on this review the application 'brain challenge lite' was selected for use. Brain challenge lite is aimed at adolescents, and targets the following cognitive functions; memory, visual attention, executive functions and calculation. The users were presented with simple puzzles by the application and rated for the speed with which they solved the puzzles (fast, normal or slow) and also their accuracy. Fast is completing the subtask within a second or two, and slow is completing the subtask in a time greater than four or five seconds, approximately.

One of the drawbacks to measurements involving cognitive performance is that participants' cognitive abilities vary thus making direct comparisons problematic. To limit this, each participant was asked to complete the task three times. The results from each session were analysed and the differences between the sessions were compared to other participants' differences, rather than comparing participants' performances directly.

Experiment

A pilot experiment, with six participants, was conducted in September 2010. The main experiment ran from November to December 2010. Each session of the main experiment took approximately 6 minutes for a participant to complete. Written permission to use data gathered during the experiment was obtained from all participants and a briefing was also supplied to all participants in advance of the experiment.

Null Hypotheses

1) A change in the physical environment, when the user remains stationary, will not cause an increase in extraneous cognitive load.

2) Moving from one physical environment to another in any environment will not incur a change in extraneous cognitive load.

3) Changing environments and exposure to environmental stimuli will not affect the learning performance.

Analysis

The application kept a record of results and these results were used to indicate performance, learning and cognitive load. Also the participant completed a NASA TLX questionnaire and the results of this were used to indicate cognitive load. The use of both approaches was intended to give a clearer understanding of the effect that the environment has on extraneous cognitive load.

A one way ANOVA [16] was used to determine any statistically significant difference between the 3 groups and if a difference was found a simple t-test confirmed the group causing the difference. Multiple elements were changing (light, sound, motion etc.) but for this experiment these were considered as one variable – the environment.

TASKS

Each participant completed the 'Daily Challenge' within the Brain Challenge application. It consisted of five tasks. And within each task there were 10-20 subtasks approximately. All five tasks were completed in each session. These tasks tested the following cognitive activities: memory, visual attention, executive functions and calculation [7]. [4]

Data elicitation

For this study the following data were obtained from the application:
%correct – this is the percentage of tasks completed correctly.
%fast – this is the percentage of tasks that were completed correctly at a fast rate.
%slow – this is the percentage of tasks that were completed correctly at a slow rate.
The difference between every session was also noted and is indicated below as follows: e.g. 'Δ1,2 %slow' denotes the difference between the %slow scores in the first and second sessions.

As already stated, the standard NASA TLX questionnaire was used. In this questionnaire the participant was asked to answer six questions on a rating scale from 0-20 [8]. Each individual score was added and the total for each session was determined. Again the difference between each session was noted and is indicated as follows: e.g. 'Δ1,3 TLX' denotes the difference between the TLX results in the first and third sessions.

Finally, observations were recorded by the experiment facilitator if anything exceptional occurred.

RESULTS

Overview

From a high level the results demonstrate that a statistically significant difference was identified between the first and second sessions across all groups and this was noted in the TLX and application data. However the application data noted a statistically significant difference between the first and third sessions whereas the TLX data noted a difference between the second and third sessions among all groups.

One statistical outlier and five outliers, from the observation notes, were identified. One individual left abruptly mid session (his sessions were cancelled as along with the other participants' simultaneous sessions). Therefore the results from sixty-six participants are presented, twenty-two in the control group, twenty-one in the simulated group, and twenty-three in the natural group.

The following sections will explain the ANOVA results and then proceed to delve deeper into the actual TLX and application (%correct) results of the ANOVA specifically where a statistically significant difference was found.

ANOVA results

Table 2 shows a summary of the twelve ANOVA tests that were completed. Results from the %fast and %slow data showed no statistically significant difference for either 'Δ1,2'`(difference between first and second session), 'Δ1,3'(difference between first and third session) or 'Δ2,3' (difference between second and third session) between all groups. It appears that the environmental distractions had no effect on the completion time of these specific tasks.

[4] Space does not permit a full description of the application.

	Δ1,2	Δ1,3	Δ2,3
Sig. Diff. %correct	Yes	Yes	No
Sig. Diff. %fast	No	No	No
Sig. Diff. %slow	No	No	No
Sig. Diff. TLX	Yes	No	Yes

Table 2 Summary of results from ANOVA

Table 2 also shows that a statistically significant difference was noted when analysis was completed on 'Δ1,2' and 'Δ1,3' when the results of all the groups' %correct data was compared. Also a statistically significant difference was noted when analysis was completed on 'Δ1,2' and 'Δ2,3' when the results of all the groups' TLX data were compared.

In the following sections specific ANOVA analysis will be presented in table, 3, 4, 5 and 6. These tables show summary information of the three groups. They display the count (number of participants in each group), the sum of each group's results, the average and the variance of the results. The table also display's the ANOVA specific results between and within the groups. For this experiment only the P-value (highlighted in red) was required.

The P-value is the probability of seeing results as or more extreme as those actually observed if the null hypotheses were true. As 'Δ1,2 %correct' (table 3) has a p-value of 0.0005, this implies that for another test there is only a 0.0005% probability of observing similar results so as this is less than the set alpha level of 0.05 the hypotheses can be rejected.

%correct analysis

Table 3 and table 4 below display the ANOVA results for the %correct data.

SUMMARY						
Groups	Count	Sum	Average	Variance		
Control	22	33	1.5	25.69048		
Simulated	21	83	3.952381	26.24762		
Natural	23	-55	-2.3913	27.52174		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	452.6906	2	226.3453	8.539129	**0.000523**	3.142809
Within Groups	1669.931	63	26.50684			
Total	2122.621	65				

Table 3 – Δ1,2 %correct

SUMMARY						
Groups	Count	Sum	Average	Variance		
Control	22	92	4.181818	45.77489		
Simulated	21	140	6.666667	41.33333		
Natural	23	-8	-0.34783	25.23715		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	560.6008	2	280.3004	7.536382	**0.001163**	3.142809
Within Groups	2343.157	63	37.19296			
Total	2903.758	65				

Table 4 - Δ1,3 %correct

As expected the environment influenced the results between the first and second sessions and also the first and third sessions. ANOVA between the three groups resulted in a P-value of 0.0005 and 0.001 for the 'Δ1,2 %correct' and 'Δ1,3 %correct' respectively.

Further investigation of the results here show that the statistically significant difference comes from the natural group alone. The simulated group did not show any difference when the environment was changed.

Furthermore ANOVA analysis of 'Δ2,3 correct' did not show any statistically significant difference between groups. This seems to imply that the effect that the natural group felt when confronted with the natural environmental stimulation remained after that stimulation was removed. That is, as the participants from the natural group completed the third session it was expected that they would revert to normal levels (their %correct scores would return to the same as their first session results) but they did not. Their results barely changed from the second session, perhaps showing that the negative effect induced by the natural environment remained when they returned to the quite room where they completed the first session.

TLX analysis

Table 5 and 6 display the ANOVA results for the TLX data.

SUMMARY						
Groups	Count	Sum	Average	Variance		
Control	22	162	7.363636	96.90909		
Simulated	21	101	4.809524	177.3619		
Natural	23	434	18.86957	241.8458		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2507.32	2	1253.66	7.243972	**0.001474**	3.142809
Within Groups	10902.94	63	173.0625			
Total	13410.26	65				

Table 5 - Δ1,2 TLX

SUMMARY						
Groups	Count	Sum	Average	Variance		
Control	22	-17	-0.77273	39.42208		
Simulated	21	-95	-4.52381	194.0619		
Natural	23	-389	-16.913	264.2648		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	3219.027	2	1609.513	9.636039	**0.000223**	3.142809
Within Groups	10522.93	63	167.0306			
Total	13741.95	65				

Table 6 – Δ2,3 TLX

As expected the environment influenced the results between the first and second sessions and also the second and third sessions. ANOVA between the three groups resulted in P-values of 0.001 and 0.0002 for the Δ1,2 %TLX and Δ2,3 %TLX respectively.

A statistically significant difference was in fact noted between the first and second sessions. Further analysis of the results again confirmed that the simulated group did not have any reaction at all due to the environmental change. Only the natural group showed a statistically significant difference implying that the environmental distractions had a dramatic effect on the perceived difficulty.

However in contrast to the %correct results there was no statistically significant difference between the first and third session. However there was a difference between the second and third session. Again this difference was limited to the natural group.

Summary

These results indicate a distance affect on ECL from the environment factors. ICL and GCL are assumed to remain static so observed changes to cognitive load are seen to be caused by extraneous factors. The TLX data suggests a difference between the first and second session and also the second and third session and the %correct data suggests a difference between the first and second session and the second and third session. The following section will now explore the actual TLX and %correct results and will attempt to determine the approximate performance effects of these factors.

DISCUSSION

Overview

Interpretation of these results implies that there is a statistically significant difference between groups when a participant completes the same task while moving between different environments. Therefore the null hypotheses 2 and 3 can be rejected.

The null hypothesis 1, however, has been proven and it is accepted. There is no difference in extraneous cognitive load when the environment was changed and the participant remained stationary for this experiment. However there still remains the question of whether the participants were in fact under-loaded in this scenario; perhaps it is possible that the tasks may not have been intrinsically complex enough to allow any effect to be noticed when the extraneous load was increased. Future research should address this.

Increased cognitive load

The natural group showed a significant increase in cognitive load when they completed the second session (under natural environmental conditions walking through the college) in relation to the first session ($\Delta 1,2$) for both the %correct and TLX data. This implies that the visual, audio, tactile and motion distractions presented to the participant proved too resource hungry for the participants cognitive performance and as such cognitive processing was overloaded.

The natural group showed a very interesting discrepancy between the %correct application data and the TLX data. The application data records the actual performance and the TLX records the participant perceived performance.

Only the %correct results showed a statistically significant difference for the $\Delta 1,3$ and the TLX results did not. Also the natural group's %correct $\Delta 2,3$ showed no statistically significant difference while the TLX data did.

The $\Delta 1,3$ application data implies that the control and simulated group improved equally but the natural group did not. Their performance was lower than the expected rate as determined by the control group.

However the natural group's TLX $\Delta 2,3$ shows a difference to the other groups. The participants 'feel' that the third session is less cognitively demanding than the second session, but the actual results from the application suggest that it was not in fact less cognitively demanding. This could also indicate that the induced cognitive load remains after the environmental factors are removed at least from the subjective assessment of the participants if not from the objective results from the application.. For the cognitive load to remain beyond the actual distraction suggest that the cognitive processing dealing with ECL has assimilated information from the distraction to long term memory (i.e. learned from the distraction), this seems to be the only explanation for the lingering effect and this seems to imply that the learner learned from the extraneous cognitive load. If learning can only occur when germane load is present then this suggests a hint of germane learning in the extraneous distractions.

A model for extraneous cognitive load

Each task was different and at the same difficulty to the participant so there was little possibility for the intrinsic cognitive load to change. As the intrinsic load did not change the germane load also remained the same. Of course there could have been some reduction of intrinsic (and associated germane load) due to participant analysis of the presentation of the problems; essentially the participant 'learned' aspects of the application and the presentation of the problem and not the problem itself. However it is assumed that the overall intrinsic load associated with the difficulty of the task was substantial and largely unchanged. Extraneous cognitive load was different for each group so any changes in overall cognitive load would be directly due to extraneous cognitive load.

As the participants completed the second session their TLX result shows an increase in cognitive load in the control group ($\Delta 1,2$ = 7.4%) and the simulated group also shows a slight increase ($\Delta 1,2$ = 4.8%). It is not clear what is causing these increased cognitive loads; but it is most likely the participants understanding the task better and working harder to solve the tasks, hence reducing ECL and applying more GCL to solving the tasks. This effect is reversed in $\Delta 2,3$ with all groups seeing a drop in cognitive load. This can be attributed to the users apparent reaching of an 'expert' level of the application tasks having completed it for the third time.

However the natural group showed a large and statistically significant increase in cognitive load, 19%, for $\Delta 1,2$. This shows a direct correlation between the environmental stimuli and the extraneous cognitive load.

Decreased learning

The natural group %correct $\Delta 1,3$ showed a statistically significant difference to the other groups indicating that the learning (performance in the task in relation to the first session) increase was lower for the natural group.

Here again the TLX data did not agree with the application data. The natural group TLX $\Delta 1,3$ showed no difference to the other groups. It is believed that the participant could only compare the TLX 'rating' to the previous ratings; in other words, they cannot remember the first TLX ratings and so cannot give an adequate rating for cognitive load overall. Further analysis of this phenomenon should be investigated.

A model for learning

As the participant completed each session their performance (%correct) increased slightly in the control group ($\Delta 1,3$ = 4.2%) and the simulated group ($\Delta 1,3$ = 6.7%). The natural group showed a 0.3% performance decrease for $\Delta 1,3$ thus implying a performance decrease in relation to the control group, and therefore a degradation of learning in relation to the other groups. The simulated group showed no statistically significant difference to the control group but there was a small improvement in performance. This could possibly be due to the white noise effect [12]. This possibility is discussed below in the section on speculative findings.

Speculative findings

Some results of this experiment were surprising. Although not the focus of the experiment, the following aspects were observed. These may help to aid interpretation of the main work and they may help to direct future research.

Subjective assessment vs. application assessment

The application's data can be used by the experimenter to make a specific calculation in relation to a participant's performance (e.g. results from first, second and third sessions can be compared), but a participant has difficulty recalling a feeling or level previous to the current one (can compare from first to second, and second to third but perhaps not from first to third).

It was noted that TLX data indicates that the natural group participants noticed an increase in load while completing the second session but a decrease in load while completing the third session. While the $\Delta 1,2$(%correct) from the application data supported their feeling, the $\Delta 1,3$(%correct) did not. Perhaps this is because when the participants completed the third session they rated the load in relation to the second session alone - they simply found the overall load 'easier' in relation to the second session. Literature does not exist on such an application of TLX data on multiple sessions; perhaps the participants 'learned' to use the TLX questionnaire in the same way they 'learned' to use the application but it is also surprising that the TLX data returned to a similar level after the distraction to what was reported before. Again this should be further studied.

Conversely the application data shows that the cognitive load level actually remained the same for both the second and third session. This raises the question: if the extraneous cognitive load due to the walking environment has been removed, what has taken its place? It seems likely that a new extraneous load has replaced it or it has in fact lingered in another guise after the event. This seems to support the theory that learning has in fact taken place due to extraneous load and this is why it remains when the load is removed. Perhaps the learner is still thinking about what they saw or experienced on the walk. This could infer problems with the current model of cognitive load as learning is only believed to take place when germane or intrinsic load is applied.

There is also a possibility that the extra cognitive load has induced false memories [14] and so disturbed the participants' ability to accurately rate the TLX. Future research will critically investigate CLT further with a view to refining it.

The control group vs. the simulated group: no difference?

One of the more surprising outcomes of this study was the findings of no statistically significant difference between the control group and the simulated group. The simulated group's second session was subjected to a video designed to distract them but it did not seem to have that effect.

Visually the participants were focused on the screen of the device and they did not focus on/see the projector screen playing the video so it is quite likely that there was little to no visual distraction and therefore no extraneous cognitive load due to the visual distraction. Furthermore, Mangipudy found, in her Doctoral theses, that for successful distraction, causing extraneous cognitive load, both audio and visual effects must be experienced by the participant [13]; i.e. visual distractions must interfere with the task. This did not happen in this experiment as the user could simply look away from the projector screen displaying the video.

In terms of audio, distraction to participant's auditory system comes from pitch/frequency changes [11]. Four audio clips were sourced that in themselves were distracting. They were then combined and added to a video clip to make the video that was played to the second group to simulate a distracting environment. Perhaps this 'combination' made 'white noise' which can actually improve performance in some instances [12].

Individual Improvement vs. Individual result

Cognitive load depends on the task, the environment and the participant's knowledge/experience. Therefore it is extremely difficult to compare one individual's load to another when they have differing knowledge / experience in the task domain and equipment use. This is one of the reasons why each individual's improvement was compared and not the individual result.

Speed vs. accuracy

Cognitive overload should affect efficiency as well as effectiveness; that is the task should take longer and the participant should make more errors.

There was no difference in speed throughout the experiment. The extra load did not seem to affect the %slow or %fast data in the slightest and so it seems to go against the belief that cognitive load slows down efficiency but does not affect accuracy [10]. Also there was a statistically significant difference in the natural group for %correct and so it was confirmed that cognitive load affects accuracy by making the participant more prone to errors.

Germane load decreased with every session?

It was originally hoped that the overall cognitive load would decrease for the control group on each session thus showing that as they performed the task more their performance would increase i.e. the task became easier and the load reduced (indicating a lowering of germane cognitive load in relation to learning).

It now seems that the overall cognitive load increased for each session and a model of change in germane cognitive load could not be realised. This was due in part to the application's design but most likely to other unknown elements.

Summary

The results of this experiment clearly indicate that environmental factors can and do effect performance and learning and they also incur an elevated level of extraneous load. Also there were several unsubstantiated observations that were noted and can help to inform future experiments and research.

CONCLUSION

In this study the intrinsic load appeared to remain the same and the germane load also appeared to remain the same. The extraneous cognitive load appeared to vary based on different environments.

When the participant moves in the natural environment there is an increase in extraneous cognitive load. In the control environment and simulated environment there is also a smaller increase in extraneous cognitive load. It is unclear why this was the case and further research should be carried out to investigate this.

This study accepted the null hypotheses 1: there is no change in extraneous cognitive load when the environment is changed for a stationary learner.

However it rejected the null hypotheses 2: there is no change in extraneous cognitive load when the environment is changed for a learner traversing environments and also the null hypotheses 3: learning performance is affected by changing environmental stimuli.

In the control group, during the second session, there was a participant-perceived natural cognitive loading (from the TLX data) of approximately 7.4% along with a performance increase (%correct) of 1.5%. In the control group the final performance increase after the third session was 4.2% meaning that all things considered an average user should show a performance increase of 4.2% on their third session on the application.

If we consider the effect the natural world has on the mobile learning participant we can see the following. Using a mobile device while traversing through an environment causes an increase of 12% (the natural group TLX $\Delta 1,2$ - the control group TLX $\Delta 1,2$) extraneous cognitive load *(TLX scores being a direct representation of overall cognitive load)* and a drop of 3.9% in performance (the natural group %correct $\Delta 1,2$ - the control group %correct $\Delta 1,2$).

In terms of learning the control group displayed a 1.5% increase in performance (%correct) in their second session compared to their first session, a 2.7% increase in performance in their third session in relation to their second session therefore giving an overall performance increase (due to learning) of 4.2% from first to third session.

Again if we consider the effect the natural world has on the mobile learning participant we can see the following: Using a mobile device while traversing through an environment causes a 4.5% reduction in learning (the natural group %correct $\Delta 1,3$ - the control group %correct $\Delta 1,3$).

Impact for mobile usability

Future mobile web application developers could use the above results to inform their design of relevant applications.

A heuristic called 'Consider the changing environment' could be created for mobile devices. This heuristic could inform the application developers that changing environments can affect the cognitive load, performance and learning associated with the application and it should encourage the application developers to consider how and where the device and application will be used.

FUTURE WORK

These results confirm that there are considerable concerns with mobile learning while the environment is changing. But this effect is not only limited to learning, it affects all tasks completed on our mobile device, from work to games.

Mobile software developers can use this model of extraneous cognitive load to develop suitable strategies to predict changes in human performance due to changes in the environment. Modern devices are already built with technology that can detect changes; microphones can detect frequency and pitch changes, onboard photoreceptors or built in cameras can detect changes in lighting and visual distractions, accelerometers can detect motion and GPS systems can detect location and movement. When these changes are detected the content should attempt to reduce the ICL or GCL to counteract the changes to ECL so the user does not become overloaded. There are many different methods for this such as restructuring ICL [3].

When the device detects that the participant is in fact overloaded with extraneous cognitive load they may implement any of the strategies for managing cognitive load identified in earlier work such as restructuring the intrinsic cognitive load [3].

A lingering effect was identified where actual cognitive load remained after the distraction was removed. This was validated by the results from the application; however perceived cognitive load seemed to diminish. This suggests that learners learned from the distraction (ECL) and suggests that there are some elements of our accepted model of cognitive load theory which are confusing especially when considering learning and germane cognitive load. This area will need to be researched further but it suggests a more comprehensive model of cognitive load is needed.

Future research should also attempt to develop a model of germane cognitive load change when learners are exposed to environment conditions. This is not a simple task; as intrinsic cognitive load changes so does the germane cognitive load: they are directly linked. Also as extraneous cognitive load reduces germane cognitive load may increase and conversely as extraneous cognitive load increases it causes both germane cognitive load to decrease (affecting learning) and perhaps an overall cognitive overload (affecting performance). Furthermore, as identified above, extraneous and germane cognitive load may be more involved than is currently considered.

Finally future research should investigate the discrepancy between the TLX results which measure the participant's perceived cognitive load and the application data measuring the actual effect of cognitive load. Why do the participants feel the cognitive load has been removed when the results show no change in performance?

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Wait, Am I Still the Green Guy? User Experience as Learning Transfer

Gearóid Ó Súilleabháin
DEIS Department
Cork Institute of Technology
Cork city
Co. Cork
IRELAND
00353 21 4335933
gearoid.osuilleabhain@cit.ie

Joey Campbell
Media Communications Department
Cork Institute of Technology
Cork city
Co. Cork
IRELAND
00353 21 4335810
joey.campbell@cit.ie

Dr. Julie-Ann Sime
Educational Research Department
County South College
Lancaster University
LA1 4YD
UK
0044 1524 593572
j.sime@lancaster.ac.uk

ABSTRACT

Learning transfer is defined in a number of different ways but broadly relates to the influence of prior learning on new learning tasks or challenges. This article examines how learning transfer as a concept might help frame research into the way prior experience influences user experience in particular with regard to novel, unfamiliar or just plain "bad" interfaces. The authors report on the use of concurrent think aloud and stimulated recall as two main methods in a study exploring participants' subjective experiences of negotiating a purpose built 3D shooter game developed specifically to deliberate prime negative transfer (the transfer of learning which has a negative or "interference" effect on new learning challenges) and to essentially 'wrong foot' experienced computer game player. A number of observations are offered with regard to the way in which the interplay of prior learning and efforts to meet a new learning challenge is evidenced in the participant protocols. Discussion follows with regard to the manner in which cumulative past experience and extensive background understanding set the stage for new learning experiences with some concluding remarks being offered with regard to the use of computer games as research environments for further investigation into a range of user experience and learning transfer issues.

Categories and Subject Descriptors

H.1.2 User/Machine Systems: Human Factors, Software psychology

H.5.2 User Interfaces: Evaluation/methodology, Theory and methods

K.8.0 General: Games

General Terms

Measurement, Design, Experimentation, Human Factors, Theory.

Keywords

Learning transfer, computer games, video games, game-based learning, user experience, usability, think aloud, stimulated retrospective think-aloud.

1. INTRODUCING LEARNING TRANSFER

Learning transfer is, variously, "knowledge being applied in new ways, in new situations, or in old locations with different content" [1]; "The process that enables people to make previously learned responses in new situations" [2]; or again, that which occurs "when learning in one context or with one set of materials impacts on performance in another context or with other related materials" [3].

Many introductions to the topic of learning transfer begin however not with formal, and often potentially controversial, definitions but with everyday examples of the learning transfer in action. Often these relate to the transfer or application of abstract mathematical knowledge – as too, incidentally, does a disproportionate amount of the empirical research. In this vein Ellis [4] in his introduction to a review of the transfer literature offers the transfer example of a student who, having first mastered algebra now finds progress onto topics like Calculus easier; Perkins and Salomon [3] similarly give us Maths as a preparation for the study of Physics, and Barnett and Ceci [5] give us the ability of young Maths students to apply knowledge of geometry to estimate the area of their family's new home. Everyday examples abound also: we have the tennis players who quickly masters squash [6]; we also have the harder to verify idea that learning to get along with one's siblings may later help one to get along with others in the wider world [3] or the way in which chess may be a possible preparation for strategic thinking in politics and business [3]. Haskell sees transfer at work in the world of scientific discovery, as key to the apprehension of lightning as a "big spark" or the process of metal rusting as "slow combustion" [7]. Gick and Holyoak [8] relate the development of new scientific theories to a kind of analogical transfer, giving us the "hydraulic model of the blood circulation system, the planetary model of atomic structure and the 'billiard ball' model of gases" [8].

Transfer emerges from these stories as a significant, multiform and multifaceted phenomenon which can happen over long or short time intervals and which may be discerned at work in everyday and commonplace learning acts while also underlying less habitual acts of discovery and creativity.

1.1 Negative Transfer

Transfer stories in the literature, as in the real world, can be negative as well as positive, a distinction again made clearer in vignette than in formal designation. In another Maths story, for example, we have the child who is unable to "make change" in the shop despite having mastered basic classroom arithmetic [9] or, again, the "seventh-grader who writes admirably crafted and organized compositions in her English class [but who] writes papers in her science class that show almost no craft or organization" [10]. Examples like the negative effect learning to drive a car with standard transmission might have on driving a car with automatic transmission [1] or the negative results of carrying unhelpful syntactic patterns from one language to another [11] begin to suggest ways in which so-called negative transfer might also begin to describe certain frustrations users experience in learning new interfaces or new software.

1.2 The Study of Learning Transfer

Both positive and negative learning transfer have been studied at least since the time of the publication of a series of seminal articles by Thorndike and Woodworth which served to challenge the then dominant view that transfer or "improvement in…mental function" from mastery of formal disciplines like Geometry or Latin was general in the sense of being wide-spread across a range of contexts, domains, disciplines etc. As an aside the view that a learner could gain a general improvement in their formal reasoning from, say, a study of geometry and go on to use or apply this improvement across a range of dissimilar situations and tasks is not so dissimilar to the promotion of certain computer programming languages – in particular the functional language LOGO and its many dialects and derivatives – as educational tools with a special ability to improve general thinking, learning and problem-solving abilities [e.g., 12].

Quite how general or specific transfer effects are, has been discussed and disputed extensively from a range of evolving theoretical frameworks and perspectives, many such as activity theory, quite familiar to researchers in the Human Computer Interaction (HCI) field, as we will see in the next section,

Over this time there have been many reconstructions and reinterpretation of the phenomenon and some calls [e.g., 13] to abandon transfer entirely as a object of inquiry yet, for most, the question – or questions – of transfer remains fundamental to the practice and study of education and training. Singley and Anderson [14] call it "perhaps the fundamental educational question" [14]; Haskell starts out on yet another reconceptualisation of transfer with the following statement:

> "The aim of all education…is to apply what we learn in different contexts, and to recognize and extend that learning to completely new situations. Collectively this is called transfer of learning. Indeed, it's the very meaning of learning itself." [7].

How does such an important concept in Education and Educational Research relate to the field of HCI? What can it tell us, if anything, about the way in which prior experience influences new technology experiences? If HCI is interested in, inter alia, the learnability and memorability of new interfaces and systems then what might it be like to frame these goals as learning transfer issues? How might constructs like negative transfer help shed new light on design in general or specific questions with regard to appropriate levels of system support or transparency?

2. LEARNING TRANSFER AND HCI

Learning transfer appears to make very few appearances in the HCI literature and when it does appear it does so often in a disguised or informal way. The term "baby duck syndrome" for instance, which is sometimes used to describe a sort of innate preference users have for systems and interfaces similar to those they originally learned on – in the same way that a baby ducks imprint on whatever they are first exposed to [15] – is in every way an issue of learning transfer. On one level – and there are many -- it relates to an understandable user preference for "spontaneous, automatic transfer of highly practiced skills" [16] as beside the kind of effortful abstraction that characterizes a different, more mindful, kind of learning transfer. Viewed another way, baby duck syndrome is about negative transfer, about the interference effect prior learning can have on new learning challenges and the way in which we as designers and developers need to be careful not to cue the wrong responses or, unintentionally, to encourage a false perception of the transfer challenges any new system represents for the learner – points to be returned to later in this paper.

There are deeper connections between HCI and transfer however. Both, for instance, are arguably still emerging from epistemological assumptions born in the models and methods of classic cognitive psychology. The post-cognitivist theoretical landscape for both transfer and HCI shares similar sights and scenery: we now have ethnographic approaches to system design [e.g., 17] but also ethnographic approach to learning transfer research [18] or, again, the use of concepts like affordance from the field of ecological psychology applied originally, in Don Norman's [19] seminal work on user-centred design but taken up also by, for example, Greeno and colleagues [20] in yet another reconceptualisation of transfer; Activity theory, which J M Carroll, gives as in his history of HCI as the "most canonical theory-base" [21] has also, naturally, had a telling influence in the reframing of the transfer debate [22, 23].

2.1 Transfer as Preparation for Future Learning

While remaining cognisant of the contributions and value of these theoretically heavy frameworks and perspectives a relatively "light" approach to the reconceptualisation of learning transfer is taken in the remainder of this paper based primarily on the work of Bransford and Schwartz [24]. It is a perspective born out of an insight into the limits of the experimental tradition of "direct application" (DA) theory of transfer that "characterizes transfer [solely] as the ability to directly apply one's previous learning to a new setting or problem" [24]. In place of this empirically dominant view of transfer Bransford and Schwartz offer "preparation for future learning" (PFL), which emphasizes transfer as an active process and focuses on "'extended learning' rather than on one-shot task performances (p. 78). Whereas in classic transfer experiments subjects are "sequestered" from information sources and given one chance only to demonstrate transfer, studies based on a PFL reconceptualisation of transfer would allow participants – no less or more than in the real world – the opportunity to make mistakes without this being seen as outright failure, to demonstrate promising transfer trajectories of learning and would be afforded the chance to "bump up against the world" (p. 93).

3. THE STUDY

3.1 The Game

As part of a larger study of the PFL conception of transfer and computer games a purpose-build shooter game with the tongue-in-cheek working title “Shoot Me” was used. The game was developed in Unreal Development Kit, a customisable game development framework based around the game engine used to create some of the world’s best known commercial computer and video games. The kit or framework allowed the researchers to manipulate a number of key gaming conventions to deliberate prime negative transfer and to essentially ‘wrong foot’ experienced computer game players. Camera behavior in the game is what usually termed “third person”, offering a view of the game world “from a position external to the representation of the viewer [i.e. the player character] within the game” [25] and the game as a whole appears to offers a interface style similar to third person shooters like the well known Gears of War series or third person action adventures like Resident Evil 4 and 5 where an interactive camera follows above and behind the game character .

Figure 1: Gears of War 2

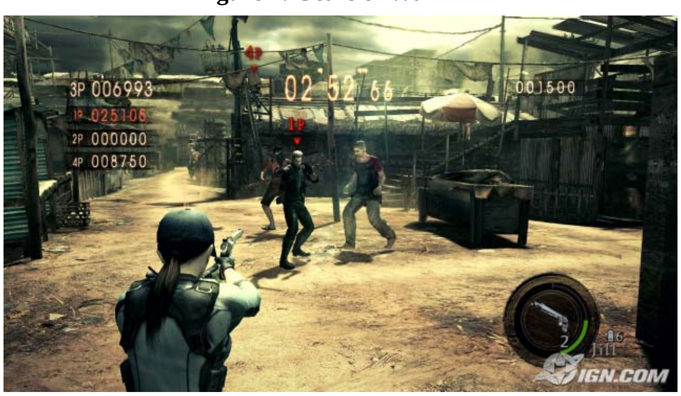

Figure 2: Resident Evil 5

Camera behavior in our game however, while technically third person, is also stationary or fixed and is actually positioned back and above the game arena. Throughout the game there are just two characters “on stage”, the player character and a non-player character (NPC), aka “the enemy”; while both are visible when the game begins, the player character, in contradiction to the conventions of most action adventure and character-based shooter games, is actually the one furthest from the camera and is, at the outset, turned towards the camera. An obstacle at the rear of the game environment also allows the player character, if moved behind it, to be obscured; a phenomenon technically termed “occlusion” [25]. There is other minor occlusion to bottom left and right of the screen.

Occlusion in general it should be noted, though entirely deliberate here, is regarded as something to be especially avoided in game design particularly for games with third person camera and much effort has been expended by game developers in evolving complex techniques for occlusion prediction, avoidance and fail safe resolution to prevent any potentially negative effects on gameplay [25]. In this and other ways indicated Shoot Me might be simply termed a “bad interface” – albeit one with good intentions.

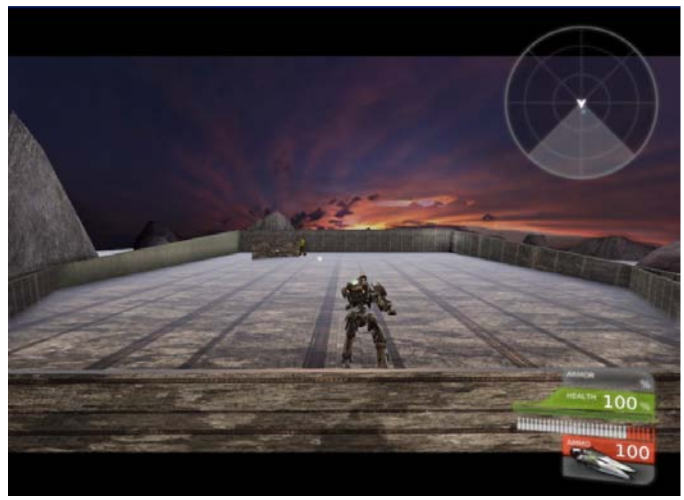

Figure 3: Shoot Me. The NPC, aka “the enemy”, is actually the character closest to the camera.

As may be seen from the screenshot above, the game interface incorporates armor, health and ammo indicators, conventions used in both first and third person shooter games; there is also a minimap in the top right of the interface which is accurate to the position of the player character.

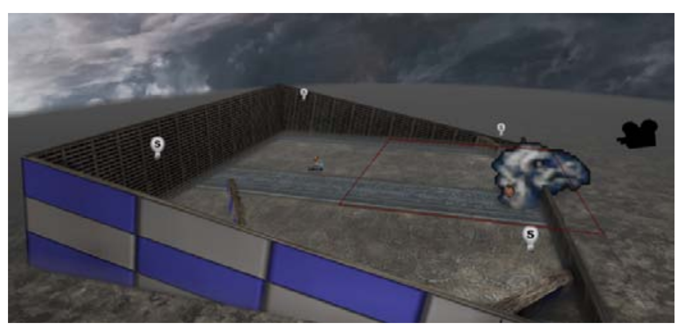

Figure 4: Design mode perspective on the game stage indicating character start positions and the position of the camera

As in-built scripts in the Unreal Development Kit were essentially set up to create first person style games these scripts had to be customised both to place the player character facing towards the camera and to adjust the way in which user control of the character worked. Further adjustments needed to be made to the artificial intelligence of the enemy characters along with their aggression and armour/health levels of to ensure that player characters weren't eliminated too quickly.

Figure 5: Joypad and Controls

As shown in diagram above, moving the left stick controls movement and the right stick controls the direction the character is facing in (pressing left turns him anticlockwise, pressing right turns him clockwise) the top right bumper controls primary fire (the shooting of mid range single fire bolts) while the left bumper controls secondary fire (shorter range continuous beams). 2 makes the character crouch, 3 is used to jump, though neither of these actions plays much, if any, role is achieving victory in the Shoot Me game.

3.2 Methodology

The two main methods used for the study were those of concurrent think aloud and (retrospective) stimulated recall, both targeted at exploring participants' subjective experiences of negotiating the Shoot Me game with a particular focus on the interplay between prior learning and new learning challenges the experience may have represented for them. There was also a short post-hoc interview (a "technology biography") with regard to participant's past experience and knowledge of computer and video games.

The concurrent think aloud and (retrospective) stimulated recall as methods were intended to work together in such a way as to increase confidence in the results ("between-method triangulation") but also to support each other's methodological weaknesses -- e.g. concerns regarding the prevalence of post hoc rationalisation with stimulated recall are partially kept in check by the availability of concurrent verbal protocols; the weakness of concurrent think aloud with regard to investigating affective aspects and automated actions was to be addressed in part by use of stimulated recall protocols.

Data analysis – not, at time of writing, fully complete – is thematic, working broadly from an initial first order descriptive coding to a second order thematic coding and involving a process of "analytic induction" between various interpretations and a range of cases.

3.3 Participants

Sampling was purposive/theoretical [26, 27], i.e. concerned not so much with sample representativeness but with the construction of a theoretically and empirically meaningful study group. In this context participants broadly were recruited based on the requirement for a wide variation in terms of computer and video games experience and experience.

A call for participants interested in taking part in the study was send out by email to a number of higher education students, respondents were invited to complete a short questionnaire which provided an initial list of 24 respondents from which 10 were selected for the study based on quotas and criteria regarding gender balance, age, gaming experience and information/media literacy etc. Results for one participant had ultimately to be disregarded due to technical glitches on the day of the study.

Some initial information regarding the remaining group – note: participants have been given pseudonyms based, in part, on their placement, according to gaming frequency, in the initial list of 24 volunteers.

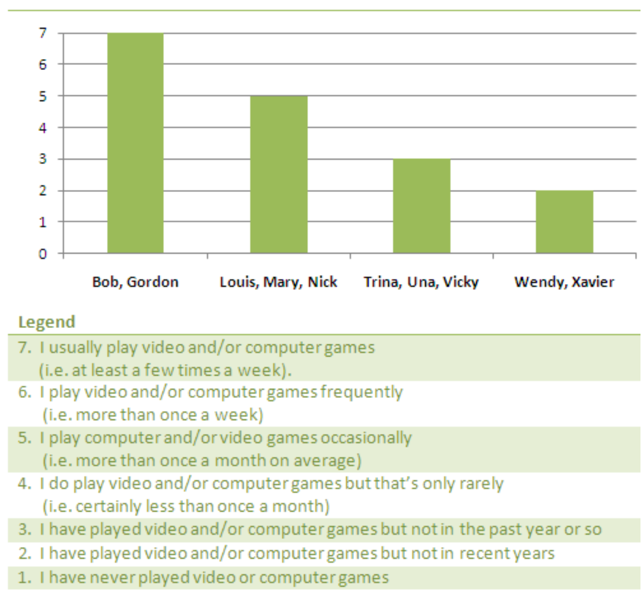

Figure 6: Self-reported gaming experience/expertise across the sample

4 of the final participants were female, 5 were male (the disregarded results were from a female participant). 6 of the participants were between 18 and 21 years, the 3 remaining were between 22 and 28 years.

3.4 Procedure

During each session the individual participant was asked to play the game for six minutes or until they had killed their opponent, after which they were invited to review a "synched up" recording of their game play and verbal protocols and to comment further on the segments the researcher had tagged for review while they played. During this simulated recall phase participants themselves were also allowed to interrupt the replay and make further comments etc if they so wished.

Technical setup for the study was based around a single laptop which, on the participant side, was connected to a monitor, a headset (primarily for audio O/I), and a gamepad; the researcher, on their side, had access to the laptop display and the laptop's keyboard and trackpad to set up the recording, control the game and monitor any technical issues. The researcher also controlled a second computer with application sharing which was used primarily to concurrently tag segments of the gameplay for later review.

Concurrent tagging and data capture was conducted primarily via a user testing solution called "Morae", subsequent data management and thematic analysis was supported with the qualitative data analysis software, "Nvivo".

Figure 6: Technical Setup

3.5 Overview of Results

Note: An intermittent bug relating to collision detection scripts caused the non-player character to self-terminate and meant the game had to be reset during a number of the sessions. As the problem only occurred when both characters were in or very close to their starting positions it is not deemed to pose a serious threat to the validity of the results. Any time lost in resetting the game as a result of this technical glitch has been factored out of calculations given in the table below.

As may be seen all but one participant, Trina, fell, as it were, for the illusion of being initially in control of the NPC or enemy. The one participant who seemed not to fall for the illusion states during the stimulated recall session as she watched back over her in-game behavior.

> "I didn't actually know that it had started I thought you were still setting it up or something, that's why I didn't, I didn't do anything…" (Trina)

The participant's initial passive observation of the onscreen action unfolding without any apparent action on her part most likely explains her singular response to the game – in order to avoid leading the participant or fishing for answers she was not asked directly during the recall session if she ever thought she was the enemy character.

	Pior Game Exp.	*Player deaths (no #)*	*Sees illusion (secs)*	*Finish Time (secs)*
Bob	7	0	10	26
Gordon	7	1	39.6	130.9
Louis	5	1	15.3	142.7
Mary	5	0	29.9	126.7
Nick	5	5	41.7	Did not complete
Trina	3	4	No illusion	311.8
Vicky	3	5	5.6-28.1 (vacillates)	311.3
Wendy	2	9	61.1	Did not complete
Xavier	2	5	35.4	320.7

Table 1: Overview of Results

There was a varying degree of interpretation required in determining the exact moment when each participant finally realised they were controlled the further off of the two onscreen character and in one case there was a relatively extended period when the participant vacillated back and forth between believing they were in control of one or the other.

3.5.1 Some Correlations

As shown in the table, self-reported game expertise appear by and large to correlate with metrics such as number of player deaths and time taken to complete the game though, as an aside, there doesn't seem to be quite such a strong correlation between how quickly participants work out what character they are controlling and how long it takes them to defeat the enemy. In any case the self-reported quantitative measures of game experience are not given too much weighting in the analysis, and post-hoc interviews with participants with regard to their game playing experiences offer a far richer story.

Bob, for instance, far and away most effective player, when asked about his earlier video game playing experiences tells the interviewer he "cannot remember [a time] not playing video games" and mentions playing a number of third person shooters such as Gears of War, Half Life – though also indicates there are not his "main gaming interest". By contrast Nick, who indicates his playing experience as 5 ("I play computer and/or video games occasionally, i.e. more than once a month on average") but who did not manage to complete the Shoot Me game, indicates in his interview that, despite being introduced to computer/video games at an early age "wasn't much good" and quickly decided he "didn't have much of an interest", shortly after which he says, "throughout my life I never developed much of an interest".

Wendy was the one other participant not to complete the game and similarly declares in her post-hoc interview:

"I was never really interested in shooting games or anything like that…they were always kind of boring to me...I just had no interest in them really" (Wendy)

4. Qualitative Analysis

Although analysis is by no means complete and the study being described is just, in any case, one part of a larger study involving three other games, a number of interesting observations still emerge from a first pass over the qualitative data gathered from the participants' think aloud, recall and post hoc interview protocols

.

4.1 The interplay of prior learning and new learning challenges

First of all, the interplay of prior learning and efforts to meet a new learning challenge – this serves perhaps as the broadest and most theoretically neutral definition of the phenomenon that learning transfer research takes as its object – seems to dominate much of the experience of interacting with the Shoot Me game. Participants evidence a fair degree of explicit prior learning in their think aloud and recall data. Two (Gordon and Louis) actually recognise the game as having been created in the Unreal Development Kit; half of the players make explicit reference to the rules and conventions of other shooting or "fighting" games as they play.

In the post hoc interviews some of the more experienced players reference a number of specific game titles in trying to indicate past experiences that might have helped, e.g. Gears of War (Bob, Gordon), Counter Strike (Bob), Metal Gear Solid (Xavier), Medal of Honour (Vicky), Uncharted 2 (Louis). Only one participant seemed to imagine any possible source of help from past experience outside the world of computer and video games, analogizing the enemy to a schoolyard bully who leaves you with the choice to either "fight back…or evade the danger". Some dismiss the influences of games which, to the uninitiated at least, might be thought to have some applicability.

> "I suppose since it's a kind of third person you could kinda go for like Gears of War, something like that but since it's [the camera] not over their shoulders you couldn't really apply anything from there…since it's not a first person shooter you can't apply anything from one of those" (Gordon)

Others see a kind of general transfer from computer and video games.

> "Just knowing like that there's going to be probably a jump button and probably like a firing button and then, do you know, the kind of toggles…" (Vicky)

Aspects of this kind of general background knowledge can also be discerned in these passing comments.

> "I can just...hope this guy has less health than me" (Gordon)

> "He [my character] must have some power" (Wendy)

A comment Wendy later explains during her recall session in this way:

"You know how different characters can have different, ah, attacks methods".

4.2 Language and Terminology

Prior learning is also very much evident in the language and terminology the participants use to describe their experiences, perhaps most conspicuously with regard to talk of the game controls and game controller: a number of participants talk about the "analog stick" on the controller, some with apparently the same meaning of the "toggles" or "toggled-ie" ones. Gordon speaks of shoulder buttons (essentially the most generic name for buttons placed along the edges of the gamepad); Louis and Xavier both use the terms "L1" and "R1" -- usually used in reference, respectively, to the top left and right shoulder buttons -- though apparently to refer to different parts of the controller. The names given to the weapons in the game are almost as various again and perhaps even more revealing: one participant (Wendy), for instance, talks about being "electrocuted" by the enemy, another (Vicky) plans to "hit" the enemy with her "green fire thing", Xavier, on the other hand, decides "R1" controls "streamy thing".

4.3 What is noticed

Prior experience may also be responsible for what participants notice, for what they see as being the "givens" of the environment. Only four participants for instance (Bob, Gordon, Vicky and Xavier) seem to notice the radar display in the top right hand corner of the screen for instance which, for those in the know, offered a hint as to what was really going on in the game. As Bob, the most successful player, states in his recall session:

> "I did notice up in the corner, the radar, it was turning while I pressing thing so I knew there was things I wasn't seeing...".

Gordon is arriving at a similar point in this section of his think aloud just before he realises who is he controlling.

> "I can see the radar moving when I move the joystick but I don't seem to be moving when I use the left stick"

What is noticed may often be part serendipity part past experience:

> "I saw this dude hop up when I pressed circle…that's usually the jump button and I just saw this little yellow dude pop up in the back so I presumed I was him then"

4.4 The "Epiphany"

The dawning of what one participant (Gordon) calls the "epiphany", i.e the realisation of which of the two onscreen characters is actually under the participant's control, naturally very much dominates both think aloud and recall data. A number of the think aloud verbalisations capture the moment, or the moment just before the epiphany, very well.

> "I have the wrong, the wrong guy I think, do I?" (Nick)

> "Oh I'm behind the thing!" (Vicky)

> "The controls don't seem to be doing anything...must be a sort of intro sequence or something..." (Xavier).

Again the role of prior learning and experience appears important if not key, as suggested in a number of the following recall statements:

> "From the point of view...I automatically assumed I was the guy in front, that would have been the natural assumption for me anyway" (Nick)

> "...as the character is in the foreground I thought it was me in case it was, ah, you know a third person shooter, cause that's the kind of regular stance it would be in for a third person shooter" (Louis)

> "In most fighter games the kind of...view would be of the first character there [indicates foreground on screen] you know that would be the character's kind of view" (Wendy)

4.5 The Controls and the Controller

The sense of lacking control extends beyond the moment of the epiphany as is effected by the mapping of the player actions to the gamepad (something again influenced perhaps by participant's past experience):

> "The controls seems counter to what I'm trying to do so when, when I'm moving the analog stick one way it's making me go the other way I think I should be going(T)...It was just it was confusing me cause when I was trying to go one direction it would send me the other way" (Louis)

> "I didn't feel I was actually controlling him even though I was controlling if that makes any sense" (Mary)

> "If I could figure out how to turn around I could shoot at him but I just seem to be facing in the wrong direction..." (Trina)

On the affective level frustration seemed to be most conspicuous – and predicable – response, best captured perhaps in spontaneous think aloud:

> "Turn around you...ahww!" (Vicky)

> "...oh Christ how do I face him?" (Xavier).

4.6 Strategies and Stratagems

Between this sense -- and reality – of lack of control and the frenetic pace of the game itself (as Trina says at one point in her think aloud, "There seems to be no let-up but") there is little enough room left for strategic thinking or stratagems and most of the attempts to plan or develop tactical approaches are of kind revealed in the protocols below.

> "…maybe if I just run up towards him and shoot" (Trina)

> "…even though your man was shooting at me like mad I couldn't do anything anyway so I just said I'd just go slowly and try and aim properly and get him facing right before I started shooting... " (Vicky)

Some participants deserve points at least for sheer persistence. Wendy, for instance, the participant with by far the most character deaths – 9 in all – repeats four times as she runs again and again towards the non-player character: "Going to try and shoot the enemy".

There is some evidence of real world to game world transfer in one participant's comment on his efforts to beat the game

> "…in games or in real life if you don't know what to do the only thing you can do is try to evade the person or run so that's probably what I was doing now, that's my only tactic..." (Nick).

One, as it were, field proven tactic, as followed by Bob who defeated the enemy just 16 seconds after his epiphany, appears to be that of bringing the character around to the front of the stage which reorients the action and perspective to that more resembling a conventional third person shooter.

> "I got him [the player character] up into this position and I rotated him, having finally worked out what was going on, and, I guess, shot to kill." (Bob).

Having the right solution in mind however doesn't always translate into success.

> "Just when he was in front of the screen I felt yes oh now I can like kill the guy, cause I felt more in control then cause it was the usual position that I thought he should be in. But then he moved and I lost it." (Vicky)

4.7 Other Learning Trajectories

A number of other participants who do not excel in terms of what we might call "performance metrics" often exhibit interesting and even promising learning trajectories. Some of these, like the following, have to do with what the game is actually all about.

> "…still none the wiser about how to fire the weapon...unless the game is about evading rather than...actually retaliating? (Nick)

> .”..so I thought they were both [the two onscreen characters] maybe just computer guys and then I thought that I was like the viewer of the screen so I was behind these two guys altogether and I was supposed to shoot them or something...” (Vicky)

5. CONCLUSIONS

5.1 Setting The Stage For Learning

Much of what has been detailed above would be entirely missed out by taking a more traditional transfer research approach, an approach, argue Bransford and Schwartz [24] "work[s] well for studying full-blown expertise" but represents what is simply "too blunt an instrument for studying the smaller changes in learning that lead to the development of expertise." [24]. By focusing as much on the unfolding of the encounter between the participant and the game – or the encounter between prior and current experience in the game – rather than just on the final product of this encounter promising insights it seems can be gained with regard not just to interesting trajectories of learning but into the active nature of transfer itself and the way in which past experiences strongly affect and are inseparable from our efforts to negotiate new learning challenges and tasks.

The situation and lesson is analogous perhaps to usability studies which by focusing too much on performance metrics such as time on task, number of mouse clicks, and number of errors committed [28] may miss out on important constituents of the user experience and of important past experiences underlying those again.

Past experience does not have to be regarded as some nebulous vague force in the constitution of a user learning experience or challenge, and may largely determine what is noticed, what are taken to be the givens of a new learning task, be it a game, a computer interface or even conventional text-based learning materials. In the field of perceptual learning, which studies enduring improvements in the performance of perceptual tasks *as a function of experience*, contrasting cases – e.g. different kinds of scissors laid out side by side – are seen as key with regard to our noticing different features of an experience. Past experiences with contrasting cases, even though the individual cases are not remembered, affects what ones notices in new event and situations which in turn affects what we "think" the new event is about and how we go about dealing with and dealing in the new situation.

Bransford and Schwartz argue that our past experience, that with which we "know with" in new learning situations is even more complex and broader, it is not limited just to perceptual alternatives but in a similar way it sets the stage for all future learning challenges. The contrasting games cases that one participant compares the Shoot Me game to seems consonant with this setting of the stage.

> "[In] old Crash Bandicoot games you'd, there'd be a boss room and they would have a fixed camera position and you've have to go around…[however] you didn't have to aim, you just had to move and that was fine, that made sense…I suppose since it's a kind of third person you could kinda go for like Gears of War, something like that but since it's [the camera] not over their shoulders you couldn't really apply anything from there…since it's not a first person shooter you can't apply anything from one of those" (Gordon)

Compare this a more typical response from to another participant who offers the following when asked much the same question

> "It reminded me of war and…I don't really like war games" (Mary).

5.2 Conclusions: The Complete Stage For Transfer and Experience

Some participant responses hinted, as has already been suggested, at a more general and more background "setting of the stage", some of it drawn from experience beyond the domain of shooter games or even computer and video games in general.

> "I can just...hope this guy has less health than me" (Gordon)

> "He [my character] must have some power" (Wendy)

> "…when you see a gun you know how it should operate I guess… and if someone is firing at you, you feel, you know, the immediate danger, so the reaction is…to fight back or evade the danger" (Nick)

> "I wouldn't really be into those kinds of things [shooting games] I just knew I had to shoot back to survive so that's what I tried to do" (Trina)

At one level some of these comments may seem facile, banal or overly general – he was shooting at me so I knew I had to shoot him or not be shot by him etc – on another however these are hints of an extensive general background knowledge without which even playing a computer game very "badly" – e.g. scoring poorly or being killed often – would not be possible.

The protocols in particular of the lower performing participants, recalls what Bourdieu speaks of in another context with regard to

> "… the representation of action which is forced on agents or groups when they lack practical mastery…and have to provide themselves with an explicit and at least semi-formalized substitute for it in the form of a repertoire of rules." [Cited in, 29]

Such practical mastery must, in our context, include or presuppose an experience of a whole nexus of interrelated "things" such as game controllers, gaming consoles and game interfaces but also certain conventions of, say, computer-based simulation (the "meaning" of certain sounds and of so-called "3D" representation), certain physical conventions with regard to desktop computing (e.g. the function of a monitor, of an input device etc) and so on.

And it must go beyond also to a Heideggerian notion of the background understanding which underlies or is revealed in our everyday coping and practical activities, that extensive and pre-conceptual know-how which works to press forward into the possibilities of a situation, be it a computer game or the hammering of a nail. [29]

It is, moreover, only perhaps in the space that the current study begins to clear between the experiences of the competent or habitual player and those of the novice that we can best appreciate and investigate these activities and the interplay of prior experience, background understanding and new learning challenge that they represent.

This final point, of course, reframes learning transfer as one of the most fundamental – and perhaps most badly understood – concomitant and determinant to learning "success" and of learning experience in general. It suggests we take, in every way, a bigger look at past experience and prior learning in trying to better to understand what we mean by human experience and human learning and, conversely, what our learning and our experiences mean to us. It suggests we look not at once-off learning or experiences that are atypical and/or artificial but at our whole cumulative past as setting the stage for the meeting of new learning challenges and the constitution of new experiences, and that we also look beyond the purely verbal, and purely cognitive. There are interesting, if not entirely new, questions here with regard to the manner in which our highly and uniquely individual responses and experiences are cohered and made cohesive by, for example, our shared biological apparatus, our brains and our bodies, and by our shared socio-cultural contexts and practices

These last point goes well beyond the limits of this paper and of the data presented but if we have been led to it at all it speaks perhaps of a potential value in the research approach. Gaming is, on the one hand, an authentic everyday activity and social practice; games themselves, on the other hand, are highly manipulatable environments which can be altered – in ways not so easily achieved even in traditional clinical settings and certainly not "out in the wild" of authentic practice – to adjust the angle and reflection of the light on familiar phenomena, revealing new features, new background practices, new inter-relationships.

The authors are currently continuing work in analysing data from participants' experiences with the Shoot Me game and three further games – each chosen to investigate different themes and constructs in the transfer literature – and hope, as the work develops, to return in greater depth to the various themes touched on here. There is a sense already that both learning transfer -- or learning preparedness – and learner or user experience as objects of study extend deeper and reach further than traditional accounts or theories of either allow and there is a strong sense also that the two topics are inextricably circled together, with neither fully explicable without reference to the other.

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HCI for Dementia Sufferers: Developing a Large Multitouch System for Recreational Activities

Andrew McGlynn
Galway-Mayo Institute of Technology
Galway
Co. Galway
G00173551@gmit.ie

Paul Dunne
Galway-Mayo Institute of Technology,
Galway
Co. Galway

Shaun O'Keeffe
NUI Galway
Galway
Co. Galway

ABSTRACT
This paper outlines the development of a multitouch system for dementia sufferers which includes usage logging capabilities for further analysis. Dementia is a growing problem worldwide. Very few recreational technologies are being produced for dementia sufferers. Dementia inhibits a person's ability to learn new skills and using a standard computer is almost impossible due to the high level of training involved. Popularisation of direct input devices such as touch-screens can make interactions with a computer quite intuitive. This paper discusses the design of a Frustrated Total Internal Reflection (FTIR) multitouch screen with software applications suitable for dementia. Testing and evaluation techniques are also described.

Keywords
User Interface, dementia, elderly people, older adults, multitouch, FTIR.

1. INTRODUCTION
Dementia is caused by complex disorders in the brain. It is not a disease but a syndrome, an umbrella term that categorises various cognitive impairments that can effect a person's cognitive functioning [1]. Dementia affects the patient's memory, thinking, behaviour, mood, social and daily functioning. Dementia is likely to occur to people aged 65 and over [2]. One third of people aged 80 and over, develop the illness [1].

There are many different forms of dementia, including, vascular dementia, Parkinson's disease, and Frontotemperal dementia. The leading form of dementia is Alzheimer's disease. The Alzheimer Society of Ireland highlight that there are currently almost 50,000 people in Ireland who are diagnosed with dementia. This figure is expected to increase to 104,000 people by 2036 [3]. The World Alzheimer Report estimate that there will be 115.4 million people suffering from Alzheimer's disease worldwide by the year 2050 [4].

There is currently no cure or reversal for dementia, however, research has shown that participation in creative activities can improve quality of life [5]. Dementia patients who are also diagnosed with depression have a 90% increase in positive mood when engaging with activities [6]. However activities for people with dementia are limited especially in a hospital/nursing home setting. This can cause agitation or depression with the dementia sufferers.

Learning how to use a computer can be a daunting task for anyone who has never used one. Many hours of practice go into learning how to use a computer. Currently, on average, older people have significantly less computer experience [7]. Learning new skills is difficult for people suffering with dementia [8]. The common computer interface uses indirect input devices such as a keyboard and a mouse. These devices are abstract and can cause problems for older adults [9].

1.1 Technology for people with dementia
There are various new technologies created for people suffering with dementia, most of these technologies are for analysis e.g. fall detection. There are only a few examples of recreational/leisure technologies being developed for dementia sufferers. It is these technologies that can improve the quality of life by participation in activities. Current recreational technologies developed for people with dementia include CIRCA, ExPress Play and ePAD.

CIRCA (Computer Interactive Reminiscence and Conversational Aid) [8] is a multimedia system created by a team with expert knowledge in different disciplines ranging from psychology to software engineering. The system was developed for the purpose of enabling people with cognitive disabilities to reminisce through the means of generic, nostalgic photographs, video clips and music. This system used a touch screen interface. The system was quite successful, the users of the system reminisced and they recalled memories which were not discussed before.

ExPress Play [6] is a musical, touch-based system which allows even non musically trained people with dementia to express themselves creatively through the use of this system. The evaluation of this system established that people with dementia were able to be actively creative while using the system and it provided a positive experience while using the system.

The ePAD (Engaging Platform for Art Development) [10] allows people suffering from dementia to engage in artistic activities. The system uses artificial intelligence to understand what the user is doing at a particular time. If the user gets distracted, the system can then prompt the user with the necessary steps to complete the current task.

2. MULTITOUCH TECHNOLOGY
Multitouch research has progressed significantly in the past few years. Many modern consumer electronic devices are currently incorporating multitouch technology, in particular, mobile phones. Apple uses multitouch technology in their iPhone and iPad. This type of technology is being recognized as a natural user interface (NUI) due to its intuitive tactile nature. The main advantages of using a multitouch display is the direct manipulation experience, there is no use of indirect input devices.

Tabletop multitouch devices such as Microsoft Surface [11] allow users to interact on a large multitouch screen. Other benefits of using this type of system are the option of allowing more than one user to access the display while working independently.

There are different types of multitouch sensing technologies. Smaller devices such as mobile phones use a different sensing technology to large tabletop devices. The more common types of multitouch sensing include resistive, capacitive and camera-based techniques. Many modern consumer electronic devices such as the iPhone and iPad use the capacitive sensing technique. Systems like the Microsoft Surface use a camera based approach coupled with infrared optics to detect touch events.

Considerable development has gone into the area of camera-based multitouch technology. There are several types of camera-based sensing techniques, these include: Diffuse Illumination (DI), Laser Light Plane (LLP), Diffuse Surface Illumination (DSI) and Frustrated Total Internal Reflection (FTIR). All of these technologies use infrared (IR) optics and cameras to sense touch events.

It was decided that a camera-based multitouch tabletop system will be developed for this research. Commercial tabletops such as the Microsoft Surface were considered as a potential test system for this project. The Microsoft Surface table is too expensive for projects with a limited budget. Custom-made multitouch screens can be developed for a fraction of the price of the commercial equivalent. As commercial systems are further developed, their retail price could drop dramatically; if this is the case, the feasibility of developing a multitouch screen from scratch could be questioned.

2.1 FTIR

Han introduced the frustrated total internal reflection (FTIR) sensing technique for multitouch technology [12]. This technique is based on the principles of total internal reflection (TIR). When infrared light passes from polycarbonate to air, depending on the angle of the light, the light will either get reflected or refracted. The phenomenon of light getting reflected is known as total internal reflection. This phenomenon is demonstrated in Figure 1.

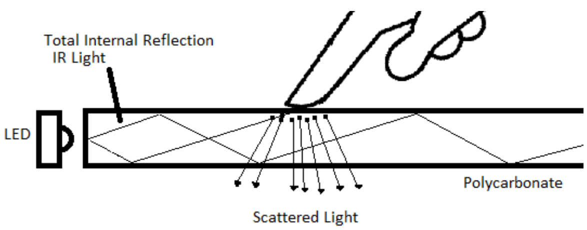

Figure 1: FTIR Explanation

For total internal reflection to occur within the polycarbonate, many infrared light emitting diodes (IR LEDs) are placed along the edges of the polycarbonate until it is flooded with infrared light.

When the fingertips touch the surface of the polycarbonate, the infrared light gets disturbed from the regular path of the total internal reflection. The infrared light therefore gets scattered along the surface of the polycarbonate where the finger press has occurred, resulting in a 'blob' of infrared light. This is illustrated in Figure 1. The blobs of infrared light can then be detected by an infrared sensitive camera positioned below the polycarbonate; this is shown in Figure 3. Figure 2 shows this effect on the author's first FTIR prototype screen.

Figure 2: FTIR Effect

Visual feedback to the user of the system can be done by using a digital projector and projection material. A typical FTIR setup with projection is shown in Figure 3.

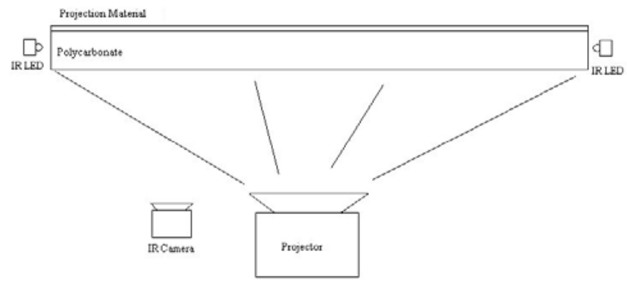

Figure 3: FTIR Multitouch Screen Setup

2.2 Multitouch Software

The software for a tabletop multitouch system consists of various layers. This creates an independent structure where layers are interchangeable software packages and are technology independent. The layers of a typical multitouch system include the operating system, tracking software, communication protocol and a multitouch framework or toolkit.

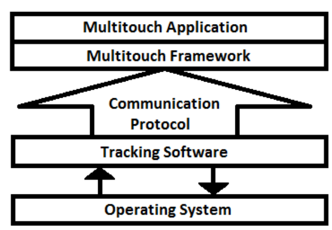

Figure 4: Software Layers

Multitouch tracking software detects blobs of infrared light originating at the touch screen. The tracking software performs many types of image filtering and produces touch events based on the input from the touch screen. The touch events get sent via a communication protocol to a multitouch framework. CCV [13] is an example of open source tracking software.

There are many multitouch frameworks available, indeed most programming languages have a multitouch framework. Two popular multitouch frameworks are "Multitouch for Java" (MT4J) [14] and PyMT [15] for the Python language. These frameworks provide various tools to make visual multitouch applications.

A communication protocol transfers information from tracking software to a multitouch framework. TUIO [16] is a popular communication protocol. TUIO is a simple UDP-based protocol that was developed for tracking tangible objects. TUIO has become the de facto standard for multitouch systems. It is a protocol for sending tracking information from the tracking software to the multitouch framework. In most cases the tracking information is sent to, and from, programs on the local machine.

3. PROPOSED SYSTEM

A multitouch-based system for engaging dementia sufferers in recreational activities is proposed. Various multitouch recreational activity applications will be developed for this system. These include a reminiscence therapy application and an artistic therapy application. The system will use the FTIR multitouch sensing principles and will collect usage data while in operation.

The tabletop form factor was chosen as the most suitable design for this research. It was believed that multitouch tablets could be suitable but could cause problems for those with fine motor control problems due to the size of the screens. It is asserted that the large screen from a tabletop system will reduce the need for any fine movements; the size of the screen will also be beneficial to those with poor vision. The touch surface of the screen will be tilted at an angle towards the user to prevent the strain on the user's neck when viewing the screen.

3.1 System Hardware

The hardware for the system consists of a polycarbonate sheet, IR LEDs, digital projector, projection material, infrared sensitive camera, standard webcam and a boxed frame. The boxed frame is used to support the screen and to abstract all the hardware components from the user. This is shown in Figure 5.

Figure 5: Proposed Multitouch Frame

3.2 System Software

An integrated webcam will be used to take a photo of the system user for session metrics. Session tracking usually involves a user logging in and logging out. The effects of dementia will make this login/logout task quite difficult. The use of automatic data logging and the use of the webcam to capture an image of the user will solve this problem. Touching the screen will trigger an event which will begin the session. An image of the user will be taken at the start of each session. Touch events keep the session active, all touch event data will be stored from the session. If there is no touch activity, a timeout will occur and the session will end and the system will then become idle. It will stay in this state waiting for another session to initiate. The system will also incorporate a database for data logging. The logged data will be used to measure how long the dementia sufferer used the system from week to week and their frequency of using the system. This database is expected to be remotely analysed for evaluation.

Ethical approval and consent is required for people who participate in research [17]. The participants in this research will not be able to give their own informed consent due to the symptoms of dementia. In this case, the next of kin will be contacted as well as obtaining consent from the person with dementia. There are certain elements about the test system which are unethical; this includes the collection and storage of images of the user and logging their interactions. Ethical approval and consent must be acquired before the participants may be involved in this research.

3.3 Applications

The system will have various applications specifically created for the needs of people with dementia. All of the applications which will be developed will respond to simple intuitive gestures performed on the touch surface. These gestures will consist of drag and tap events. Complex and abstract gestures will not be implemented in these applications since they might be too difficult for the dementia sufferer to remember and perform. Text displayed on the screen will be large for those with poor vision. The background of the applications will be neutral, this will allow maximum contrast between the background and the foreground; this is expected to keep the user's attention on only the interactive components in the foreground.

The first application will be an artistic therapy application; this will assess if dementia sufferers can be assisted in creativity by using a multitouch computer system. The artistic therapy application will present a creative activity for the dementia sufferer; this will allow them to paint and draw virtual pictures by using simple multitouch gestures.

A multimedia reminiscence therapy application will be created; this will test if reminiscing while using the system will improve social interactions between dementia sufferers and their families or carers. The reminiscence stimuli which will be used in this application will consist of images, video clips, songs and newspaper articles. The theme of the reminiscence material will be of Ireland between the 1930s - 1970s. All the media used in the application will be placed throughout the user interface similar to real photos scattered over a real table. The dementia sufferer may then manipulate the piece of media by using multitouch gestures. Since dementia affects short term memory, long videos would not be suitable in the application; due to this fact, the length of all videos will be kept under three minutes. All stimulus will be large for those with poor vision and fine motor control problems.

4. TESTING AND EVALUATION

Research by Riley [6] suggests that using multiple phases of testing with different groups of people with different cognitive abilities is a suitable approach when developing a system for people with dementia.

The proposed system will involve different phases of usability testing. The initial testing of the system will be done with informal evaluation methodologies such as the heuristic evaluation [18] and/or the cognitive walkthrough [19]. Both of these evaluation techniques can be used throughout the entire design process.

The heuristic evaluation involves the evaluation of the interface by assessing the interface for design problems and to mark the severity of the problem.

The cognitive walkthrough requires an evaluator to evaluate a system by performing tasks and recording what steps are needed to complete the tasks. This will be a crucial evaluation technique for this project since dementia sufferers need a simple interface.

A phase of system testing and evaluation will involve the system being placed in a populated area where it can collect data from many different people. Here the software will get a rigorous testing from regular interaction from many different people. The people using the system will in this phase will have full cognitive functioning.

The last testing phase will involve testing the system by the actual end users. This phase will require between 5 - 20 people suffering with mild or moderate cases of dementia to interact with the system. The dementia sufferer is expected to use the system while being supervised by a care-giver. At the end of each interaction session, the dementia sufferer will be asked to complete a short questionnaire. The questionnaire will consist of approximately 5 open ended questions and 5 close ended questions. Open ended questions that will be asked will include what they liked/disliked about the system. Close ended questions will ask their opinion on using the system, including if they enjoyed the application/activity and would they like to use the application again. The care-giver will be asked to give a short report about the session. This report will contain information such as reporting any changes in the dementia sufferer's mood, the dementia sufferer's engagement with the system and any difficulties faced when using the system.

5. CONCLUSION/DISCUSSION

This project will build a large prototype multitouch FTIR system. The assertion is that a computer system with a multitouch user interface will aid dementia sufferers in the creative process and improve their quality of life, social skills, mood and potentially memory. Medium-sized single touch interfaces being used with recreational activities have proven to improve the quality of life of dementia sufferers [6, 8, 10]. This research will investigate if a large multitouch system would be more intuitive to use and provide a more immersive experience.

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Citizen Journalist: Use of Mobile Technology in a Collaborative and Participative TV Context

Oliver Leamy
Department of Media Communications
Cork Institute of Technology
Cork
+353 21 4335810
Oliver@VideoTV.ie

ABSTRACT

This paper examines the potential human-human interactions between a Live TV programme viewer and the programme presenter which would be mediated by a complex evolving communications system.

The early inspiration came from the concept of the swarm-cam [1-4] but does not follow the path of swarm intelligence which would be the natural progression of that research. Instead, it examines the current live studio processes, deconstructs the interfaces and incorporates User Experience (UX) and Interactive Design (IxD) guidelines. Evaluating the UX component is notoriously difficult [5, 6] and the AttrakDiff anonymous online questionnaire [7] was adopted as the standard method for user evaluation of the early concept.

The study generated more questions than answers leading to a rich set of future research possibilities. One is the production of internationally recognised graphic overlays at the Smart-Phone, enabled by the director/broadcaster to provide mediated collaboration in real-time composition.

Categories and Subject Descriptors

H.5.3 [**Group and Organization Interfaces**]: Asynchronous interaction, Collaborative computing, Computer-supported cooperative work, Theory and models

General Terms

Design, Human Factors, Standardization.

Keywords

User Experience, UX, Interaction Design, IxD, Mobile Phone, Smart Phone, Citizen Reporter, Citizen Journalism, Community TV.

1. INTRODUCTION

Virtually all radio stations have a flag-ship phone-in program with large audiences – the same is not true for Television. It is generally difficult for the average person to have their ‘voice heard’ – the main avenues open to them are to produce their own documentary or seek invitation to participate in a live studio discussion. Neither solution is ideal and both are time-consuming. This paper examines the role that modern mobile technology could play in the development of a new Collaborative, Participative, Live TV (CPLTV) genre that would enable the average person have direct access to live TV shows.

The overall broadcasting system, encompassing a broadcast studio, interfaces with users (actors) at the station, communications between it and remote citizen journalists (actors) and how those journalists interface with Smart-Phones, is a complex system that dynamically alters its operational characteristics dependant on the experience of the actors at the end-points. The original study considered interactions at both ends of the communications system, this paper relates solely to the operational aspects from the perspective of the Citizen Journalist utilising support structures to engender positive experiences and feelings of community.

2. GENERAL CONTEXT

This paper examines the potential human-human interactions between a Live TV programme viewer and the programme presenter which would be mediated by a complex evolving communications system.

Contextually, the proposed system sits astride a number of conceptual models – The Community, TV Interaction, Citizen Journalism.

2.1 The Community

The traditional definition describes Local Communities as communities that have a relationship in real life due to the physical location of dwellings [8]. While exploring the design of online communities [9] there is a reference to a more general definition [10]

- People who interact socially as they strive to satisfy their own needs or perform special roles
- A shared purpose that provides a reason for the community
- Policies that guide people's interactions
- Computer systems to support and mediate social interactions and facilitate a sense of togetherness

In online communities lurking is generally defined as a passive and negative behavior [11] and research has been carried out to examine how they might be enticed into greater participation [12]. It was shown that 'sense of community' is a very strong driver for participation. Interviews with 26 lurkers [13] revealed that they were intimidated by the active users and probably did not have a good feeling of community ownership. What some producers failed to realise was that without a mass audience, the mass media function would be incomplete [14] making lurkers a requirement for rather than a detractor from community survival.

In the CPLTV model, a support mechanism for novice users was integrated to reduce the possibility of intimidation and enhance community inclusion.

2.2 TV Interaction

A number of distinct levels of interaction have been identified and categorised in international research papers. The main categories being Interactive TV, Social TV (STV) and Participative / Collaborative TV.

2.2.1 Interactive TV

This is usually categorised by the use of SMS messaging as in live game shows or talent contests (recent Eurovision Song Contest). The outcome of a programme is directly influenced by the viewers in real time. There are also more complex systems based on the remote control [15] which, I believe technology is now bypassing.

2.2.2 Social TV (STV)

This started with SMS messaging between younger viewers [16, 17] which then migrated to social networks. Its expansion fed on the need for viewers to interact with like-minded viewers [18]. The interaction between viewers in the social domain has no impact on the outcome of the TV programme - contemporaneous web chat during Formula-1 events.

2.2.3 Participative / Collaborative TV

The concept of the SwarmCam [19], [2] depicts how users with Smart-Phones can collaborate locally by providing video feeds to enhance the overall enjoyment of an event. Also the concept of staged live multimedia events [20] were all instrumental in driving the thought processes for the initial concept.

2.3 Citizen Journalism

From a broadcast media perspective the emergence of the Citizen Journalist has the potential to bring about a sea-change in how media is integrated into mainstream broadcasts. Citizen Journalists are manifestly different from mainstream journalists in that they are intimate members of the community with associated societal ties (quite often embedded in the activity) and using consumer-grade ubiquitous technology.

July 7th, 2005 was a seminal moment for BBC news coverage. That day, within 6 hours of bombs exploding in the London transport system, the BBC received more than 1,000 photographs, 20 pieces of amateur video, 4,000 text messages and 20,000 e-mails [21]. Similar proliferation of Citizen Generated Material (CGM) occurred during the Spring Revolutions in North Africa this year.

3. DESIGN CONTEXT

While the HCI community has traditionally looked upon design as an add-on, something to provide 'surface structure or decoration' [22] it is nonetheless a good starting point. More recently, the idea of User Experience (distinct from Usability) has evolved and would appear to have most potential to draw in lurkers/passive viewers as it would appeal to the enhancement of 'self' rather than solely cold 'task' (i.e. Hedonic over Pragmatic). An additional tool of note was Interaction Design (IxD) which considers the interactional behaviors. The study borrowed from these three design disciplines.

4. METHODOLOGY & METHODS

Usability, User Interaction (IxD) and User Experience (UX) have evolved over the years with a strong common DNA. In the study, while all three were used, there was a difference in emphasis dependant on the area of CPLTV being explored.

The CPLTV system was considered to exist within a specific problem space categorised by the following statements:

- The iPhone (or its Android based equivalents) will be the platform of choice for the conceptual system components.
- The community sector will form the target population for initial study of the potential product market-space.
- Enhancing the User Experience is the area of research that is most likely to produce innovative designs that will enable CPLTV acceptance by the ordinary user.
- There will be a high level of interaction between the end-points of the system which will be characterised by Human-Human Interactions mediated by an evolving communications system.

While the original study generated two artifacts, this paper will consider only the artifact for use by the Community Contributor (The Reporter) - The App on the mobile phone. The interface is pre-defined by the Operating System and the thrust of the study was to produce an experience for the user that would encourage participation and generate a sense of community and belonging. In this instance, UX was the dominant design methodology.

4.1 Ideation Phase

During the conceptual stage, the Interview method is more suited to researching specific requirements and tasks that are known only to 'experts' in a field. These are, generally, non-conceptual in nature and more akin to fact-finding expeditions.

Focus groups, on the other hand, lend themselves to discussion of concepts and designs generating 'more elaborated accounts' as they include a 'range of communicative processes' [23] which make them a good fit for brainstorming and ideation.

4.1.1 Interviews

When one considers the conceptual phase of a design process where the interviewer and respondent must explore ideas in a diverse and creative manner with the interviewer required to bring the respondent forward to a point of knowledge (possible new to the respondent) so that a new conceptual world can form the basis of a 'what-if' knowledge conversation, the traditional interview method where data is considered fixed and repeatable seems invalid. There is also the concept of a Creative Interview in which knowledge is actively constructed where the subject is 'enlivened' by the process and where knowledge is being generated dynamically [24]. This is the form of interview method that was used in the study.

4.1.2 Focus Groups

The focus group process is a method for collecting data focused around a particular topic [25]. Further, there is the evolution of truth or reality which changes dynamically within the group since participants will influence each other changing opinions with new insights [26].

This method gives a high level of validity when exploring CPLTV, especially where the outcome may evolve during the process. To cater for these requirements a semi-structured [27] approach was adopted as this allowed the 'conversations' stay focused on pre-existing models and still allow sufficient group dynamics to encourage fresh thinking on any novel emerging models.

The choice of participants was problematic. Some suggest 10-12 similar people for participation [28] and separate groups for differing segments of population to facilitate comparison and identify patterns [26]. Others suggest that focus group sizes as small as 2 are meaningful [29]. Because of the nature of IxD, there would be a need for multiple iterative sessions and so a compromise would be necessary that would allow sufficient diversity coupled with time for completion within the schedule. The focus group sizes were limited to four people and two member profiles.

4.2 Prototyping Phase

During the initial concept stage, it is often the case that ad-hoc paper prototypes are used or the materials may not have any bearing on the final design and the structure and form might be significantly different from the product under discussion. As this project intended evaluating user experience and the use of emerging technologies it was decided to use a non-paper approach and produce simulated operational artifacts.

4.3 Evaluation Phase

A central pillar of this study was whether or not (or to what extent) mobile technology could be an enabler of general population participation in live TV productions. The subtext was that current technology inhibits such participation and emerging mobile technology would overcome that barrier.

Surveys are described as ‘a systematic method for gathering information from (a sample of) entities for the purposes of constructing quantitative descriptors of the attributes of the larger population of which the entities are members’ [30] which made Surveys a prime candidate for a method to be employed during this phase. However, with UX, attributes can be vague and the quantitative descriptors could be influenced by temporal as well as spatial influences resulting in a lack of clarity with the research community on best fit methods for UX measurement [31, 32].

Selecting appropriate methods for UX measurement can be problematic due to lack of a shared understanding of UX itself [32]. Of the 17 papers submitted to the 2008 Icelandic Conference on UX Measurements [33], 7 referenced work on Hedonic and Pragmatic measurements [7] directly or subsequent evolutionary work. Two of the papers [5, 34] used an online UX survey called AttrakDiff [35]. In both instances ten users formed the sample size. With the first paper, AttrakDiff was the sole method used and they found a strong correlation between actual measurements and expected measurements. The second paper used AttrakDiff as a comparator to two other measurements and found the AttrakDiff results being slightly lower to field trials but not significantly so. These research report papers, gave me confidence to use this online questionnaire as a method in evaluating UX.

4.3.1 Data Gathering

A series of Researcher-Administered surveys was considered the most likely to have a high level of reliability as the concepts could be difficult for some participants to comprehend and having it Research-Administered would allow for areas of confusion to be immediately addressed and clarified by a ‘common’ researcher.

The prototype form was such that it was not possible for a user to experience first-hand an actual task-execution or activity as it was conceptual in nature displaying a simulation of possible usage scenario videos on the Smart-Phone. The objective during this evaluation was to review the scenarios, determine their relevance and potential experiential outcomes within the limitations of no actual end-to-end interaction.

5. STUDY & DISCUSSION

5.1 Introduction

The purpose of the study was to evaluate the potential for leveraging developments in mobile technology to support a lightweight Live TV production platform (suitable for use by non-technical members of a community) – specifically in the field of live TV productions and live user interaction and collaboration.

5.2 Ideation Phase

The proposed system built on pre-existing workflows and objects – namely the television studio vision mixer, audio mixer and feeds from remote cameras all coming together through traditionally evolved workflows to create a live television programme.

For this project, while being cognizant of personal and social factors, the problem space was defined as the interaction between a viewer/contributor with a broadcasting facility and the mirror interaction between the broadcasting facility with the viewer/contributor in supporting that interaction with a live TV programme.

In order to fully explore the conceptual design in terms of acceptance and usage by the target population, a number of interviews and focus group sessions were conducted.

5.2.1 Interviews

Trial interviews were conducted and a set of categories generated to act as general guidelines for subsequent sessions.

5.2.1.1 Selection of Participants

- An Existing Local Commercial Radio Station
- An Embryonic Community Radio Group
- An Existing Community TV Station
- An Embryonic Community Television Group
- Two Independent TV/Video Producers
- One Print Journalist

5.2.1.2 The Interviews

A total of 7 interviews were conducted, the duration of each varied from 13 minutes through to 31 minutes. Surprisingly, the shortest produced the richest amount of data while the longest produced the least. Excluding those two interviews, the average was 20 minutes. All interviews were recorded (audio only) for later analysis and coding.

5.2.1.3 Coding Analysis

The NVivo software package was used to transcribe and categorise the various elements. As the process continued, a structure evolved that was used for task analysis and requirements specifications (Circles in Figure 1).

Some salient points from an initial examination of the interviews:

- Because of the broad spectrum of participants, no single interview covered all relevant areas, but the totality did give a broad base for determining the likely acceptability of preconceived platforms and interactions as well as some variations ‘on a theme’.
- As would be expected from interviews, specific requirements would be dominant as these relate to individual expectations and operations at end-points of a complex system. The other expected result was that the interviewees with existing station experience spent most time talking about these aspects.

5.2.2 Focus Groups

The interview process was a very important initial tool in the ideation stage as it gave clarity regarding the ‘state of play’ of industry activists but it was lacking in concept building and interaction role-play – something that would be crucial in the development of a prototype that would have general appeal. The ‘Focus Group’ was the method employed to fill this gap in the research.

5.2.2.1 Selection of Participants

A different process was used for selection of groups. At the outset, it was felt that a diversity of views would be beneficial between groups – rather than within groups. Due to time constraints it was decided to limit the process to two groups. The actual selection was accidental and opportunistic.

The first was held with a group from within the main CIT campus and the other was a group from the attached School of Music.

The membership of these two groups was varied with the former having a membership age profile of early 20s, and the latter spanned early 20s to late 40s. Further, the former were of a graphics and arts background and working on a branding project for a student TV channel, the latter were from within the 'music industry' with broad experience in the audio and music technology sub-sectors.

5.2.2.2 *Focus Group Sessions*

The purpose of these sessions was to expand on the very narrow field of exploration that was pursued within the interview process. This was experimental, with an expectation that participants would interact with each other and with basic props so that an understanding could be elicited on an optimum concept for studio programme production and the interactions with a citizen reporter. Existing products/processes within live TV production were discounted and a blank-sheet approach taken to developing a system that would enable the average person make 'phone-type' conversations with Live TV programs in a casual manner.

- As would be expected, there was no discussion of existing procedures with broadcasting establishments as none of the members had any broadcasting experience.
- There was a rich ideation process (when compared to the Interviews), however, this did not necessarily entail the creation of new or innovative ideas, but rather it was a more in-depth conceptualisation, interaction and definition of the processes (tasks) involved.

5.2.3 *System Components*

Following on from the conceptual interview and focus group process, a requirements and tasks list was generated (Figure-1) which dictated the system components that would form the basis of the design phase.

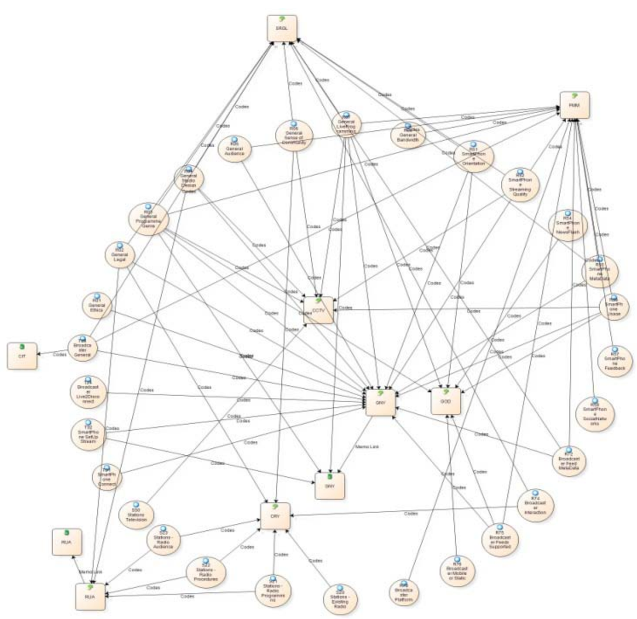

Figure 1 Requirements and Tasks Generated

The main system components identified were:

Novice: A person who makes a call to a live programme. For the novice, this may be the first time to do this activity or may have only very limited experience. Context, at home, college, socialising, at sports.

Experienced Reporter: A person who is no longer a novice. Will have a history of making video feeds and is confident of handling the interaction procedure right through to 'going live'.

Trusted Reporter: A person who is well known to the production, has a history of producing reliable video feeds and trusted not to provide anything that may be considered unethical or inappropriate.

Remote Feed: Information in the form of audio/video being transmitted live from a Reporter to the broadcasting station.

The App: A software application that runs on a Smart-Phone. It handles all communications between a Reporter and the broadcasting station. There are three variants in terms of tasks – The Novice, The Experienced Reporter and The Trusted Reporter.

Presenter: A person who acts as an anchor for a live program, interacting in real time with Reporters and/or other presenters or studio guests. Context – in a TV studio, commentating at a sports event etc..

Researcher: A person who acts as a gatekeeper between the Reporter and the Presenter validating the Remote Feed. Context – TV studio

The Broadcaster: An object/module that enables the Presenter interact with Reporters and route a Remote Feed to the Broadcast Feed.

Broadcast Feed: The audio and video (information) that is made available to the viewers. Beyond the feed is the hardware / software module that handles the actual delivery of the programme on a specific platform (e.g. Cable, Terrestrial Signal, Internet …)

5.2.4 *Participation Process*

The process required that the average person could make casual contact with Live TV. The solution – the Community Contributor would launch The App to make contact and underlying technology would offload all unfamiliar activity, allowing more direct access over time as the contributor gained experience and confidence. Having launched The App, a VoIP call would proceed to a Researcher who would follow normal pre-screening (as with Radio), then the call would be handed over to 'The Studio', still in voice mode. The transfer from voice to visual would be by agreement so that the caller would not be intimidated and could perform multiple voice calls before actually going live with video. This incremental movement through the interaction chain was considered key in the focus group sessions. The concept of a contributor taking on different roles depending on experience and earned trust was felt crucial by all participants and, that these 'hard-earned' roles could be lost quickly by any abuse of privilege. The concensus was that priviledge should be difficult to achieve but easy to loose thus giving it intrinsic value.

5.3 Prototyping Phase

At the outset, it was the intention to radically rethink the work-space of live video switching since the existing models were non-intuitive (for people not cognisant with existing studio practices) and so a barrier to ad-hoc live programming for community level programme production.

5.3.1 *Basic Design Goals*

Intuitive: The user starts The App and, thereafter, the system provides an interface suitable to the level of experience that the user has – from a novice who has never used it before, to a seasoned (experienced and trusted) reporter. For the novice the interface is no more daunting that making a traditional phone call.

Attraction: Because of the very simple menu (only 2 buttons and one is called 'Next') there is no real scope for additional 'attraction'. Future work proposes a novel form of attraction to enhance composition and visual quality of Contributor Generated Material (CGM)

Feedback: A major concern was feedback to a user who would be streaming content live – the prototype recreates the feedback that an actual user would experience while communicating with the broadcaster. It varies from live voice through various simple iconographic 'traffic light' symbols. More advanced feedback is proposed for future work.

Minimum Text Entry: There is no textual entry although there is one possible selection from a drop-down list for experienced and trusted users.

System Learns to Offload Tasks: A reverse of this concept was implemented. Initially, the system does everything and only later allows the user bypass some of the tasks as they gain experience and trust.

Uncluttered Physical and Conceptual Design: Simple Android Interface

The additional goals (below), although postulated for enhanced UX with On-Line Networked Communities [36], have particular resonance with contributors to an interactive broadcasting station and were considered core to the design process for The App prototype.

Feeling of Being Part of the Community: During the Novice stage, there is personal contact which will promote the community aspect of the enterprise. Also, when 'on-air', the availability of user history further enhances the feeling of belonging/identity.

Trustworthiness and Security: In order to allow time to build trust, there is a two way negotiation facility through personal contact between the user and the broadcaster without time-limit. The App enforces this trust building stage.

Personal and Social Benefit: The App is central to 'Real Life Integration' as it allows a user communicate real-life events and 'be heard'.

Maintaining Interest: Status, as a kind of 'Social Reward' is the prime motivator and supported intrinsically by the system [12]. As the user becomes more proficient, increased trust levels are assigned by agreement. Other motivators are programme genre by the broadcaster (outside the scope of The App).

User Support: Initial User Support is an essential part of good UX and is inherent in the Novice mode of the App. Proficient and Experienced users are allowed higher degrees of direct access to the broadcaster.

5.4 Evaluation Phase

To determine the number of participants required during evaluation studies, the International Standards Organisation states in IS-20282-2 that, if 4 out of 5 users in a usability test were successful, even if the testing protocol was perfect there is a 20% chance that the success rate for a large sample of users might only be 51% [37]. However, other papers submitted to the same workshop [33], most notably [5, 34] produced meaningful results using 10 as a sample population and AttrakDiff for data gathering and analysis. Also, it is not uncommon with conceptual prototypes to use a small number of participants coupled with personal supervision/guidance during the process – 9 participants were used to evaluate the concept.

5.4.1 Data Gathering

5.4.1.1 Community Reporter

Because of the complex nature of the underlying interactions in CPLTV, cognitive interviews were conducted as a pre-test of the questionnaires. These showed that there was a knowledge gap between participants and the CPLTV concept which elicited unreliable survey data. This was in keeping with the fact that 'the most reliable UX evaluation comes from people who have actually purchased and used a product on the market' [32].

To overcome this gap, an alternative interview format was adopted - meetings were held with participants on a one-to-one basis. The Apps were explained and then the participant was given time to familiarise himself with the various use scenarios being simulated. The participant was then invited to fill out a short questionnaire and finally given access to the AttrakDiff website to fill out the UX evaluation anonymously.

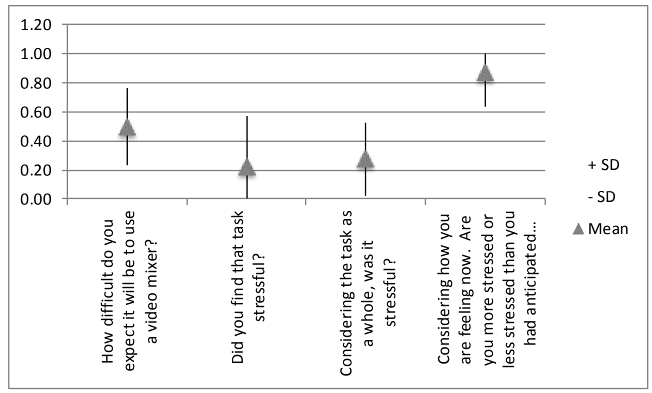

Figure 2 Stress Level

A VideoMixer prototype was also evaluated during the project and, while not the subject of this paper, there was one interesting finding that does have a bearing. The participants were asked to measure their perceived stress levels with 1 denoting highly stressed and 0 denoting very relaxed. Prior to evaluating the prototype the general level was <0.5, after each task the level was approximately 0.2 but after the evaluation process was completed the participants felt that the overall process had been more stressful than they had originally anticipated (>0.8) - which was at odds with their measurements during the tests (Fugure 2). This highlights the difficulty of UX measurements in terms of reliability as the time when the measurement is carried out can have a significant effect on the results.

5.4.2 Presentation of Results

5.4.2.1 AttrakDiff

The AttrakDiff online questionnaire was used as the primary source of collection for UX data – this uses 28 word pairs over four categories (Pragmatic PQ, Hedonic-Identity HQ-I, Hedonic-Stimulation HQ-S and Attractiveness ATT). The overall results (Figure-3) show that there was the desired balance between the Hedonic and Pragmatic aspects.

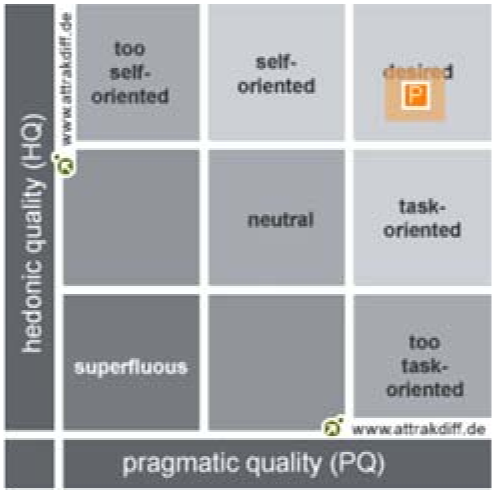

Figure 3 AttrakDiff Overall Result

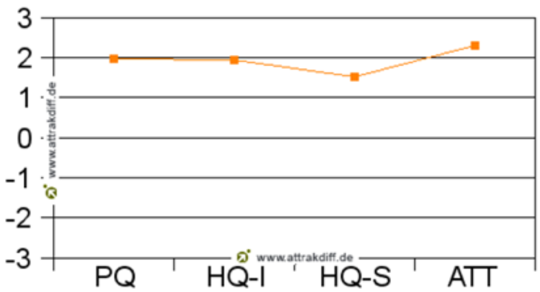

Figure 4 AttrakDiff Results by Categories

Analysis (Figure 4) showed a lower than expected score for Stimulation which was caused by a lower than expected score for the word pair Undemanding/Challenging (Figure 5).

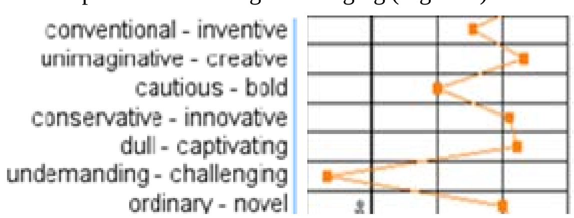

Figure 5 Stimulation Word Pairs

Subsequent interviews of participants put into question the validity of this word pair with Undemanding/Stimulating being proposed as the word 'challenging' was considered to have negative connotations in this context. There were similar concerns expressed by other researchers [34].

5.4.2.2 General Surveys

From a statistical standpoint, the small number of participants (<10) would be a cause for concern if one wished to make any generalised population predictions. However, it is common during early conceptual stages to carry out such limited surveys as a general confirmation of theory where results, which have a very strong agreement between participants, are considered good indicators for deciding which areas should (or should not) be included in subsequent research/development work.

5.4.2.2.1 Citizen Reporter App

There was general consensus that The App was suitable for use at an 'Outdoor Football Match', 'Press Conference', 'Street Interview'(large deviation), by 'People Over 55' and while 'Sitting', 'Standing' or ' (Figure 6). Interestingly this is in step with other research that showed people interact more easily with News, Quizz and Sport programmes [38] which could indicate the type of programme genre that would facilitate CLPTV.

Surprisingly, even though a person with severe literacy problems could use the system, the score is less than optimal for this group – the low score came from the younger participants which may indicate a lack of appreciation of specific disability constraints (Figure 6).

The sense of community and member support was considered 'enhanced by the Novice mode' of The App and that the feedback system was considered 'good' (Figures 6 and 7).

There was also consensus that people would not be embarrassed to use The App in public (Figure-7) which is possibly at odds with the statement that it was inappropriate for use in Pubs and NightClubs and the wide divergence on use for 'Street Interview' (Figure-6). Further, other research shows that the use of mobile phones in public (for video) has an embarrassment factor [39] which might point to a sample set that was not representative or that the data was not reliable or there is possibly a strong variation between generations.

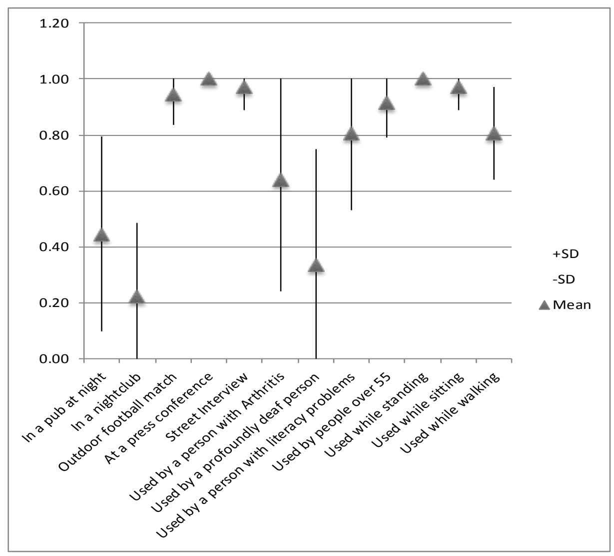

Figure 6 Usage Scenarios

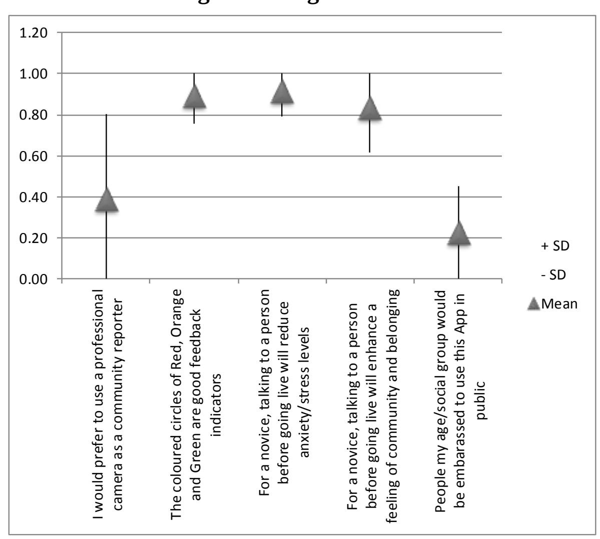

Figure 7 General

This embarassment factor might also explain why the participants preferred to use an unobtrusive Smart-Phone camera rather than a professional one (Figure 7).

There was strong support for the structure whereby The App forced a communications flow that would alter dependant on experience and earned trust (Figure 8).

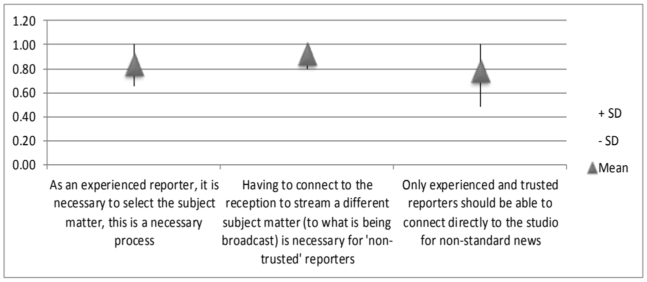

Figure 8 Human Contact

6. CONCLUSION

Simple citizen interactions have been attempted by the mainstream TV broadcasters in recent years using products like Skype and webcams, but these have been of a novelty value and not sustainable. The overall study took a fundamental look at the interactions between the citizen and the broadcaster from both ends of the information pathway.

A key aspect of the concept was to base the design around ubiquitous items (like Smart Phone and iPad type devices) that the general population would consider ‘non-intimidating’. This strategy allowed technology to be of only passing concern to the participants allowing other areas of research come to the fore – namely the social and person factors of interaction.

Further, as this new technology allows developers a level of control over the user interactions that could not be contemplated with existing cameras and/or video switchers, it opens up the entire process to new insights and innovative design which can be experience centered - focusing on this particular niche.

CPLTV has only scratched the surface, it has shown that feedback can be implemented seamlessly into current Smart-Phone technology through graphical layers, it has shown on the personal level that a community member can easily progress from a simple phone conversation to true video interaction moderated by the community - at a pace that is enabling and non-intimidating.

7. FUTURE WORK

The findings are very encouraging and give a clear message that CPLTV has the possibility of breaking the mould in terms of a collaboration between Broadcasters and Citizen Journalists.

The area of feedback was considered important by all stakeholders and was a central part of the conceptual design – even though it was implemented in a simple manner. Current mobile video feeds are of poor technical quality [40, 41] and this could be greatly improved through a CPLTV feedback path allowing the director influence shot composition in a manner supporting far superior UX when compared with other prescriptive modes [42]. These new converged devices offer the opportunity for mediated collaboration through the use of paired graphical overlays acceptable and usable by non-technical/non-experienced contributors whereby composition will evolve dynamically in real-time in response to broadcaster/director originated ‘suggestions’.

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Development of a General Internet Attitude Scale

Mary Joyce
People and Technology Research Group
School of Applied Psychology
University College Cork
m.joyce@ucc.ie

Dr. Jurek Kirakowski
Human Factors Research Group
School of Applied Psychology
University College Cork
jzk@ucc.ie

ABSTRACT
Whether at work or play, more people than ever encounter the Internet on a daily basis. In June 2010, there were an estimated 1.5 billion Internet users worldwide. With widespread use of the Internet in social, educational and work settings, it is important to understand how people interact with the Internet. This paper outlines the development of a General Internet Attitude Scale which measures people's attitudes towards the Internet.

General Terms
Measurement, Human Factors, Theory, Reliability

Keywords
Attitude, Internet, Measurement, Scale

1. INTRODUCTION
Since the beginning of the twenty-first century, the Internet has been a prominent and indispensable feature of many people's lives. This widespread interest has emerged as a result of the importance of the Internet in the workplace, educational contexts and many other environments. With it so distinguished in numerous different settings, the need to measure how one relates to the Internet has become an extremely important aspect of Human-Computer Interaction.

This widespread interest with the Internet brings about the need for an Internet attitude scale to measure people's attitudes towards the Internet. Individual reactions to the Internet are diverse [1] and it has been observed that people's attitudes to the Internet may affect their subsequent evaluations. Thus, in practice, a scale which measures people's attitudes towards the Internet will be of use to explain any variance which occurs in various evaluations of the Internet.

There have been a number of attempts at developing an Internet attitude scale in the past decade[2] [3], [4], [5]. However, these attempts have produced unsatisfactory means of measuring Internet attitudes. The most significant difficulty evident in past research is the lack of clarification and distinction between the terms 'attitude' and 'self-efficacy'. Within the discipline of Psychology, attitudes and self-efficacy are identified as independent constructs. However, much of the research carried out to date on Internet attitudes includes self-efficacy as a subscale of an Internet attitude. A crucial difference between these two constructs is that an Internet attitude refers to a person's feelings and their likes and dislikes about the Internet whereas Internet self-efficacy focuses on how a person evaluates their personal capabilities with using the Internet. This fundamental difference between feelings and capabilities determines that self-efficacy should not be regarded as a component of an attitude. Such issues highlight the need for a scale which independently measures Internet attitudes.

A further difficulty arising with previous Internet attitude research is that many of the proposed scale items do not actually represent an attitude or what might be considered a component of an attitude. This may be due to the absence of a theoretical framework in the measurement of Internet attitudes. For example, the subscale 'behaviour' has frequently appeared in previous Internet attitude scales [4], [6]. These behavioural statements which have been included assess previous practice and frequency of Internet behaviours. Whilst 'behaviour' has been proposed as one of the three components of an attitude, Katz and Stotland [7] clearly outline that the behavioural component of an attitude should outline the predisposition to action. An attitude should *precede* behaviour. Thus, if a behaviour subscale were to be included in an attitude scale, it should incorporate what an individual might intend to do rather than addressing what has previously been done. Therefore, it is crucial that an appropriate attitude model be applied to the measurement of Internet attitudes to address this inveterateissue.

Additionally, the more recent attempts at developing an Internet attitude scale have flaws in the wording of the proposed attitude statements. For example, Morse et al.'s [5] attempt at developing a General Internet Attitude Scale include statements which refer to the completion of specific tasks on the Internet i.e. "I would rather pay to download music than purchase CDs from a store". Attitude statements should reflect the attitudinal nature of the Internet and not address specific uses or tasks which can be performed on the Internet. Once again, this issue quite likely results from the absence of an attitude theoretical framework being applied to Internet attitude research.

With all of the above in mind, this paper presents the application of an appropriate psychological methodology to the measurement of Internet attitudes. The methodology which is applied to the current Internet attitude scale is outlined and preliminary analyses on the proposed Internet attitude scale are presented.

2. METHODOLOGY
The methodology applied to this research utilises both 'classical' and 'modern' psychometric approaches for the development and analysis of the proposed scale. This research aims to clarify the outlined issues with previous Internet attitude measures through the application of a well-known attitude model to Internet attitudes.

The development of a scale requires the generation and composition of a pool of statements which are selected and compiled from a larger number of statements [8]. A scale is the most desirable method of measuring attitudes as it can be tested for its reliability (ensuring that the items that make up the scale are all measuring the same underlying construct) and its validity (the degree to which the scale measures what it is supposed to measure). In line with this, it was decided that the development of a scale was the most appropriate type of measurement for this research.

The attitude model which is applied to this research is that of the three component model of attitude. Katz and Stotland[7] propose that attitudes consist of three components: affective, cognitive and behaviour. This three component model of attitudes had been adopted and favoured by attitude theorists to the present day. These three components are described as follows:

1. affective - an emotion or feeling connected with the object
2. cognitive – the belief of the individual about the object
3. behavioural – the action tendency of an attitude and the behavioural readiness associated with the attitude

3. METHOD

This research used Katz and Stotland's three component attitude model as a framework which was then applied to statements gathered from previous Internet attitude measures. The item pool for the attitude scale was created through the selection of appropriate items from: Weiser's Internet attitude survey [9]; Tsai, Lin & Tsai's Internet attitude scale [10]; Durndell and Haags's Internet attitude scale [3]; Zhang's Internet use attitude scale [11]; and Morse et al.'s General Internet Attitude Scale [5]. There was a pool of 128 items from this initial collection of statements. Careful deliberation of statements to be included in the Internet attitude scale was crucial for the development of this scale.These statements were studied carefully and the deletion of items was achieved through the adaptation of the following elimination criteria:

1. Statements referring to specific Internet activities
2. Statements outlining specific previous Internet behaviour
3. Statements which were ambiguous
4. Statements which were repetitive or better said elsewhere
5. Statements which could not fit within the three component framework

When this was completed, the final scale resulted in 27 items consisting of 11 cognitive statements; 8 affect statements and 8 behaviour statements.

3.1 Participants

428 participants took part in this study. 227participants were female and 201 were male. Participants' age range was from 15-65 years of age. A large number of participants (66%) were between the ages of 18 and 24. The majority of participants used the Internet on a daily basis (90.9%). The occupations of participants varied across a large number of professions including students, doctors, nurses, and teachers. Participants were recruited using ad hoc sampling.

3.2 Materials

The final questionnaire consisted of two main sections. The first section requested participants' basic demographic information including gender, age, occupation, frequency of Internet use, and uses of the Internet. The second section listed all 27 attitude statements. Participants were asked to indicate how much they agreed or disagreed with each statement on a 5 point Likert-type scale where 1 is "strongly disagree" and 5 is "strongly agree".

3.3 Procedure

Participants were instructed to go to the following web address: http:hfrg.ucc.ie/gias. Participants were informed that the questionnaire would take no longer than five minutes to complete. They were also informed that their data was completely anonymous and that they could withdraw from the study at any time.

4. RESULTS

All of the questionnaire responses were collated and the data from each was analysed. There were three analyses carried out on the data.

4.1 Elementary Linkage Analysis

The first analysis carried out was Elementary Linkage Analysis. Elementary Linkage Analysis seeks to identify and define the clustering of certain variables within a set of variables. Similar to Factor Analysis, Elementary Linkage Analysis searches for interrelated groups of correlation coefficients.

Elementary Linkage Analysis yielded six clusters from the data. The results are summarised in the following table:

Cluster No.	No. Items	Scale items	Attitude Component
1	5	1, 4, 11, 22, 25	Affect
2	5	14, 15, 17, 23, 26	Affect
3	4	5, 18, 19, 20	Cognitive
4	4	12, 21, 24, 27	Behaviour
5	7	3, 7, 8, 9, 10, 13, 16	Cognitive
6	2	2, 6	Behaviour

Table 4.1.Scale items and attitude component for each cluster

In the table it can be seen that each of the clusters are largely represented by one of the three components of an attitude. Cluster one however, while largely comprising of affective statements, also contained one behavioural statement and one cognitive statement. Similarly, cluster five, comprising primarily of cognitive statements also included one behavioural statement. On the whole however, the three component model of attitudes is supported in this analysis.

4.2 Exploratory Factor Analysis

The second analysis carried out on the data was Exploratory Factor Analysis which aimed to obtain a clearer factor structure of the Internet attitude scale. KMO statistics and Bartlett's Test of Sphericity confirmed the adequacy of the sample for factor analysis (KMO value = 0.896; Bartlett's Test of Sphericity = $p<0.000$). Three, four and five factors were extracted from the data. The five factor model produced the clearest meaningful structure of factors as two sets of factors could be appropriately merged to create a three component model of Internet attitudes as we proposed from the supporting literature on attitudes. The results are displayed below:

Factor No.	No. Items	Scale items	Attitude Component
1	9	1, 3, 7, 8, 9, 10, 13, 16, 22	Cognitive (positively worded items)
2	5	14, 15, 17, 23, 26	Affect (positive and negative)
3	5	12, 21, 24, 25, 27	Behaviour (positive)
4	5	5, 11, 18, 19, 20	Cognitive (negative)
5	3	2, 4, 6	Behaviour (negative)

Table 4.2. Scale items and attitude component for each factor

It can be seen in the table that each of the three components of attitude are largely represented by merging two sets of factors from the five factor analysis.

4.3 Multiple Groups Confirmatory Factor Analysis

The third analysis which was carried out was Confirmatory Factory Analysis. A Multiple Groups Confirmatory Factor Analysis (MGFCA) was conducted to assess the fit of the five component model of Internet attitudes. By generating "model fit measures", we were able to assess how well the proposed model captured the actual covariance between all the items on the test. Unlike traditional tests of model fit such as maximum likelihood and chi^{2,} which only indicate how well the tested model fits the data, the Post Hoc Monte Carlo analysis adopted for this study compares the tested model with 5,000 random models. The obtained results indicate that the five factor model specified provided the maximum fit, with an overall pattern of 0.901 for the actual data which yielded a fit index greater than 2 standard deviations from the mean (mean fit for the random data = 0.664, sd = 0.048, z value = 4.938; $p < 0.001$). The factor fit indices for each subscale were also considerably high: 0.891, 0.959, 0.910, 0.918 and 0.854 respectively. One can therefore have considerable confidence that the factor structure obtained in the two earlier analyses (which were exploratory in nature) is confirmed as being extremely unlikely to have arisen by chance.

4.4 Reliabilities and Intercorrelations

We can now reduce the subscales to three by combining the separate positive and negative factors extracted in the exploratory factor analysis (negative items will have to be reverse-scored). The three subscales make sense semantically. To what extent do they work statistically? There are two analyses to be carried out: internal consistency (using Cronbach's alpha) and between scale correlations. Statistical criteria are: high internal consistencyand low between scale correlations.

The reliability of each subscale was assessed to ensure that all of the subscale items were measuring the same underlying attribute (internal consistency). All Cronbach's Alpha values were above 0.7, which is an extremely acceptable cut-off point for attitudinal measures [12].

Subscale	Cronbach's Alpha
1	0.827
2	0.831
3	0.784

Table 4.4.1 Reliability of subscales

Between scale correlations were then calculated on the data. The subscales were moderately correlated. The correlation values are displayed in the following table:

Factor	2	3
1	0.517	0.424
2		0.607

Table 4.4.2 Inter-correlation values between subscales

Although these correlations are not extremely low, they are lower than the alpha coefficients and in general compare moderately well with inter-scale correlations of established questionnaires with supposedly orthogonal factors [13].

4.5 Conclusion

The final 'General Internet Attitude Scale' emerged with three underlying subscales. Two sets of factors were merged from the five factor model which produced the clearest structure of factors from the exploratory factor analysis.

Each subscale replicated a factor from the three component framework of attitudes thus confirming the three component model of attitudes in its application to Internet attitudes.

5. DISCUSSION

The analysis which was carried out confirms the three component model of attitudes in its application to the Internet and presents the first attitudes towards the Internet measuring tool to be created in the predominant paradigm of psychological attitude research.

5.1 Future research and applications

Although the General Internet Attitude Scale as it stands meets the standard psychometric requirements well, future research will concentrate on two aspects of development:

1. to attempt to clarify each of the three subscales (by re-wording, item deletion, and so on in order to decrease the inter-scale correlations) and
2. to investigate whether there are super-ordinate factors which underlie people's attitudes towards the Internet over and above the traditional three-factor generic attitude structure (perhaps a simpler two factor structure).

The use to which the General Internet Attitude Scale is intended (apart from academic research) is to enable practitioners to account for at least some of the wide variance typically found with any usability measurement activity [1]. Thus, another line of future research anticipated with the General Internet Attitude Scale is to use it in conjunction with a tool such as WAMMI [14] or measures of time on task in order to test the hypothesis that measures of attitude to the Internet predict a significant amount of variance in user data.

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Developing a new Social Network and the "Facebook Factor"

Darragh Coakley
DEIS Dept Cork Institute of Technology
Bishopstown
Cork
+353.21.4335935
Darragh.Coakley@cit.ie

Maria Murray
DEIS Dept Cork Institute of Technology
Bishopstown
Cork
+353.21.4335935
Maria.Murray@cit.ie

ABSTRACT
The use of social networking continues to grow. A number of social networking platforms now count users in the hundreds of millions and have changed the way in which a generation interacts with computers. This article examines the piloting of a new social network platform as part of a project called "Elvin" – a European Union (EU) KA2 Lifelong Learning Programme Project aimed at creating an informal social network to support and facilitate language practice and how user's prior experience with other social networking platforms influenced their initial impressions of this new platform with regard to its usability. The authors report on the development of the platform, entitled "MyElvin", as part of the Elvin project and the subsequent process of piloting the platform to users. This is followed by an examination of the pilot participant's experiences with the platform and how their prior experience with other social network platforms affected their impressions of MyElvin – a process commonly known in usability terms as "baby duck syndrome". The authors report on the findings of the piloting in usability terms and how these findings can be related to baby duck syndrome and the process of learning transfer. A number of observations are offered with regard to how baby duck syndrome and prior user experiences can be considered when developing new systems/ interfaces and details the experience of the Elvin project consortium in addressing this issue.

Categories and Subject Descriptors
H.5.1 Multimedia Information Systems: *Evaluation/methodology*

H.5.2 User Interfaces: *Graphical user interfaces (GUI), Screen design (e.g., text, graphics, colour, User-centred design*

H.5.3 Group and Organization Interfaces: *Computer-supported cooperative work, Web-based interaction*

General Terms
Management, Performance, Design, Experimentation, Human Factors, Languages, Theory.

Keywords
Social networking, collaboration, e-learning, technology-enhanced.

1. INTRODUCTION
On the 25th of 2011 an uprising in Egypt began. This would see a process of non-violent civil resistance begin across Egypt, a process which would lead to the resignation of President Mohammed Hosni Mubarak on February 11th, a mere 2 weeks later. The uprising was fuelled in part by the use of social media tools. One activist noted "We use Facebook to schedule the protests, Twitter to coordinate, and YouTube to tell the world." [1]. Such was the power of social networking revolution that the Egyptian government shut down internet access for most of the country on the 27th of January - two days after the uprising began [2]. This is a prime example of the influence which social networking now exerts on our society [3]. The role of these online social network tools has expanded to facilitate radical changes in society and collaboration which impacts on society on a mass scale. As noted by M. Boler: "People are using new media approaches to intervene in public debate and to try to gain a seat at the table. Central to this has been the introduction of the sociable web" [4].

The above example is an indication of the impact which social networking tools can now possess and the number of users which they can influence. A number of social networking platforms now count users in the hundreds of millions and have changed the way in which a generation interacts with other computers. This paper seeks to explore what we have termed the "Facebook factor" - how a number of dominant social networking sites have come to represent the primary standard(s) in human computer interaction in social network systems (particularly with regard to usability) and how these systems currently define what users have come to expect – an example of the usability phenomenon commonly known as "baby duck syndrome". The results of this have arisen as a result of the experiences of the DEIS Department in the Cork Institute of Technology as part of its participation in an EU-funded project called Elvin aimed at developing a social networking platform and integrated digital repository solution to support language learning in the Public Sector.

2. THE ELVIN PROJECT
The ELVIN (European Languages Virtual Network) project (http://www.myelvin.com/) is a European Union (EU) KA2 Lifelong Learning Programme Project aimed at creating an informal social network to support and facilitate language practice. The project is coordinated by the Castile and Lion School of Public Administration, started in November 2009 and is currently on the second and last year of its development. Ten

institutions from six different countries are involved in the project.

Figure 1. The MyElvin logo

Following from its aims to bring together online social networks, professional profiles and language practice in an informal educational context, the main deliverable of the project is an online platform based on a social network. This platform is named "MyElvin". Since its initiation in November 2009, until now, the project has been focused on the technological development of the main MyElvin platform. This social networking platform connects learners for language practice based on their own professional, academic and/or personal needs and abilities.

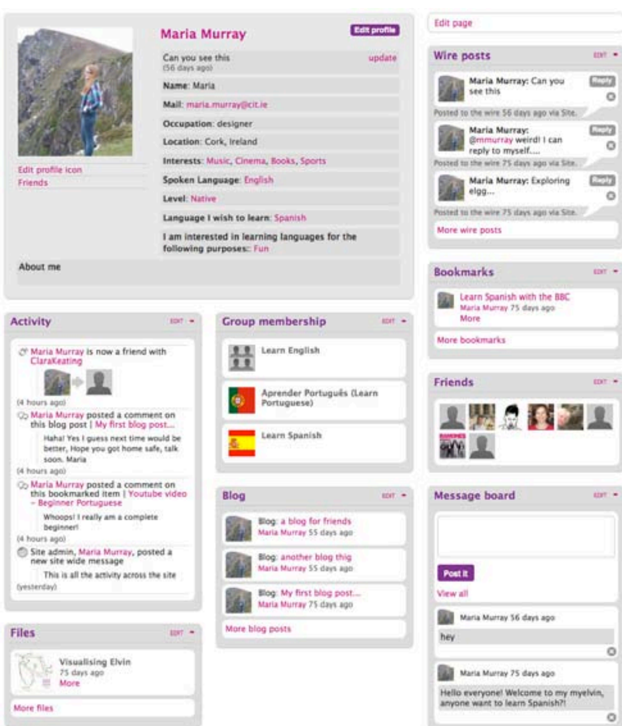

Figure 2. A screenshot of the MyElvin social network in its piloting stage

The process for the development of MyElvin began with examining the various open source platforms available to develop social networks. After profiling the different solutions, the partner consortium choose to develop the My Elvin platform based on the popular open source social networking engine "Elgg", an open source web application combining elements of weblogging, e-portfolios, and social networking to create a "learning landscape where learners engage in the whole process both academically and socially" [5].

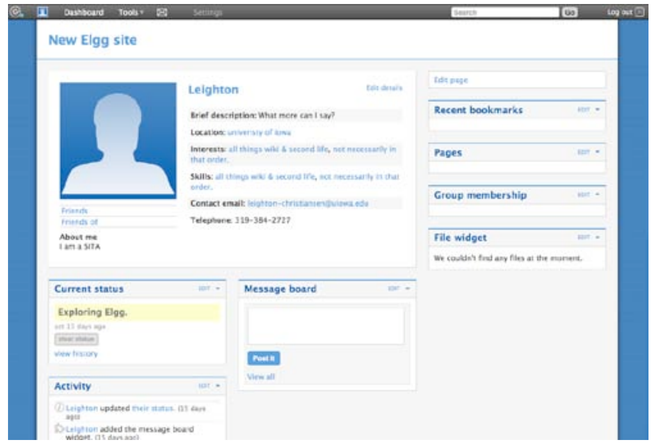

Figure 3. A screenshot of the ELGG social network platform in its default appearance

As part of this development process, the Learning Object (LO) model [6] was also defined and the MyElvin repository was implemented based on DSPACE [7].

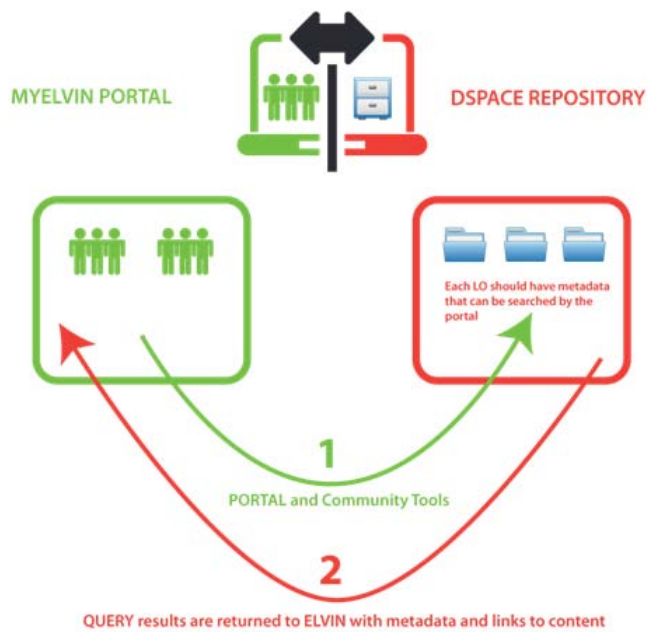

Figure 4. The inter-relationship between the MyElvin portal and Learning Object model in the DSPACE document repository

3. MYELVIN PILOTING

Following development and initial testing of the MyElvin environment, the process of piloting the system to prospective learners began. The platform was ready for initial usability testing and piloting in autumn of 2010 with the first pilot action carried out from November 4th, 2010 until December 10th, 2010. Many of the findings of this paper have been drawn from the conclusions and the user feedback which arose from this first MyElvin pilot.

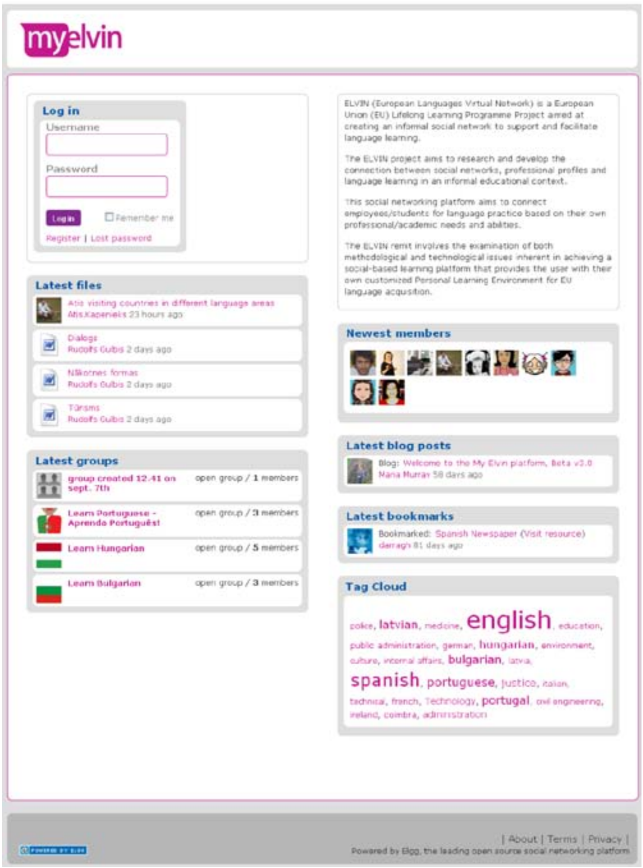

Figure 5. A screenshot of the MyElvin interface

The piloting of the MyElvin platform sought to identify interests and expectations by the MyElvin pilot participants, the interactions triggered by the platform, the areas of the platform which could be improved, etc. The applied methodology used by partners involved quantitative (and often qualitative) tools to collect data on user's general impressions, their level of' satisfaction with the platform, usability issues which they encountered, etc.

The process of piloting the platform necessitated the sourcing of a minimum of 10 pilot participants from each of the Elvin project partners (according to local conditions). As an indication of how many participants took part, review statistics gleaned from Google analytics, from the period of November 1st to December 16th 2010, there were 2489 visits from 636 unique visitors. Following initial registration by participants to the platform, introductory questionnaires were issued in order to identify users' expectations and initial assessments of the portal. Users were then asked to participate in typical platform tasks, interacting with people and content in MyElvin. Once the participants finished the defined tasks, they were asked to complete a survey gauging their immediate reactions to the tasks and the platform. User's participation was centred on a number of tasks and/ or scenarios which pilot participants were asked to perform, including:

- Publically discussing topics, practicing language, sharing web resources together in groups / forums, etc;
- Privately discussing topics, practicing language, sharing web resources together, such as chat / email / Skype one-to-one;
- Solving problems with the platform by interacting in conversations and discussions with tutors (expert users) in one-to-one interactions, groups, forums, as well as using help desks monitored by tutors, or other kinds of support suggested by tutors;

Figure 6. A screenshot of a MyElvin group discussion

Tasks defined as necessary for the piloting were both central to the main goals and concerns (of the product) and also had a high probability of uncovering usability problems [8].

In addition to the use of questionnaires to gather quantitative data, many project partners also undertook to use qualitative data gathering tools such as post hoc interviews and direct observation techniques (e.g. think-aloud sessions) during pilot participation to collect additional qualitative data. For example, within DEIS, usability software "Morae" was used to deliver the surveys but also to record the screen during user piloting (including recording associated data such as the time spent on each task, on each web page, etc.) while the user undertook the pilot tasks. At the same time, direct observation of the participants took place as they performed a "think-aloud" session while attempting the pilot tasks listed above.

The methodology applied gathered data on:

1. The degree of MyElvin users' satisfaction with the social network;
2. The mechanisms and dynamics of the software that supports the Social Engine: characteristics, mechanisms of content provision and resources; matching, etc.;
3. The language practice and informal learning dynamics used;
4. Any other issues of usability.

4. THE "FACEBOOK FACTOR"

In addition to various technological impediments encountered by participants, several usability issues were identified following the piloting of the MyElvin platform. Chief among these were issues relating to the use of resources and applications such as the matching and communicating with users of different nationalities, etc. It should be noted that nearly all project partners identified in their reports on the piloting of the platform in their respective countries that the vast majority of pilot participants had existing Facebook and other social network accounts.

One of the most recurring usability issues expressed by participants which arose throughout the pilot actions in the separate partner countries, however, came to be referred to colloquially by project partners as "the Facebook factor". Many partners considered this "Facebook factor" a usability issue of particular interest as participants reported that they were confused by the platform & were unsure how to perform tasks. Participants did not define specific usability problems with the platform interface, but rather noted that their expectations were not met with regard to the platform's terminology and functionality and that some features did not behave as expected (and so were considered redundant by participants). Spanish partners ECLAP, describing a common complaint which arose as part of their report on their piloting, noted that:

> "The "problem" is that the interface is not like Facebook. This issue was reported by several users, they are used to Facebook and it's hard to change their minds in order to learn how to use another tool. This is more a comment, than a problem".

Figure 7. A screenshot of the Facebook interface

Other partners encountered similar observations by pilot participants. Indeed, the extended use and popularity of Facebook may be attributed to several initial usability problems which arose when users first accessed the platform. During their piloting experience, the DEIS Department encountered a number of users who, during directly observed "think-aloud" sessions, made explicit references to the Facebook platform when attempting to complete certain tasks . References included such comments as: "If I want to add a friend, I should try to go to their wall" (during a task requiring participants to add a friend – the term "wall" here refers to the section in Facebook whereby all of a user's recent activities are listed) and "okay, how do I like this?" (in reference to the function in Facebook "like" function, which allows a user to share content with other friends on Facebook).

Figure 8. The Facebook "like" function

Although the myElvin platform provides many of the tools equivalent to those found in Facebook- albeit with different descriptors, e.g.: in myElvin there is a "dashboard" (renamed as a "news stream" following the piloting) and an "activity widget" compared to Facebook's "wall" – these tools were generally overlooked by pilot participants. Upon further investigation, it became apparent that users had not registered these tools in the interface. One participant, who took part in the piloting undertaken by Spanish Partner ECLAP indicated that the use of different terminology and the position of these tools in the MyElvin interface (compared to the name and position of the equivalent tools in Facebook) had led her to overlook them. It should be noted that functions within the MyElvin platform which were similar to Facebook were also identified by participants – one DEIS pilot participant, when progressing through the platform noted during the "think-aloud" session that: "the friend system here seems to be the same as in Facebook" and was able to complete the task with ease.

Figure 9. A screenshot of a Facebook "wall"

Thus, the "Facebook factor" referred to by the project partners conducting the piloting was considered to be present when the extended use and popularity of Facebook may be attributed to the immediate nature of interaction and connection on the MyElvin platform and where this may have affected users' initial motivations and expectations towards MyElvin and the platform's functions.

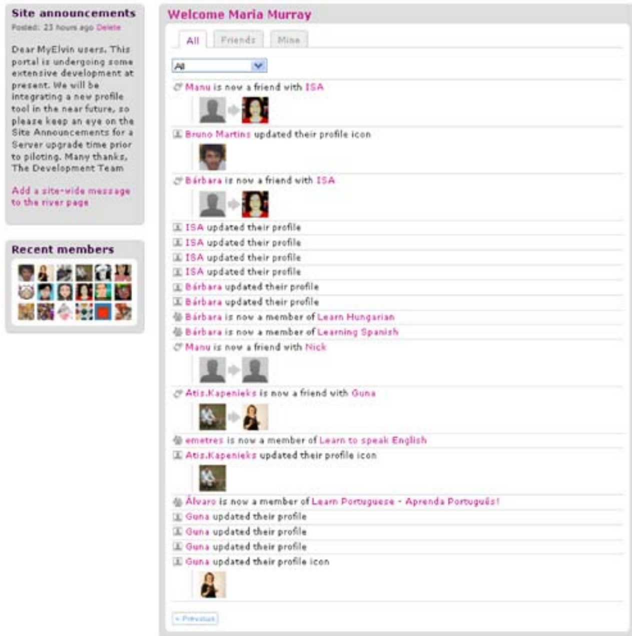

Figure 10. A screenshot of the equivalent in MyElvin (the "dashboard")

It could be argued that as a first-stage pilot, the myElvin platform retained a number of technical development issues with regard to a number of its functions and could be considered more of an experimental environment (rather than a fully-developed platform) and that this, coupled with a comparatively small number of users and the pilot-related motivations aimed at discerning usability areas for improvement, serve to make comparisons between MyElvin and Facebook, and therefore, the "Facebook factor" encountered as part of the piloting, unsubstantial. Some usability concepts, however, seems to suggests otherwise. "Baby-duck syndrome", described in the next section of the paper, can be seen to corroborate the concept associated with the "Facebook factor" encountered during the piloting.

5. BABY DUCK SYNDROME AND IMPRINTING

The origins of the term "Baby duck syndrome" are based in the work of Konrad Lorenz, an Austrian psychologist who, while studying the behaviour of birds (specifically greylag geese – although the behaviours observed could be generalized to other birds – e.g.: ducks) noted within a short time frame after baby birds hatch, they "imprint" on whatever suitable moving stimulus they see, regardless of whether it is suitable or not. [10].

But how, one may ask, do these geese relate to the findings of the MyElvin platform piloting? The term "Baby-duck syndrome" was adopted by the computing community as a means of describing the tendency of users to display favouritism for the systems and interfaces which they initially practiced on and to compare all succeeding systems and interfaces to the instance which they are familiar with. [11]. The obvious upshot of this is that users generally prefer systems which are similar to those which they have learned on and will tend to dislike or lack interest in systems which they are not familiar with. Frequently, the movement to a new system or platform will require users to discard or adjust previous practices which can result in negative feedback. An example of this may be seen in the frequent criticism of systems which impose design changes, as has been previously seen with Facebook [12], or in the updating of systems which differ to how they previously functioned, as has been previously seen with Windows Vista [13]. From this, we may extrapolate that baby duck syndrome is often closely related to an important element in good interface design (and an important element in HCI) - consistency, a design principle which emphasizes uniformity in both appearance and behaviour. Consistency: "significantly affects usability. Users expect certain aspects of the interface to behave in certain ways, and when that does not happen it can be very confusing." [14].

As the "imprinted" system/ interface (the system/ interface which the learner is so familiar with, or which they learned on) is so engrained with users, the functionality that it provides and the interface that it presents (including the terminology and imagery used) can heavily influence how a learner approaches an unfamiliar, if similar, system/ interface. To examine this in a different light, one can relate baby duck syndrome to the process of learning transfer. Learning transfer can be defined as "prior learning affecting news learning or performance"[15]. For the purposes of the MyElvin project, this is a useful description, as the effects of this transfer of learning/ prior "imprinting" can be either beneficial or harmful when considering usability.

As an example of both the positive and negative effects which this may incur with regard to usability, we may look at the "friend" system used in MyElvin. If we consider the task requiring participants to add a friend in the MyElvin platform as part of the piloting, partners indicated that no users had doubts or queries on how the friend system operated when asked as they were familiar with the "friend" system made popular by Facebook – beneficial knowledge for new users of the MyElvin platform. The negative influence of the user's prior experience with and subsequent transfer of learning/ imprinting from other social networks is also visible in this same function as a number of participants reported difficulties in completing the process due to differences in the project interface. As noted in the DEIS report on piloting which they conducted: "participants complained about the syntax of the "add friend" button. They felt it should be "send friend request', more in keeping with conventions in other popular social networks and also with the actual function of the button"

Figure 11. A screenshot of the MyElvin "add friend" function

Figure 12. The "send friend request" function in Facebook

In this way, we can see the influence of baby duck syndrome in the MyELvin pilots. Perhaps a more explicit definition of this is noted in the DEIS piloting report, which states: "42% of participants felt there were some features missing that they had come to expect from social networks"

6. CONCLUSIONS

Although the baby duck syndrome was identified during the piloting, the Elvin project consortium still had to question how it could be addressed. Indeed, it was important not to dismiss the results which arose from the piloting of the MyElvin platform – the prior experience of users and the resulting baby duck syndrome which was visible during the piloting had to be brought into account. In the period concluding the piloting of the myElvin platform, re-development and refinement of the system took place. The "Facebook factor" was a major point of discussion during this period of development - the subject of contention being whether to attempt to actively make the platform interface and terminology more in keeping with what was used by Facebook, or to attempt to make a distinction between the MyElvin platform and the Facebook platform by using a different interface and different terminology.

Following careful discussion it was noted by the project partners that the strength of individual social networks lay in their individual aims and objectives rather than in any common interface & set of terms. The emergence of specific social networks for specific functions can be attributed to this belief – such as the emergence of Linkedin as a business-related social networking site or the use of myspace as a tool for musicians [16]. To this end, it was agreed by consortium members to attempt to satisfy user usability requirements identified in the pilot in as much as possible without actively attempting to replicate the Facebook interface and/ or terminology. Such measures included the addition of a "like" function and the adaptation of more terminology more akin to that of existing social networks (for example, the "dashboard" in MyElvin was renamed as the "News feed").

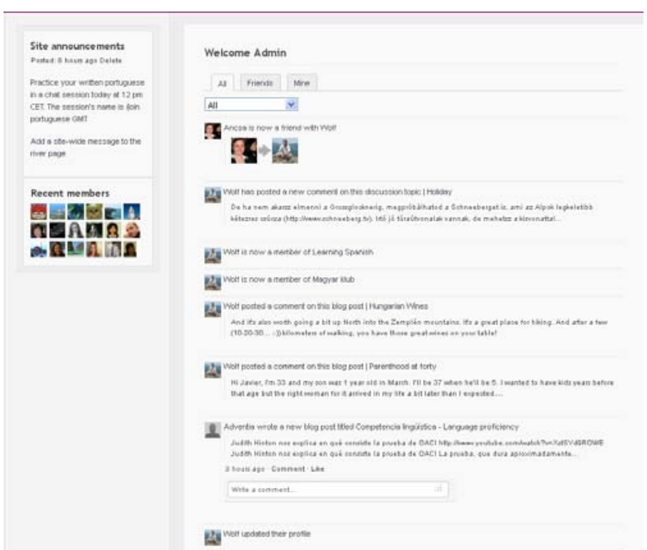

Figure 13. The updated "News feed" (dashboard) with the "like" function

Due to the dominance of a small number of social networking systems in the market, it is ultimately impossible for any new social networking platform to escape comparison with Facebook, Twitter, et al - no more than a new operating system could escape comparison with Windows, Mac Os, etc. This does not mean however, that all social networking systems must follow the exact path laid out by Facebook, nor should they fail to account for existing user experience with social networking systems, but should aim to leverage existing user experience to their benefit while remaining true to their initial aims and objectives. There is room for more than one social network. As noted by Bob DuCharme in "The Operating System":

> "Show me someone who insists that a certain operating system is superior to all others and I'll show you someone who probably only knows one operating system." [17]

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Learning on the Move: Harnessing Accelerometer Devices to Detect Learner Styles for Mobile Learning

Tracey J. Mehigan
Dept Computer Science
University College Cork
Ireland
t.mehigan@cs.ucc.ie

Ian Pitt
Dept Computer Science
University College Cork
Ireland
i.pitt@cs.ucc.ie

ABSTRACT
Learner style data has become an important area of consideration in the development of eLearning (Electronic Learning) systems. The development of personalized user models to meet the specific needs of individual learners allows for improved learning outcomes. This practice currently relies on the prior completion of questionnaires by system users, the completion of which can be time consuming.

Recent research has indicated that it is possible to identify the learner style of an eLearning system user based on the Global / Sequential dimension of the FSLSM (Felder-Silverman Learner Style Model). This can be achieved through the measurement of a user's mouse movement patterns. Other biometric interaction technologies, including eye tracking and accelerometer technology have also facilitated the detection of Global / Sequential learners using interaction data.

While eye tracking systems are becoming smaller and suitable for use with mobile devices, the accelerometer is now available as a standard feature in many high-end mobile devices such as the iPhone, bringing direct potential for automatic student modeling through accelerometer movement patterns for mLearning (Mobile Learning) environments. In this paper we discuss the potential of the accelerometer device for the detection of Visual / Verbal learners. An outline of a pilot study conducted to assess the potential of a full study for the detection of Visual / Verbal learners as outlined in the Felder-Silverman Model and achieved results is provided.

General Terms
Measurement, Human Factors, Interaction, Accelerometers, Learner Styles, Adaptive systems

Keywords
Measurement, HCI, Accelerometers, Learner Styles, User-Modeling, Adaptive systems, eLearning

1. INTRODUCTION & BACKGROUND
The aim of adaptive eLearning systems is the automatic provision of personalized learning content to individual learners. In recent years there has been an increased focus on the development of this type of system within the field of eLearning for the delivery of improved learning outcomes for individual learners based on their 'fit' within defined scales of a chosen learner style model.

A number of successful studies have incorporated the Global / Sequential dimension of the FSLSM (Felder-Silverman Learner Style Model). Mouse movement patterns were examined by Spada et al, 2008 [24] as a means of gathering user data for the detection of learner styles. Other studies have also considered user behavior patterns in LMS (Learning Management System) interaction as a means of extracting user data [11]. Scrolling and time spent on pages were included in the study. Bayesian Networks [10] and Feed Forward Neural Networks [26] have also been applied in this respect, showing a positive outcome.

This work has been successfully extended by the authors to include eye tracking [18] and accelerometer devices [19] as a means of detecting the Global / Sequential dimension of the FSLSM. The incorporation of the accelerometer has recently been seen in devices such as the Apple iPhone, iPad and Android devices, providing an opportunity to extend this research to mobile devices through the use of biometric technologies.

There is potential to extend this work further to include the Visual / Verbal dimension of the FSLSM based on work conducted by Popescu (2008) [22] and Cha et al (2006) [4], both of whom assess visual and verbal learners through user behavior based on time spent on visual and verbal learning objects for the provision of personalized content in eLearning environments.

1.1 Learning Styles
Learning styles reflect the way that a student *characteristically and collectively acquires, retrieves and retains information*. Learner styles have been defined as follows:

- Learning Styles are the " *generalized differences in learning orientation based on the degree to which people emphasize the four modes of the learning process*" [16],
- "*The ways in which individuals begin to concentrate on, process, internalize, and retain new and difficult information*" [5],
- "*The characteristic strengths and preferences in the ways individuals take in and process information*" [8].

There are many popular learner style and personality models in existence which could potentially be used in the development of adaptive eLearning systems. Models that have been used to date in the development of such systems include the Big-Five model [3], the Myer-Briggs Type Indicator Model [20][21], and the Cognitive Style Analysis Model [23].

The main focus of this paper is the FSLSM (Felder-Silverman Learner Style Model). The model, put forward in 1988 [8], was originally intended for use with engineering students. The model has gained popularity in recent years across many disciplines, becoming become increasingly popular for student analysis in the area of eLearning systems [10][11].

Felder-Silverman distinguishes between student learning styles based on four distinct dimensions. The dimensions are Active / Reflective, Sensitive / Intuitive, Global / Sequential, and Visual / Verbal learners each dimension having distinct characteristics at each extreme of the dimension.

Active learners learn best by doing something with information while Reflective learners prefer to think about information quietly first. Sensing learners tend to like learning facts while Intuitive learners prefer to discover possibilities and relationships. Sequential learners require information to be presented in small incremental steps of complexity. Global learners usually achieve a learning outcome through large leaps and bounds.

The focus of this pilot study is the Visual / Verbal Dimension of the FSLSM.

1.1.1 Visual & Verbal Learners

The Visual / Verbal dimension of the FSLSM represents the learner's preferred mode of input when receiving learning content.

Visual learners remember best what they see and therefore are most suited to learning through diagrams, pictures, flowcharts, timelines, video and demonstrations. These are all suitable to meet the needs of presentation in teaching style as prescribed by the FSLSM for this learner category.

Verbal learners gain more from text and auditory (verbal) explanations and they also benefit from discussion and favor verbal explanations.

Felder originally referred to Auditory learners but changed this to Verbal learners in 2002 in the Author's preface to the revised paper. His reasoning behind this reflects that although textual prose is perceived visually it cannot be categorized as visual (in the same manner as a picture) for the transmission of information. Equally, textual prose cannot be categorized as auditory as it is perceived visually. Felder states that "*Cognitive Scientists have established that our brains generally convert written words into their spoken equivalents and process them in the same way that they process spoken words. Written words are therefore not equivalent to real visual information: to a visual learner, a picture is truly worth a thousand words, whether they are spoken or written. Making the learning style pair visual and verbal solves this problem by permitting spoken and written words to be included in the same category (verbal).*"

1.2 Accelerometer Technology

An accelerometer is a sensor device that measures the acceleration and speed of motion of an object across the x, y and z axes. This is achieved by measuring non-gravitational accelerations caused by movement and vibration of the accelerometer device. When the device is moved, an electrical output is produced proportionately to the rate of acceleration. An accelerometer can also measure vibration, shock, rotation and tilting, causes of acceleration [17].

"The simplest device to measure acceleration is the spring mass system" [17]. The iPhone for example uses a MEMS (Micro-Electro-Mechanical Systems) accelerometer which "*uses three elements: a silicon mass, a set of silicon springs, and an electrical current. The silicon springs measure the position of the silicon mass using the electrical current. Rotating iPhone causes a fluctuation in the electrical current passing through the silicon springs. The accelerometer registers these fluctuations and tells iPhone to adjust the display accordingly*" [1][2]. Logitech's Air Mouse incorporates the IME-3000 3-axis accelerometer with IDG dual-axis family of gyroscopes in order to produce a 6-axis motion.

Until recently, accelerometer devices had been used mainly in engineering to measure vibration on machines, buildings, process control systems and safety installations. They have also been used to measure seismic activity, inclination, machine vibration, dynamic distance and speed with or without the influence of gravity. We have also seen the inclusion of accelerometers in the health and fitness industry in recent years. Companies like Nike and Polar have produced and marketed sports watches for runners that include 'footpods' containing accelerometers to help determine the speed and distance for the runner wearing the unit. In the medical field, accelerometers are used in machinery for health monitoring by rotating equipment such as pumps.

In recent years we have seen the emergence of the accelerometer in mobile technology. Laptops include motion shock sensors, while the iPhone (and recently the iPad) includes an accelerometer to enable 'Tilt technology' to change screen orientation. The Nintendo Wii also incorporates an accelerometer device in its WiiMote for fun, interactive, wireless gaming. More recently we see accelerometers shipping as standard in high end Symbian 60 / 80 series mobile devices such as the Nokia N97.

Since the emergence of accelerometers within mobile phone devices, there has been much research based on the potential use of such technologies to enhance game play interaction, text entry and browsing [25], scrolling, zooming and scaling [6]. The authors are currently assessing the potential of accelerometers for the detection of learner styles based on users' movement patterns.

2. Pilot Study Outline

A pilot study was conducted to assess the potential of the accelerometer for the automatic detection of learner styles based on a student's interaction with a learning application.

An application was developed to incorporate a web-based learning screen and a data acquisition model to log accelerometer coordinates and time duration for each user to an external file.

It was expected that visual learners would spend longer on the visual learning objects and verbal learners would spend longer on textual content.

The pilot study was conducted to test the following hypotheses;

1. Visual learners (as defined in terms of the Felder-Silverman LSM) will exhibit longer total time duration on visual learning content (images/graphics) than Verbal learners.

2. Verbal learners (as defined in terms of the Felder-Silverman LSM) will exhibit longer total time duration on textual learning content than their Visual counterparts.

2.1 System Interface

An educational web-based learning application was developed to comprise elements of a computer science course in web development (see Figure. 1). The application was simulated via a

Desktop computer and the Logitech Air Mouse (representing the accelerometer).

The application was developed using HTML and JavaScript. The content offered a balance of images and text. No scrollbars were used in the application to ensure simple access to information. Each student was provided with a user account to ensure that records correctly match the user.

When using the system, the user logs in with their name and email address. The 'Next' button is then clicked to take them to the learning screen. When the learning screen is loaded by the application all content is visible on screen.

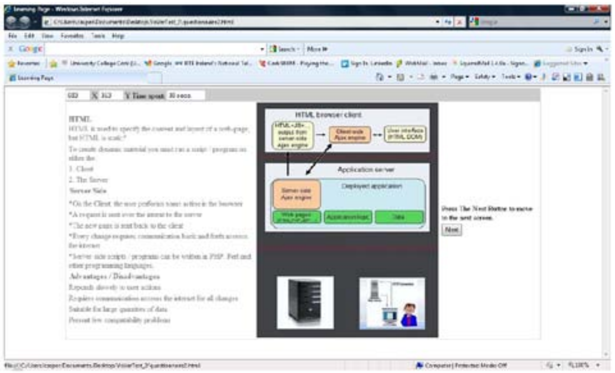

Figure 1. User Learner Screen

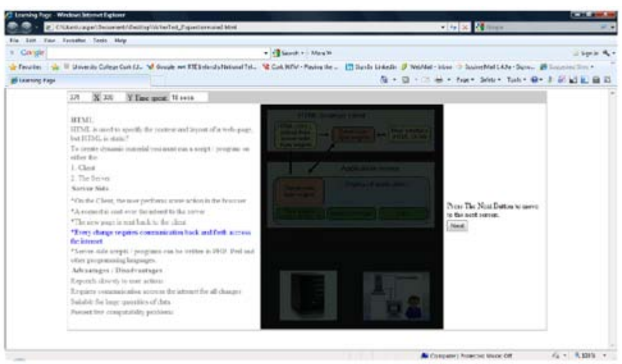

Figure 2. User Learner Screen showing Shaded Content

The user interacts with the screen by viewing and reading the content provided. The Air Mouse is used to move over, or to click on, the area of the screen content that they are reading and / or viewing. As the user moves the Air Mouse over the image content, the system is designed to shade the textual content from view and *vice versa*. When the user moves the cursor from the image content, the area of text (Heading or Sentence) under the cursor is highlighted whilst all the other areas of text on the screen remain shaded (see Figure 2). This is to ensure that the subject actually views either the text or the image content as per the placement of the cursor on the screen.

On the user's completion of viewing the content, the 'Next' button is clicked and the user is presented with a number of multiple choice questions. This represents the end of the application session.

2.2 Selection of Participants

Eight subjects took part in the pilot study, comprising four Visual learners and four Verbal learners (Figure 3).

The subjects, five females and three males, are all students, researchers, etc., between the ages of 16 and 65 years. In order to identify Visual and Verbal learners, potential subjects were first asked to complete the online FSILS (Felder-Soloman Index of Learner Styles) questionnaire. The questionnaire contains simple and unambiguous closed questions from which users must select one of two possible options via radio buttons.

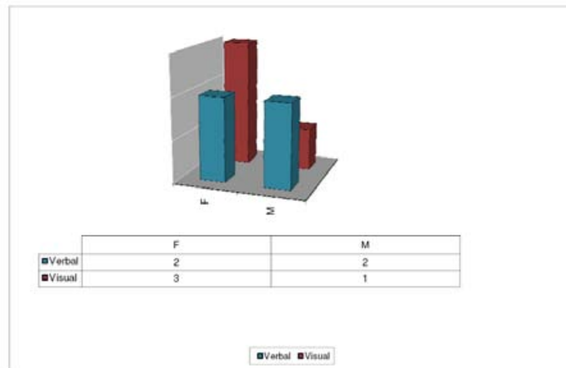

Figure 3. Participant Distribution

The information gathered was processed online. The screening of subjects continued until four of each learner type were identified, four Visual learners and four Verbal learners and each confirmed their willingness to take part in the test.

2.3 Method

Subjects were asked to undertake a PC-based eLearning task. Subjects interacted with the system using the Logitech Air Mouse.

Subjects were instructed in how to use the system, on completion of instruction, no further help or prompting was provided by the test coordinator. No user failed to complete the test.

During the task, subjects were presented with one page of learning information on a topic in the form of text and images. This screen was followed by a multiple-choice question relating to that topic, the purpose being to ensure that a learning experience had occurred. Navigation from one screen to the next was achieved through clicking a 'Next' button.

No Time limit was imposed on the user to interact with the application; the normal interaction time was approximately 10 minutes per user. This is allowing an average of 5 minutes per screen (up to two screens were included). Participants were discouraged from taking longer than a half hour to complete the test.

The learning style of individual subjects (Visual or Verbal), as determined using the Felder-Silverman ILS questionnaire represented the independent variable for the test. The Dependant variables, relative to the Visual / Verbal learner style dimension, were represented by;

a. Duration on Text points

b. Duration on Image points

These were automatically recorded by the application through the data acquisition file.

2.3.1 Data Acquisition File

The application was designed to record data as coordinates relative to the position of the cursor on screen as the user interacts with the system. This data is automatically written to an external text file by the application.

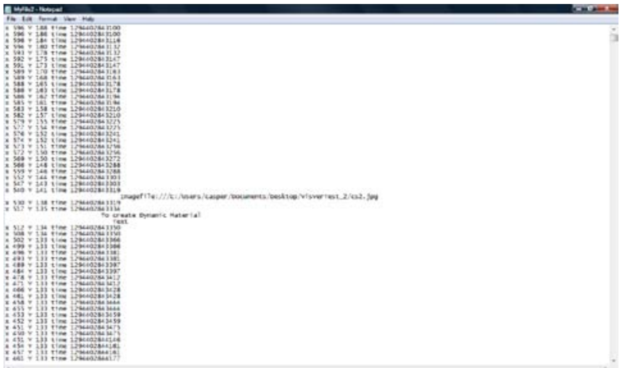

Figure 4. Data Acquisition Screen

The data recorded includes the time in milliseconds between cursor movement from one coordinate to the next as well as between images and textual areas. This information was used for the pilot study to highlight where each user had viewed / read learning object content (Figure 4). Much of this information can also be used for further analysis at a later stage.

In relation to the multiple choice question page, the system records both correct and incorrect multiple choice responses on submission.

3. RESULTS AND EVALUATION

3.1 Correlation Coefficient

In order to assess the results of the pilot study it was necessary to establish a correlation co-efficient based on the user's score on the visual and verbal learning style dimension of the Felder-Solomon ILS [7] and each of the following conditions:

1. Total time duration on text using the accelerometer.
2. Total time duration on images using the accelerometer.

Results obtained from user interaction with the application through the accelerometer device indicate a correlation coefficient of r= 0.86344 in respect of participants' total time duration on images and their score of the Visual / Verbal dimension of the FSILS. This is indicated in the scatter graph shown in Figure 5.

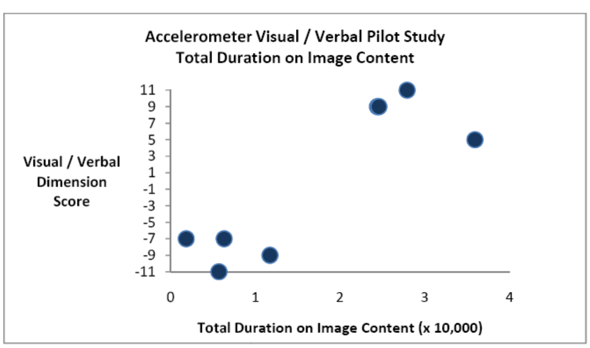

Figure 5. Total Duration (Image Content) vs. Visual / Verbal Dimension Score

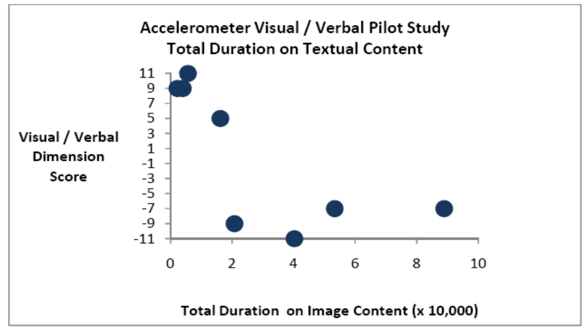

Figure 6 Total Duration (Textual Content) vs. Visual / Verbal Dimension Score

An inverse correlation of r=-0.72156 was achieved in respect of the second condition, time duration on textual content using the accelerometer vs. participant score on the FSILS as shown in Figure 6.

The correlation coefficients achieved in respect of the two conditions clearly indicate that students with longer overall time duration on visual content tend to be more visual in their learning style. Conversely, learners with longer overall times duration on textual content, tend to be more verbal in their learning style, when measured against the FSILS.

4. FUTURE WORK

The results of the pilot study have proven successful and informative. The correlation coefficients achieved indicate that it is possible to detect Visual / Verbal learners through their interaction with accelerometer devices. Consequently, there is strong potential to extend this work to the scale of a full study to further assess the potential use of accelerometers as a means of extracting user data for visual / verbal learner style analysis, particularly in mobile environments.

There is also an opportunity to examine the potential of accelerometer and other biometric technologies to tracking in determining user preference on other dimensions of the FSLSM including the active / reflective and the sensitive / intuitive dimension.

As accelerometer devices are now available as standard in many high-end mobile devices, we are currently extending this research to include handheld devices. We propose extending the incorporation of other biometric interaction tools for use in conjunction with handheld devices.

5. ACKNOWLEDGMENTS

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Building an Irish Sign Language Conversational Avatar: Linguistic and Human Interface Challenges

Irene Murtagh
Institute of Technology
Blanchardstown,
Dublin,
Ireland.
murtagh.irene@gmail.com

ABSTRACT
This paper isconcerned with research work in progress in the development of a linguistically motivated avatar for Irish Sign Language (ISL), understood as an embodied conversational agent (ECA). Conversational avatar technology for sign languages provides the potential to directly improve the communicative experience for members of the Deaf Community.It is envisaged that theECA will later be employed for real-time sign language visualisation for ISL. We discuss the development of an ECA to encode gesture. We also discuss the use of Role and Reference Grammar, a functional model of grammar, henceforth RRG, in the development of an RRG parser for sign language. It is planned to use RRGas the linguistic 'engine' in this development. It is envisaged that the RRG parser/generator described in this paper will later be used as a component in the development of a computational framework for an embodied conversational agent for ISL.

General Terms
Algorithms, Design, Human Factors, Standardisation, Languages.

Keywords
Irish Sign Language, Embodied Conversational Agent, Role and Reference Grammar, Sign Language Visualisation.

1. INTRODUCTION
Irish Sign Language (ISL), like all other sign languages, is a visual gestural language without any aural or written form. It is the indigenous language of the Irish Deaf Community and is the first language of Deaf people in Ireland. ISL is a visual, spatial language, with its own distinct grammar. [1] There are many misconceptions within the hearing community with regard to sign languages. Some of the misconceptions are: that all Deaf people are literate in a written national language e.g. English; there is only a single Sign Language; that a Sign Language is merely the visual-gestural representation of a spoken language; linguistic studies of verbal languages can easily be applied to Sign Languages; Sign Language sentences using can be easily written using spoken words.

Sign language, of particular relevance to this research ISL, is not only a language of the hands, but also of the face and body. In both speech act modality and linguistic terms, ISL is a completely different language to English or Irish. Unfortunately, even with today's technological advancements in both computer hardware and software, the Deaf community in Ireland is still overlooked with regard to the provision of public services in ISL[2].Insufficient socio-economic opportunity occurs within the Deaf community as a result of lack of access to information and communication services[3]. Sign Language interpreters are used as a means of communication between the Deaf and hearing, however, in Ireland where the ratio of interpreters to Deaf people is about 1:250 [4][5], they are often difficult to come by.

Virtual reality human modeling and animation has the potential to alleviate the communication barrier for sign language users. To date research in this area has reached the point where it is possible to construct a human avatar that is articulate and responsive enough to perform Sign Language [6]. It is possible for Sign language users to view onscreen animations and successfully interpret the movements of an avatar to understand its meaning [7]. However, to date, there is no standard computational linguistic framework available to link the divide between the linguistic and the animation interface. This linguistic component would suffice as a toll for the development of a script with appropriate instructional content to "drive" the virtual avatar. At a minimum, this linguistic component or framework should be capable of communicating to the animated avatar what actions to carry out in order to convert from the first language (in this case English) to the target language (in this case ISL).

The aim of this paper is discuss research work in progress in the development of a linguistically motivated avatar for ISL. For the purpose of this research it is intended to use RRG, which is a theory of grammar that is concerned with the interaction of syntax, semantics and pragmatics across grammatical systems. RRG takes language to be a system of communicative social action, and accordingly, analysing the communicative functions of grammatical structures plays a vital role in grammatical description and theory from this perspective. RRG will be used in this research in the development of an RRG parser/generatorwhichwill later be used as a component in the development of a computational framework for an embodied conversational agent for ISL.This poses significant technical and theoretical difficulties within both RRG and for software [8], [9]. As ISL is a visual gestural language without any aural or written form, like all other sign languages, the challenge is to extend the RRG view of the lexicon and the layered structure of the word, indeed the model itself, to accommodate sign languages. In particular, the morphology of sign languages is concerned with manual and non-manual features, handshapes across the dominant and non-dominant hand in simultaneous signed constructions, head, eyebrows and mouth shape. These are the morphemes and lexemes of sign language. This work directly seeks to improve the communicative experience for those members of the Deaf Community through the innovative use of conversational avatar technology. Potentially, this will enrich the experience of these language users within society.

2. RELATED WORK
There are presently several on-going SL related research projects of note. One of these is Dicta-Sign [10],a three-year EU-funded

research project that aims at making online communications more accessible to Deaf Sign Language users. This has been facilitated by the emergence of various Web 2.0 technologies that allow people to constantly interact with each other, by posting information (e.g. blogs, discussion forums), modifying and enhancing other people's contributions (e.g. Wikipedia), and sharing information. There is recognition that these technologies are not sign language userfriendly because they require the use of written language.Therefore, Dicta-Sign's goal has been to develop the necessary technologies that make Web 2.0 interactions in sign language possible: Users sign to a webcam using a dictation style. The computer recognises the signed phrases, converts them into an internal representation of sign language, and then has an animated avatar sign them back to the users. Content on the Web is then contributed and disseminated via the signing avatars. Moreover, the internal representation also allows for the development of sign language-to-sign language translation services.Recent research by Morrisey [11] has been on the application of example based data-driven machine translation (MT) to sign languages (SLs) is concerned with the provision of a SL MT system can facilitate communication between Deaf and hearing people by translating information into the native and preferred language of the individual. This work also focuses on Irish Sign Language - the native language of the Deaf community in Ireland. [12] eSIGNwas an EU-funded project whose aim was to provide information in sign language using Avatar software technology. The project has produced software tools which allow website and other software developers to extend their applications with signed versions.The eSIGNproject includes partners from the UK, Germany and the Netherlands.eSIGN uses Signing Gesture Markup Language (SiGML) which allows sign language sequences to be defined in aform suitable for performance by a virtual human, or avatar. SiGMLis a form of Extensible Markup Language (XML), and the SiGMLSigning software system converts SiGML to a sequence of animation frames, each corresponding to a configuration of the avatars virtual skeleton. DIVA (DOM Integrated Virtual Agents) is a web-oriented software framework that provides capabilities for the development and deployment of conversational virtual agents that are completely integrated with the DOM (Document Object Model) tree structure of web pages. The DOM is a standard interface, independent from any language and platform which allows programs and scripts to dynamically access both in read or modify modes the content, structure and the style of HTML or XML-based documents. A Sign Language utterance is built by a concatenation of atomic *signs*. Each sign is displayed as a predefined animation, built using rotoscoping. In order to build animations that are as realistic as possible, each utterance contains prologue and epilogue postures, allowing the virtual signer to begin and to end the utterance in a rest posture.

3. AVATAR TECHNOLOGIES

[13]MakeHuman and [14]Blender are the core technologies used in this research. MakeHuman is an open source, innovative and professional software tool that can be utilised for the development of 3-Dimensional humanoid characters. MakeHuman provides for the creation of virtual humanoid characters through the manipulation of a base polygonal mesh. It is possible to sculpt and shape the mesh provided by MakeHuman, by manipulating various user interface parameters. The mesh can then be exported in various formats for further use and development. Blender is an open source, cross platform 3D graphics and animation application that provides capabilities for the development of images and animations through 3D modelling and rendering. Blender was chosen as a tool for this research as it provides extensive capabilities that will aid in the development of an embodied conversational agent. Blender provides its own internal games engine, which renders it particularly attractive for real time processing. Some of the more important features that Blender provides for this research include: 3D modelling, rigging, skinning, animation, non-linear animation, shape keys, simulation and rendering, UV mapping, texturing. It provides a powerful character animation toolkit, advanced simulation tools including cloth and softbody dynamics and most importantly it supports the use of Python for embedded scripting. This provides Python scripting access for custom and procedural animation effects. It is expected that this area in particular will be central to the development of my research in the future. Another important feature of Blender is its cross platform capabilities, enabling it to run on multiple computer platforms including Microsoft Windows, Mac OS X and Linux. The version of Blender used for development was version 2.49b as this was current at the time. Within the Blender environment, the initial stage of avatar development in character animation involves working with a skeleton referred to as an *armature*. An armature behaves in a similar fashion to the human skeleton. The bones of the armature can be connected by using an array of different approaches, resulting in a controllable, intuitively movable character rig. The process of building an armature is called rigging. Figure 1 below provides a front view of the armature taken from Blender 2.49b. The armature gives the avatar structure while also providing a mechanism for creating and holding poses. The process of attaching an armature to a mesh is called skinning. The mesh for the avatar was imported from MakeHuman and attached to the custom built armature is as seen in Figure 1. Figure 2 provides an image of the right hand showing different orientations to include the palm and the back of the right hand. It also provides an image of the right hand while in Blender ‘edit’ mode. In this case the base polygonal mesh is also visible.

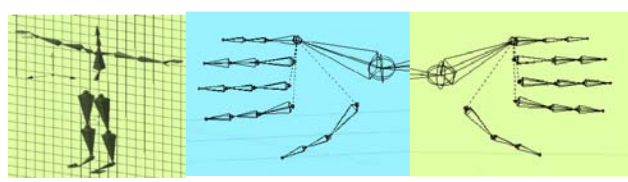

Figure 1: The Blender avatar rig and the armature of the left and the right hand respectively

Figure 2: Various orientations andviews of the avatar right hand in Blender

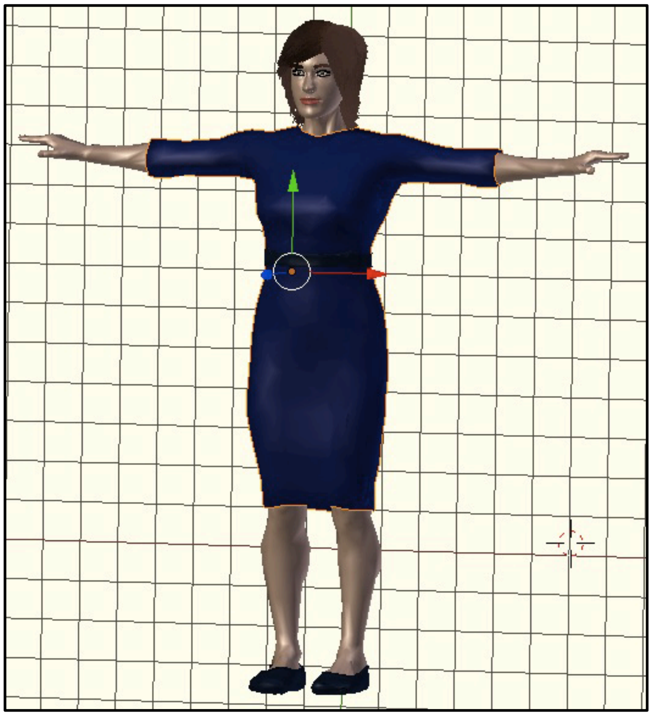

Figure 3:The avatar in Blender

Figure 3 provides a front view image of the completed avatar in Blender. The Blender particle system was used to add hair and eyebrows to the mesh. Vertex groups for the scalp and the eyebrows were created. Then Blenders particle system was used to allocate hair particles the designated groups. The clothing and footwear were developed by using a 'plane' mesh. This mesh was edited and sculpted into clothing and footwear using many of the tools and modifiers supplied by Blender. Blender utilises the Python programming language as a scripting language. Python scripts are used to extend Blender's functionality allowing for the development of custom made or procedural animation effects. It is intended this functionality will be used to help bridge the linguistic/animation interface during the next phase of research.

4. GESTURE IN HUMAN COMMUNICATION AND LANGUAGE

Human conversation is known to encompass a myriad of complex behaviours. Further to using our vocal organs to produce a speech signal, there are a wide range of complex bodily behaviours underlying human communication [15].It is important to realise that, even though speech is prominent in conveying content in face-to-face conversation, spontaneous gesture is also integral to conveying propositional content. In fact 50% of gestures add non-redundant information to the common ground of the conversation [16].In face-to-face dialogue, utterances consist of co-ordinated ensembles of coherent verbal and non-verbal actions [17] [18] [19].With regard to sign language, signs use visual imagery to convey ideas instead of single words. Sign language is used worldwide by the hearing-impaired as a form of communication with each other and with those that hear. It is a visual, spatial language, which utilises a combination of body and facial expression, lip formation and hand signs. Sign languages are fully developed natural languages and are used by Deaf communities all over the world [20]. Sign language is heavily reliant on gesture and facial expression, which play a very important role in the expression of meaning. It can be described as a natural language. It was not consciously invented by anyone, but was developed spontaneously by Deaf people and passed down without instruction from one Deaf generation to the next [21]. In terms of production, signed languages are articulated in three dimensional space, using not only the hands and arms, but also the head, shoulders, torso, eyes, eye-brows, nose, mouth and chin to express meaning [22]. Communication occurs using a visual-gestural modality, encompassing manual and non-manual gestures. Manual gestures make use of hand forms, hand locations, hand movements and orientations of the palm. Non-manual gestures include the use of eye gaze, facial expression, head and upper body movements. Both manual and non-manual gestures must be performed to produce a valid understanding and interpretation of the sign language [23].

5. IRISH SIGN LANGUAGE (ISL)

ISL is the indigenous language of the Irish Deaf community and is the first language of Deaf people in Ireland. It is a visual, spatial language, with its own distinct grammar. ISL is not only a language of the hands, but also of the face and body. In both modality and linguistic terms, ISL is very different to spoken English or Irish. "While ISL is used by approximately 5,000 Irish Deaf people, it is estimated that some 50,000 people also know and use the language, to a greater or lesser extent" [24]. ISL can be described as a minority language and therefore there is currently no real framework in place to describe its architecture. We propose to use RRG as a theory of grammar that will allow for the development of a lexicon architecture that is sufficiently universal with regard to content to accommodate ISL. We discuss RRG as a model of grammar in a later section.

6. POTENTIAL OF AVATAR FOR SIGN LANGUAGE COMMUNICATION IN ISL

ISL is a fully developed natural language used by the Irish Deaf community, however, ISL can be described as a minority language and therefore it is not currently recognised as a language in the Republic of Ireland. As a consequence, access to important information in relation to education, employment and a myriad of other resources are not available to members of the Deaf community in Ireland. Currently in Ireland, highly skilled interpreters must be employed to facilitate the communication between the Deaf or hearing impaired and the hearing. The use of an interpreter may not always be appropriate or even possible. The development of a three dimensional (3D) computer generated conversational avatar to deploy sign language communication would help to solve this problem. Conversational agents are believable humanoid avatars, capable of intelligible communication. In this particular instance communication would be through the articulation of Irish Sign Language.

7. ROLE AND REFERENCE GRAMMAR

The value that RRG contributes to this is that it is a theory of grammar that is concerned with the interaction of syntax, semantics and pragmatics across grammatical systems. RRG can be characterised as a descriptive framework for the analysis of languages and also an explanatory framework for the analysis of language acquisition [25]. As a lexicalist theory of grammar, RRG can be described as being well motivated cross-linguistically. The grammar model links the syntactic structure of a sentence to the semantic structure by means of a linking algorithm, which is bi-directional in nature. RRG is a monostratal theory positing only one level of syntactic representation, the actual form of the sentence. Therefore there is only one syntactic representation for a sentence. This representation corresponds to the actual form of the sentence. RRG does not allow any phonologically null elements in the syntax; if there's nothing there, there's nothing there. Within RRG theory, non-relational clause structure is referred to as the layered structure of the clause. The layered structure of the clause is based on two fundamental contrasts. Between the predicate and non-predicating elements, on one hand, and among the non-predicating elements, between arguments and non-arguments on the other [26]. Since these contrasts are found within all languages, RRG describes the primary constituent units of the clause as the 'nucleus', the 'core' and a 'periphery', where the 'nucleus' contains the predicate (usually a verb), the 'core' contains the nucleus and the arguments of the predicate and the 'periphery' subsumes non-arguments of the predicate. This is informally represented in the figure following. Each of the major layers (nucleus, core and clause) is modified by one or more operators, which are closed-class grammatical categories including tense, aspect, negation, illocutionary force, modality and evidentiality. Operators are another important component of the RRG theory of clause structure.An important property of operators is that they modify specific layers of the clause. This is summarized in Table 1.

Table 1: Operators in the layered structure of the clause [26]

Nuclear operators: Aspect Negation Directionals (only those modifying orientation of action or event withoutreference to participants)
Core operators: Directionals (only those expressing the orientation or motion of oneparticipant with reference to another participant or to the speaker) Event quantification Modality (root modals, e.g. ability, permission, obligation) Internal (narrow scope) negation
Clausal operators: Status (epistemic modals, external negation) Tense Evidentials Illocutionary Force

The semantic representation is based on a system of lexical representation and semantic roles. The system of lexical representation is based on [27] Aktionsart classification of verbs into states, activities, achievements and accomplishments. There are two additional classes; active accomplishments, which describe telic uses of activity verbs (e.g. devour) and also semelfactives (punctual events). Examples of each class and their formal representation, including their causative counterparts are given in (1) below.

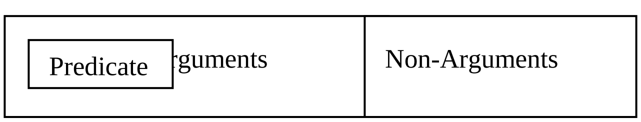

Figure 4: Universal oppositions underlying clause structure [26]

(1) a. States: *be sick, be tall, be dead, love, know, believe, have*
b. Activities: *march, swim, walk* (– goal PP); *think, eat* (+ mass noun/bare plural RP)
c. Semelfactives: *flash, tap, burst* (the intransitive versions), *glimpse*
d. Achievements: *pop, explode, shatter* (all intransitive)
e. Accomplishments: *melt, freeze, dry* (the intransitive versions), *learn*
f. Active accomplishments: *walk* (+ goal PP), *eat* (+ quantified RP), *devour*

A single verb can have more than one *Aktionsart* interpretation. For example the verb *'march'* would be listed in the lexicon as an activity verb, and lexical rules would derive the other uses from the basic activity use. The lexical representation of a verb or other predicate is termed its LOGICAL STRUCTURE [LS]. State predicates are represented simply as **predicate´**, while all activity predicates contain **do´**. Accomplishments, which are durative, are distinguished from achievements, which are punctual. Accomplishment LSs contain BECOME, while achievement LSs contain INGR, which is short for 'ingressive'. Semelfactives contain SEML. In addition, causation is treated as an independent parameter that crosscuts the six *Aktionsart* classes. It is represented by CAUSE in LSs. The lexical representations for each type of verb shown above are given in Table 2.

Table 2: Lexical Representation for Aktionsart classes[26]

Verb Class	Logical Structure
State	predicate' (x) or (x,y)
Activity	do' (x, [predicate' (x) or (x, y)]}
Achievement	INGR predicate' (x) or (x,y), or INGR do' (x, [predicate' (x) or (x, y)]}
Accomplishment	BECOME predicate' (x) or (x,y), or BECOME do' (x, [predicate' (x) or (x, y)]}
Active accomplishment	do' (x, [predicate_1,' (x, (y))]) & BECOME predicate_2; (z, x) or (y)
Causative	αCAUSE β where α, β are representations of any type

8. IRISH SIGN LANGUAGE

Ó Baoill and Matthews [22], describe the signing space as the space within which all signs must be articulated. The signing space usually extends from the waist upwards and includes the shoulders and the face. It extends outwards as far as the arms can extend. To ensure grammatical clarity, the signing space can be sub-divided for meaning. Morphemes are articulated at particular points or *loci* in relation to the signer for pronominal and anaphoric reference. Neutral space is the space immediately in front of the signer and close to the signer's body. It encompasses the area from the head to the waist and extends the width of the signer's body. Neutral space is the space that is used when producing the citation form of an item and generally does not act as a referent for particular or special meaning. The signs of ISL can be divided into eight different categories according to the manner and mode of production, as seen in 2 below. Their description is based on the following parameters, which relates mostly to whether a signer uses one or two hands in the articulation of a particular sign.

(2) a) One handed signs, including body or near body contact duringarticulation.
b) One handed signs, where the sign is articulated in free space without any body contact.
c) Two handed signs having identical shape, where the hands touch during the articulation of the sign in space.
d) Two handed signs having identical shape, where the hands move in symmetry but without any contact taking place during the articulation of the sign in space.
e) Two handed signs having identical shape, where the hands perform a similar action and come in contact with the body.

f) Two handed signs having identical shape, where the hands are in contact during articulation, however, using one dominant articulator and one passive articulator.

g) Two handed signs showing a different shape, each hand having an active articulator and having equal importance.

h) Two handed signs showing a different shape, where the dominant hand (depending on whether the signer is left-handed or right-handed) is the active articulator and the other hand is the subordinate or passive articulator.

8.1 The Non-Manual Features of ISL

Non-manual features (NMF) or markers in signed languages refer to those meaningful units of the visual-gestural language, which are used to convey additional information to the meaning being expressed by manual handshapes. The existence of NMF within signed languages has been well documented by researchers [28] [29] [30] [31]. NMF consist of various facial expressions such as eyebrow movement, movement of the eyes, mouth patterns, blowing of the cheeks and also include head tilting and shoulder movement. While NMF are normally accompanied by a signed lexical item, they can be used to communicate meaning independent to manual accompaniment. Within the linguistic system of ISL, NMF are used to express various emotions. They are also used to modulate or intensify the content of the information. In this sense NMF function as intensifiers. The use of NMF to express various syntactic properties is an identifying feature of sign languages and ISL is no exception to this. [22] NMF function as both morphological and syntactic markers in ISL. While the majority of functions expressed through the use of NMF occur at the single lexical item level, there are certain syntactic functions that are expressed by means of NMF, but are not attached to any lexical item. The following list identified by Ó Baoill and Matthews[22], include all the relevant functions provided by NMF.

(3) a) To show the degrees of emotion
b) To denote intensification or modulation
c) To distinguish declarative or interrogative sentences
d) To denote negation
e) To define topic or comment structures
f) To indicate conditional clauses
g) To show sarcasm

8.2 Hand Configuration in ISL

Stokoe [32] identified the various parameters which are relevant for the analysis of sign language. He suggested that the articulation of a sign encompassed three different parameters. A designator, which was used to refer to the specific combination of hand configuration, abbreviated to *dez*. A tabulation, used to refer to the location of the hands and abbreviated to *tab*, and a *signation* used to refer to the movement of the hands andabbreviated to *sig*. Dez, tab and sig were examples of what he called *cheremes*, the signed equivalent of phonemes. Later research refers to these parameters of sign language as *handshape*, *location* and *movement*.[33] [34] [35] Later research claimed that a fourth parameter is necessary in order to fully transcribe signs. This fourth parameter was called orientation, and denotes the orientation of the hands and fingers during the articulation of the sign. The abbreviation of orientation is *ori*.

9. THE PARSE AND GENERATE PROCESS FOR ISL AVATAR

9.1 Overview of the Process

Figure 5 shows a diagram of the RRG Interlingua bridge [8]. Using the RRG Interlingua bridge we create an intermediate semantic representation of the source text, based on RRG logical structures. These logical structures can then be used to generate our target language (ISL). The architecture of the parse and generate process for the ISL avatar is shown in figure 6. This architecture describes the flow of processing. It documents the processes from the user inputs text until an ISL articulation is produced via the Blender interface. The model accepts input in the form of an English sentence or English text. Once the inputted text has been parsed into its various parts of speech it is stored in the parts of speech (POS) lexicon. The next phase involves the syntactic parser. This parser retrieves the tokens or lexical items with their various information from the POS lexicon. It then uses the RRG linking system to convert from a syntactic description to a semantic description of the sentence or text. The output of this phase of parsing is a rich logical structure.

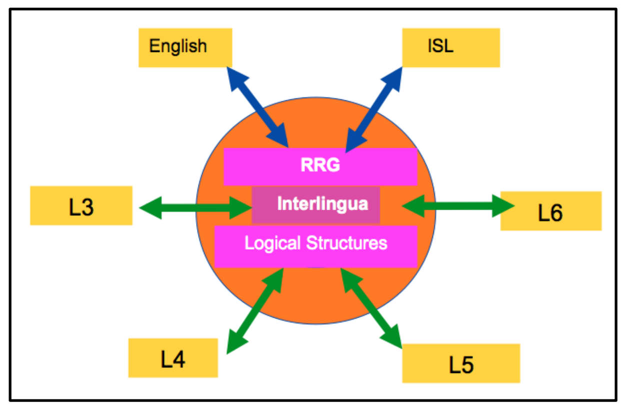

Figure 5: The RRG-based Interlingua Bridge [8]

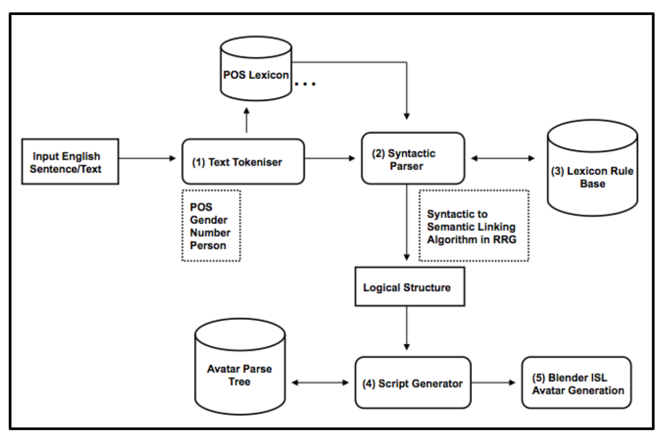

Figure 6: Architecture of the Parse and Generate Process for the ISL Avatar

Phase 4 is concerned with expanding the logical structure to produce what can be described as a meta representation of the parsed sentence. This will include agreement features, operators and constituents as well as information pertaining to the modality of the target language, i.e. the manual and non-manual features of

ISL. The final phase or phase 5 of the processing is the generation of an articulation in our target language which is ISL. ISL is a visual gestural language and therefore the ISL is outputted to the user by the implementation of a conversational avatar via the Blender UI. Blender provides Python programming interfaces and Python scripting access for the development of custom and procedural animation effects. The Python script developed at phase 4 will be used as input for the Blender interface and the result will be the generation of an articulation of the input sentence or text in ISL by the conversational avatar.

9.2 Phase 1 processing – finding the lexical items

In the initial processing phase, an English sentence will be inputted and stored in the form of a String. With regard to RRG, the sentence will be classified as one of the following: State, Activity, Achievement or Accomplishment. The sentence will then be tokenised and saved in a suitable data structure, where each token is a word. For each token the lexicon must be searched to see if the word is present and decipher its parts of speech (POS) (gender, number, person). The information must then be stored with the lexical item in the specified data structure. Once this step has been carried out for all tokens, there will be a better sense of the word order of the String.

9.3 Phase 2 processing – creating the rich logical structure of the utterance

The initial step for phase 2 is to identify where the NP is in the String. Then it must be interpreted as transitive, ditransitive or intransitive. This will clarify the type of sentence that is being processed. The next step for this phase involves the extraction of the logical structure for the verb from the lexicon. The tokens from phase 1 can then be retrieved and mapped based on the RRG theory of grammar.

(4) < …. < …. < …. [do [x… pred x, y, z] >>>

(5) The 1st NP into x, the 2nd. into y and the 3rd (typically in preposition) into z.

From the information recorded above (in the verb and the form of the verb for example run, ran, will run) information regarding the tense can be extracted and consequently the verbal and nominal structure can be determined. At the conclusion of this phase a rich logical structure will have been generated.

9.4 Phase 3 – The ISL Lexicon as an XML structure

It is envisaged that the lexicon will be developed using Extensible Markup Language (XML). XML is a platform neutral markup language, which is easily understood, while also lending itself well to computational parsing. XML will be used as a data structure for the storage and organisation of the various lexical entries i.e. verbs, nouns etc. to include the lexical items of ISL. It will be necessary at this phase of development to extend the lexicon to provide for the storage of the morphophonological handshapes of ISL as a visual gestural language. Signs are composed of both manual and non-manual features. Non-manual features are used to convey additional information to the meaning being expressed by manual handshapes. The lexicon architecture must be extended so that it is sufficiently universal to encompass both the syntactic and the semantic content of an articulation in ISL. This constitutes present work. We describe the characteristics of ISL in section 8 of this paper.

9.5 Phase 4 processing – expanding the logical structure to sign the utterance

This part of the processing will involve the development of the underlying linguistic model with bi-directional RRG. This will enable the conversion of the English text into a meta-representation in RRG logical structures and generate ISL on output to the embodied conversational agent in real time using Python scripting. ISL language specific information, for example manual and non-manual features will have to be considered at this phase of processing. The structure will then have to be expanded so that it is sufficiently universal to encompass all of the necessary parameters consistent with ISL.

9.6 Phase 5 processing – generate the utterance via Blender

This phase will allow for the interaction between the Blender interface and the output from phase 4 processing. It is anticipated that the gap between Blender and the generated logical structures from phase 4 will be bridged by the utilization of Python scripts. The Blender API provides Python scripting access for custom and procedural animation effects. The output of this phase will be the generation of the ISL articulation via the Blender UI.

10. CHALLENGES AND ISSUES

ISL, our target language, is a visual gestural language and by its very nature will prove challenging at the generation phase of this research. The development of a computational framework that will be capable of bridging the gap between the lexicon and the generation of ISL is a very complex and challenging issue. The development of a meta representation of the data, which must be sufficiently rich to encompass all of the necessary information consistent with ISL is also very challenging. Factors such as synchronisation of various articulators including articulators for manual and non-manual features of the language are currently being researched. Figure 5 is a first draft at resolving the question of how any given sign may be generated using our 3D animation tool, Blender.

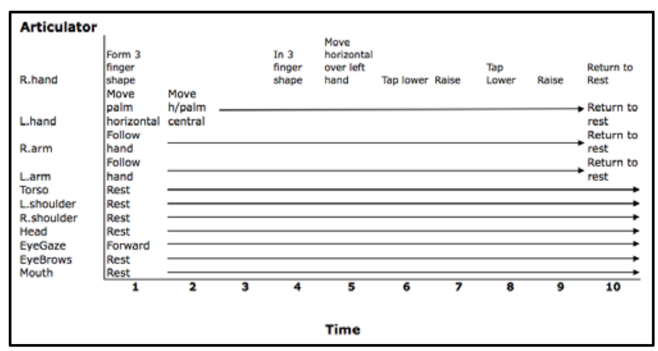

Figure 7: Realisation diagram for the sign "Mother" in ISL

It is envisaged that the articulators as shown in this figurewill be choreographed and orchestrated simultaneously, equivalent to instruments in an orchestra at the generation phase. Thisprovides a signature for the orchestration of a method to generate the sign for Mother in ISL. It is followed by the pseudocode for this signature in Figure 8.

The pseudocode provides a high level insight into the implementation details on the programming side for the avatar. It is envisaged that the avatar will be driven using the Blender-Python interface. Blender utilises the Python programming language as a scripting language. Python scripts can be used to extend Blender's functionality allowing creation of custom made or procedural animation effects. Parameters that encompass an ISL articulation such as orientation and movement together with the various articulators for manual and non-manual features will have to be considered at the implementation phase of research. Implementation details regarding synchronisation of movement of the various articulators are provided here at a high level.

```
Sign: mother = method
{           do{
                  Rhand(sign 51, orientation)
                  Tap(RH, LH, 2, x, y)
                  Lhand(sign 51, orientation)
                  Rarm(rest)
                  Larm(rest)
                  Head(rest)
                  Lshoulder(rest)
                  Rshoulder(rest)
                  Torso(rest)
                  Eyebrow(rest)
                  Eyegaze(forward)
                  Mouth(rest)
}           }
```

Figure 8: Pseudocode for the sign for "Mother" in ISL

11. DISCUSSION

The research presented here is a work in progress. To date the avatar for our research has been developed using Blender version 2.49b and MakeHuman. The avatars polygonal mesh was imported from MakeHumanand then the armature, which was developed in Blender, was attached or skinned to the mesh. The imported mesh was sculpted and edited using various tools and modifiers in Blender. The Blender particle system was used to add hair and eyebrows to the model. Various modifiers and tools were also used to develop clothing and shoes for the model. The various handshapes of ISL have been researched and identified. Ó Baoill and Matthews [2] indicate the 66 different handshapes are utilised within ISL in the formation of signed vocabulary. Within these handshapes Ó Baoill and Matthews [2] also identify the marked and unmarked handshapes of ISL, revealing a high correlation between ease of articulation in handshapes and frequency of occurrence. These handshapes provide us with an understanding of the building blocks of the formation of signs. The RRG linguistic framework and the RRG lexicon for this research have been mapped to XML. The next phase of research will involve the development of the underlying linguistic model with bi-directional RRG. This will enable the conversion of English text into a meta representation in RRG logical structures and generate ISL on output to the ECA in real time using Python scripting.

12. ACKNOWLEDGMENTS

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Can Mobile Ultrasound make a difference in Healthcare?

Cardwell Muvungani
muvungac@tcd.ie

Helen O'Connell

Bridget Kane*
kanebt@scss.tcd.ie

Dept. of Computer Science
O'Reilly Institute
Trinity College Dublin

ABSTRACT

We explore the feasibility of implementing hand-held ultrasound devices (HHU), primarily for General Practitioners (GPs) use, in the Irish primary health care system with a view to reduce patients' trips and costs associated with hospital visits. Hand-held ultrasound devices (HHU) are designed to be portable, lightweight, and run on either battery power or from mains electricity. HHUs are easily adapted to a scanning position. A review of literature on HHU devices was conducted to establish the usability, effectiveness, advantages and disadvantages of HHU devices, compared to the standard size ultrasound units (SU). The HHU is as effective as the SU when used by skilled personnel. Its portability makes it a useful tool to use out of a normal clinical setting and it has huge potential to be used by general practitioners on home visits as part of the routine physical examination for patients. Given these clinical, technical and technological possibilities the next step for the future is to establish the attitude of GPs and radiologists in Ireland with regard to using the HHU in GP family practices.

Categories and Subject Descriptors

H.1.2 [**Information Systems**]: User/Machine Systems.

1. INTRODUCTION

The Government's health strategy in primary care emphasises efficiency and disease prevention, which coupled with an efficient post-hospital follow-up system, aims to reduce the levels of hospitalisation and the associated high costs [7]. Part of the implementation plan of this health strategy requires improvements in out-of-hours co-operatives and the development of information and communications technology to improve health delivery efficiency. The Government is committed to their strategy [8] and it is within this policy framework that GP home visits are undertaken with targets to improve patient primary care. It is vital that health workers are well equipped with up to date technology to deal with the demands of delivering high standards in primary care. Patients should have a reduced number of trips to the hospitals for imaging [27], and some physical check-ups can be carried out in home environments. It is important to enable GPs to carry out all appropriate procedures such as ultrasound imaging (U/S) in the patient's home whenever possible, and avoid the unnecessary hospital visits.

Often the limitation of executing procedures in the patient's home is attributed, among other things, to difficulties with portability of medical and diagnostic equipment [16], the inaccessibility of the patient's medical record such as historical U/S images and real-time second medical opinion from experts such as radiologists. But since HHU devices can be carried around in a clinician's pocket, it is now possible to bring the device to the patient rather than the patient to the device [18]. The advantage of portable design means that the HHU can be readily available in locations that a SU cannot. In a patient's home environment, the HHU will give the GP an extra physical examination tool.

Our goal is to investigate the use of a HHU device by GPs as part of a routine patient examination during house calls. A HHU should 1) be small in size, so that it can be easily transported to various locations; (2) have a high image quality for accurate diagnosis; (3) have a large storage capacity for digital images; (4) a capability to wirelessly and securely transmit images to a repository for back up storage or for remote consultation, and (5) the ability to access the patient's previous U/S image archives stored elsewhere. It is envisaged that consultations can be conducted while the patient waits and can get instant diagnosis for some ailments, thereby reducing the waiting period for a diagnosis and possibly a faster commencement of a treatment regime.

Primary Health and HHU: In 1998 the Irish Government introduced the GP Out-of-hours' scheme [14] followed by the primary care Strategy which gave a commitment to prioritise primary health care [7]. The GP scheme is designed to provide out of hours services to patients in predefined geographical areas. Studies in Ireland and United Kingdom, report that patients highly value the impact of home visits in maintenance of their health [14, 4]. Part of the role of the GPs in the Irish scheme is to provide domiciliary visits to qualifying patients who make calls after GP's normal working hours [3], and a national contract for the installation and maintenance of IT systems in GP cooperatives is recommended [14]. It is vital that GPs should have

*IRCSET Research Fellow

Figure 1: Hand-Held Ultrasound (HHU) Device

appropriate equipment to ensure that their home visits are efficient and that they truly reduce those extra patient visits to the hospital. One such piece of equipment is an U/S machine which could form part of the routine physical examination of patients. Ultrasound (U/S) scans are used to perform diagnostic sonography (ultrasonography) which is a diagnostic imaging technique used for visualizing subcutaneous body structures including tendons, muscles, joints, vessels and internal organs for possible pathology or lesions. The difficulty is that an SU is not portable. Despite the fact that GPs home visits in other areas have specially equipped vehicles, not all GPs have these at their disposal. Even if they did, there may be a great deal of manual handling involved in setting up an SU in a patient's home.

2. METHODOLOGY

Published literature is reviewed to determine the feasibility and viability of using HHUs as part of a GP's routine physical examination during home visits and to establish: i) the feasibility of using HHUs for GP home visits, ii) the usability of HHU on same or similar medical applications, iii) the attitudes of users and potential users of HHUs, and iv) the cost of HHUs when compared with SU machines. The successes and failures of the implementation of portable US technologies in various medical applications were identified and documented from published research papers. Attitudes of potential end users with regard to the usability and the design of HHUs were examined. Reviews were categorised into Tables some of which focused on analysing specific human computer interaction factors while others focused on other general factors which may impact on the level of adoption of HHUs. Exclusion Criteria: Publications more than 10 years old were excluded, in order to take into account the fast evolving technology advances. Searches were conducted for English articles or those translated into English.

3. RESULTS

HHU devices can potentially solve the problem of portability of U/S for home visits. Figure 1 shows an example of a hand-held ultrasound device. Portability of HHU scans makes them readily available and this can result in quicker diagnoses. If their usage is limited to certain disorders their capabilities can exceed those of a stethoscope [21]. Unnecessary testing can be eliminated by detecting cardiovascular disease at a earlier stage with HHU, through improved triage and subspecialty referral [26]. One difficulty is the lack of GP training for use of ultrasonography. Without training important clinical findings can be missed [6]. But training in ultrasonography is an achievable educational goal. Students achieved a mean score of 86% for a 5-hour theory and practical course of Focused Assessment and Sonography in Trauma (FAST). It should be feasible for experienced GPs to avail of a 5-hour course in ultrasonography [12].

GPs on house calls generally do not have access to sonographers' or radiologists' expert opinions in real time. It is also important for GPs to be able to access archived images of previous U/S diagnostic imaging for a patient in question. Nowadays, 99% of U/S machines support Digital Imaging and Communications in Medicine (DICOM [1]) capability which leads to increased quality and productivity. A Picture Archiving and Communication System (PACS) was demonstrated during clinical trials, to operate successfully via a web technology between a PACS archive and a remote destination [9]. When a PACS is coupled with a hand-held device such as a HHU the benefits to the patients and the doctors' workflow multiplies. Creating a secure, wirelessly connected HHU scanner being operated by a GP on a home visit on one end and an expert consultant in a remote location may dramatically improve patient care as has been the case in other tele-radiology set-ups. Also, the GP can access the stored U/S image archives in real-time while still at the patient's home. Mobisante is an example of a HHU device which uses cloud computing and it can leverage mobile network or Wi-Fi to send and receive images for PACS archiving or for remote expert diagnosis by radiologists [22]. There are a number of commercial health information systems (HIS) available to GPs in Ireland. One such system is the HealthOne which is designed to store and manage a practice's patients' records. This system has the capability to import and export healthcare records [15]. It should be possible to allow importation or exportation of U/S images so that the GP can have access to the patient's records from the health information system (HIS) while at the patient's home. There are several reports of successes and shortfalls in the use of HHUs in a variety of medical applications. For example echocardiography was an early adopter of HHU technology and is probably the most mature medical application, in terms of the implementation of portable U/S technology [28].

Portable echocardiograph is very effective on screening, image quality, diagnostic ability, accuracy and clinical utility cost effectiveness [24]. There is little or no published research papers on the outcomes of the use of HHUs as part of the routine patient examination during GP home visits. Despite the lack of research many medical professionals be-

[1] a standard for managing medical images

Table 1: Sample Data Collected

Authors	Aims	Jadad Score	Results	Study Type
Ault & Rosen [1]	Effectiveness of HHU as compared to SU for paracenteces and thoracenteses	0	HHU Sufficient	Field
Frederiksen et al [11]	V-Scan HHU vs. standard SU for echocardiograph	3	No sig. difference for amount of users' experience	Field
Enright et al [10]	Bladder US for Dehydration assessment in paediatric ER	1	Convenient, non-invasive, objective	Field
Documet et al [9]	HIFU for Transcutaneous venous ablation	1	Effective	Ex vivo
Kansal et al [19]	Chest Pain triage in A&E	1	Ineffective	Field
Gogalniceanu et al [12]	HHU vs. SU for post-transplant liver assessment	3	No sig diff	Field
Bedetti et al [2]	HHU vs. SU to evaluate US lung comets	2	Equally effective	Field
Culp et al [5]	Pocket echocardiograph: validation and feasibility	3	Valid results. Feasible	Clinical

lieve there is great potential for HHUs. Cardiac conditions such as atherosclerosis often elude routine physical examinations but with portable U/S, these conditions can be detected using a handheld device in an outpatient setting [20]. Most of the available literature on the use of HHUs concerns the device features and benefits, from the point of view of manufactures and prototype developers. It is worth noting that echocardiographs are generally operated by experienced sonographers and specially trained cardiologists hence a high level of hospital positive outcomes are reported (Table 1).

Finally, it is important to establish the safety, security and fitness of the HHU devices. Ireland, as part of the EU, is bound by the regulatory Directives which are issued to ensure patients and end user's safety and security when using medical devices, for example the CE (European Conformity) Mark. If a product is conferred with a CE mark by the manufacturer it is a confirmation that the product complies with 'essential requirements of the relevant European health, safety and environmental protection legislation'. This means that HHU products that have CE marking can legally be sold and used in Ireland. Network service providers take responsibility to ensure data security during wireless transmission.
Usability and Feasibility: Reviews of user's reactions to the function and usability of HHU devices as compared to the SU were ranked in validity and reliability using the Jadad Scale, which categorises researches according to the strengths of methodologies [17]. Papers that score highly are those which use double blinded studies, random trials and those that include information on those subjects who drop out of studies. Table 1 is a sample of the data collected.
Attitudes of Potential Users: To establish the reaction of potential users, searches were conducted for views and attitudes on use of HHUs. Our findings have limitations since we did not restrict our searches to published peer reviewed articles. 1) Potential users of the Siemens Acuson P10 interviewed, had a positive attitude [25]. HHUs will keep many procedures 'at home' rather than being referred to imaging centres. It is acknowledged that scans can be performed simply, safely, conveniently and cheaply for patients, but concern is expressed on the need for appropriate training for primary care practitioners in using HHUs [23]. 2) HHUs can keep many procedures 'at home' rather than being referred to imaging centres [23]. Scans can be performed simply, safely, conveniently and cheaply for patients, provided that practitioners are appropriate trained [6]. 3) A U/S extension to physical examinations can bring rapid and fast evaluations of organ abnormalities, which is not possible by using a stethoscope on its own [24]. 4) Mobile U/S devices seem useful for use at point-of-care and first physical examination of the patient [24]. 5) In March 2011, the Irish College of GPs reported in an email communication to its members that very few GP's are using portable U/S devices in practice, partly due to the high initial purchase cost, the need for specialist training, the availability of U/S facilities in hospitals and private radiology centres, and the medico-legal implications of a missed diagnosis

4. CONCLUSION

In Table 1, seven out of eight reviewed studies conclude that the HHU is a useful and effective diagnostic device. Its portability is an advantage over SUs and used more successfully in environments where otherwise the SU would be physically un-usable due to its size. Many potential users express satisfaction with the design and function of HHU devices and acknowledge potential benefits. The main concern raised is the lack of training for doctors who are not radiologists or sonographers. However, doctors can be adequately trained within a reasonable timeframe to competently use the HHU in their practices [13, 12]. HHUs available on the market are capable to use the cellular network and Wi-Fi to allow links between PACS archiving systems and the devices [12]. Existence of this technical ability to link the HHU to the PACS either in real time or asynchronously can potentially allow a GP on a home visit to consult a radiologist whilst still at the patient's home. There are commercially available Health Information Systems in Ireland, which can be used on home visits to link the HHU to GP practice records. Our findings suggest that current technology of

HHUs is feasible for use by GPs in primary care.

Future Direction: HHUs have been tried and tested in other medical applications and they have proved to be adequate for use in locations where SUs are not feasible. The cost, design safety, and data security of HHUs make them an attractive physical examination tool which is largely missing in primary care. While there is limited research on usage of the HHUs by GPs, there is clearly a potential for a HHU to be used by GPs during home visits to patients as part of the routine physical examination. Perhaps the next step is to establish through a survey of GPs if they are willing to embrace the use of HHUs as a way of enhancing patient outcomes in primary care. The adoption of HHU use during patient home visits will likely increase the amount of patient investigations in the home, and reduce unnecessary extra trips to hospitals for U/S scans, which will help reduce overall health costs and improve efficiency of health delivery.

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Accessible Self-Management Kiosks for Low Literacy Clients in Primary Care

Sandra Gormley
gormlesa@tcd.ie

Niamh Harding

Bridget Kane*

Dept of Computer Science
O'Reilly Institute
Trinity College Dublin

Aislinn Enright

Fionnuala Ashe

ABSTRACT
Public information kiosk use should be intuitive and accessible for all users, despite variation in education, literacy, age, disability and familiarity with technology. Literature is reviewed which identifies kiosk design features and human computer interface design issues which should be considered in self-management kiosk design taking the needs of low literacy users into account. We present an evaluation of current interface efficacy for low literacy users and consider the current development of interfaces to reflect the particular needs of this user group. Findings and recommendations for future directions in the area are summarised. Simplicity is emphasised, and distracting animations and pop-ups should be avoided to improve usability for low literacy users.

Categories and Subject Descriptors
H.5.2 [**User Interfaces**]: Interaction Styles

1. INTRODUCTION
A need was identified from professional experience in the development of a primary care centre to include a self-help kiosk within a reception area with the aim of helping people manage their self-care and assist them to navigate the health system and other local services. The local health authority wanted to develop a service to meet the requirements of a complex community by providing clinical services and to link this to what is called "social value" services. These social value services include: employment, life style, English as a second language, and low literacy services which engage with the complexities of modern life.

Literacy involves listening and speaking, reading, writing, numeracy and using everyday technology to communicate and handle information [27]. Health literacy is an individual's ability to find and use health information; whatever an individual needs to successfully navigate their healthcare environment [12]. Low health literacy is linked to problems with under usage of preventative services, self-management skills and delayed diagnosis [31]. The last International Literacy Survey in the mid-nineties, concluded that even the simplest literacy tasks, such as reading and interpreting the instructions on a packet of Aspirin®, pose problems for 25% of Irish adults, compared with 6% in Sweden and 5% of adults in Germany [6]. Whilst this does not demonstrate "illiteracy" in 1/4 of the adult Irish population, it represents a significant proportion with difficulty at the lowest level of literacy - Level 1. A 5-Level scale is used. Level 3 is considered the minimum level needed to actively engage in Irish society [6]. In response, the Irish government has funded over 50,000 adults to attend literacy courses in Ireland [27].

Current health care policies across the world promote self-management, by encouraging individuals and carers to take responsibility for their own well-being. This policy is being replicated in Ireland with a move to primary care and the promotion of self-management [8]. It is believed that by supporting self-care, health and quality of life can be improved significantly [4]. It has been shown that if clients are provided with the skills and education they need including up-to-date and easily accessible information, appropriate tools and devices to have better control of their lives and access to local self-care and support networks, visits to the GP can reduce by up to 69% [4]. However, despite this evidence there are several reasons why many clients feel that they do not get the information they require.

Many clients report that clinicians often do not involve them in their care and fail to give them information on their conditions. Studies have found that 21% of people do not know their treatment/service options. Over 55% feel they often do not get support and 33% report they never had any support. Only 30% of people know about access to local self-care and support networks [11, 22]. For those people who do get support there are significant inconsistencies, such as inadequate information about treatment options, and a mismatch between the reading levels of health information materials provided [3]. For example a study of women experiencing hormone replacement therapy found that many have limited information and general literacy skills [9, 7].

The National Adult Literacy Agency (NALA) asserts that health service providers have a part to play in making in-

*IRCSET Research Fellow and corresponding author

formation and services more accessible because of their own contribution to the problem of health literacy [30]. NALA [30] has provided training to health care staff since 2001 in the design of literacy friendly educational material through its "Plain English" service. A recent NALA health literacy audit using the National Framework of Qualifications (NFQ) as an assessment guide found that information leaflets were either at Level 3 or Level 5 - Junior and Leaving Certificate respectively. Level 2 is recommended as the optimum level at which to pitch medical information/services leaflets to enable them to be read and understood [30].

Public information kiosks have been in use internationally for many years, in varied applications including tourist guides, banking, voting, and photo manipulation and printing. Interaction is typically via a touch-sensitive display, considered to be a more practical input technology than keyboards, speech recognition or sensors such as cameras [24].

The challenge of incorporating universal accessibility into the design of the human-computer interface for public information kiosks is a central theme of this paper. It is advised that a universal usability research agenda must address multilingual and multicultural users as well as users of all ages and abilities/ disabilities including low-literacy users [25]. A kiosk user interface must be self-explanatory and accessible without prior training [24], and must be understandable to its users [10]. Target users encompass a wide variation in education and literacy, age, disability and familiarity with the technology used. The design of a multimodal intelligent user interface which adapts to the physical characteristics of the user, with a touch-sensitive display to adjust height of the screen and a digital camera allowing text size adjustment by measuring the distance of the user from the screen, has been suggested [7]. *Button Size* and *Spacing* are key design considerations when designing for older people [7, 13]. *Manual Dexterity* does not significantly affect the performance of touching an isolated button, but when presented with a row of adjacent buttons, older users are less accurate [13].

2. METHODOLOGY

We carried out a literature review on user interface design, focussing on design challenges in respect of the low - literacy user. The online databases IEEE, ACM, Cochrane and Google Scholar were searched using the terms: 'Low-literacy user', 'Information kiosks', 'User interface design' and 'Universal design'. Papers written in English, or which had been translated into English within the last 10 years, were included. Relevant publications were identified and studied to extract information on interface usability for low-literacy users. We focussed on the relevance of the characteristics and general habits of low-literacy users when engaging with user interfaces. We grouped our findings under general practices performed by low literacy users when searching and retrieving information and presented some ideas for resolving these issues as they relate to the interface design process.

3. FINDINGS

Due to poorly designed interfaces, low literacy users face severe challenges in using search engines to find requested information, navigating to desired information and reading content when or if they find it. Fortunately, there are techniques to help low-literacy users get more out of using kiosk interfaces, and these techniques do not breach the principles of interface design for other users. Several general habits of low literacy kiosk users are identified:

Avoiding search tools: Low-literacy users can go to extreme lengths to avoid searching, requiring designers to take into account how they use interfaces differently to high literacy users [17]. Low literacy users have been found to take 8 times longer to accurately search for information, use less focused search strategies, seem to be less informed by results and are 13 times more likely to be "lost" than high literacy users [17]. It has also been found that the reading level of the information provided is often not suitable for low literacy users [17, 1].

Searching requires spelling and not all search engines can deal with spelling errors. The methods by which search results are displayed can make information difficult for low-literacy users to process. Summers found that when forced to use search tools, low-literacy users click on the link that appears first [28]. To overcome this problem interfaces should be designed using simple page titles, in a large font. Plain language should be employed and simple graphics used where possible. Search functionality should also be optimized and be tolerant of misspelling, even providing 'hints' for what a user might be looking. Nielsen's design principles explain that constraints should be considered during the design process to restrict possible actions that can be performed by a user, and help prevent the user from selecting incorrect options [20]. This is especially significant when designing for low-literacy users.

Difficulty in navigating: Users tend to read through all navigation links initially then select the option they think most appropriate. If something becomes too complicated low-literacy users are more likely to skip it entirely and potentially miss something important. Some low-literacy users attempt to reduce the amount they have to read by bypassing information [28]. These users skip from link to link throughout the site, sometimes overlooking page content completely and have very low success rates. Usability for low-literacy users can be dramatically improved by limiting the number of links per page.

Avoiding scrolling: Users can become distracted by content located in the margins [18]. Kiosk interfaces should have a single starting point which is easy to locate and to which the user can return when necessary. Low-literacy users have better success in retrieving the information they are looking for when content appears in one main column. These users do not scan text and their visual concentration can be broken by having to scroll. As a result, interface design should include the most important detail in the centre of the screen. Retrieving information should be as simple and intuitive as possible.

Limiting field of view: Low literacy users usually read through content line by line, narrowing their field of view. They may miss details outside the main section of text. As a result, on-screen distractions should be avoided. Images that move or flash also divert the attention of the general user. Low literacy users' attention may become distracted by too much auditory and visual information. Steering clear of these images and avoiding text that changes allows users to concentrate more effectively. Nielsen's principle of minimalist design suggests that a user interface should not contain irrelevant information or illustrate information that is rarely needed, so as to maximise the impact that relevant information may have on the user [20]. **Consistency:** is especially important for low-literacy users. Screens and pages should be streamlined and have the same 'feel' throughout the system. Users should not have to speculate whether different words are being used to describe the same thing nor should they have to differentiate between icons that are supposed to represent the same thing [26, 18].

Kodagoda et al [16] suggested three interface design sketches which adhere to Nielsens' [20] heuristics to reduce the difficulties faced by low-literacy users, and include:
i) Reduce the working memory load: text at an entry reading level with audio modality. ii) Improve focus and context problems: Reduce dense pages to bullet points and remove anchor links, remove sub-level classifications on the home page, use colour-coding of main menu and continue throughout. iii) Reduce the abandon rates: remove duplicated information, minimise scrolling down lengthy pages. iv) Encourage low literacy users to verify information. Include suggested links.

Situated in a primary care setting serving uninsured, low health-literate clients, a health information kiosk with a pictorial touch screen interface, that combines an audio option via headphones, is described by Teolis [29]. The choice of listening to information explaining procedures and conditions in simplified English means users do not rely on their reading skills, and addresses the needs of those who may have learned English as a second language. Clients report easy use of the kiosk and a greater understanding of their health issues, thus improving health literacy for users. Locating the kiosk in a working clinical environment facilitates the direct referral by physicians of clients to use it following consultation, and Jones [14] advises that information kiosks have a role when information provision is integrated with services.

4. INTERFACE EVALUATION

Evaluation approaches and methods vary according to the type of product and stage of development, with the majority closely integrated with the design stage. Combinations of user studies and field testing may be most appropriate to evaluate established products. In the design phase an iterative approach of formative evaluation, heuristic and usability testing should be employed [23]. There are few reported evaluations of kiosk interfaces targeted specifically for low literacy users. However, general evaluation methods used in design, could be adapted with a focus on the specific requirements and needs of this group. Evaluation procedures should verify that the user needs are met and that the required functionality is provided [15], thus meeting Nielsen's [20] goals of social and practical acceptability. Keates et al also suggest that formal evaluation questions be answered by assessment and iterative redesign, and by methods such as questionnaires, focus groups and interviews with the users.

Understanding health information can be challenging for anyone, notwithstanding their literacy level. Nielsen [21] described results of research on low-literacy usability of the kiosk content for a major pharmaceutical product. Following the rewriting and simplification of the content, usability metrics collected beforehand were repeated and showed that the revised site had dramatically better usability. Users took much less time to retrieve required information and liked the site more. Users were from both low and high literacy groups. The higher-literacy users also had higher scores across all metrics following updates to the site "People capable of understanding complex information nonetheless preferred more straightforward health information" [21].

A list of 17 heuristics is proposed in [24] to evaluate public touchscreen kiosks, combining 11 heuristics for general human computer interaction evaluation with a set of six heuristics novel to their study. Measures of clinical variables and a user questionnaire informed a randomized controlled type trial in a public clinic, which assessed a multimedia kiosk based intervention aimed at educating low health literacy users about diabetes and was successful [5]. A study on diabetes education in low literacy groups evaluated touchscreen kiosk use by means of usage data generated through the kiosk software as well as by voluntary paper user surveys [2]. Automatic collection of data from data logs built into the kiosk eliminated any interviewer/respondent bias, and findings indicated high usage. Data logs were successfully used to establish metrics for evaluating the early public touchscreen kiosks installed by the NHS in medical locations in the UK [19]. Significant variations were found in different age groups with respect to usage, with the over 75 year's group recording low numbers of page views and longest time spent per page.

5. CONCLUSION

Adapting to the needs of low-literacy users need not result in design that feels and looks demeaning to low-literacy users. The use of interfaces that use speech and dialogue interaction and display non-linguistic graphics are particularly suited. Interfaces that adapt to the literacy level of the user, and accept input by microphone and touch screen are considered appropriate for illiterate users [10]. The approaches in design for low-literacy users have been shown to have potential to increase usability for all without reducing user satisfaction.
Design: Key points to consider when *designing* such interfaces are i) avoid search tools, and when using text, large font size and plain language is recommended. ii) Limit options to help ease navigation and iii) keep content to screen size to avoid scrolling. Above all, keep it simple and avoid distracting flash players animations and pop-ups.
Evaluation: Just as interface design purporting to include low literacy users must take into account the different needs of this group in retrieving information, so must the evaluation of the use and impact of the interfaces allow confirmation that those specific needs are being met. Prior to setting up a health kiosk in a primary care setting prototypes should be tested through focus groups, interviews and questionnaires. Equally once the kiosk has been deployed there should be on-going reviews. Goal setting can be used such as counting the number of users, or using questionnaires to rate users' experience. Staff in primary care clinics could take on additional roles to help support users and to integrate the kiosk. Despite the limited evaluations on low literacy users of health kiosks, current research is still optimistic about their use. Kiosks can help improve self-management, and interface design can successfully meet the needs of low literacy users. Kiosk use is still relevant where information provision can be integrated with services [14]. Further research is recommended to harness the potential

of IT in this area in order to acknowledge and best assist low-literacy users in their quest for information.

Acknowledgements
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poster presentations

Human-Data Relations and the Lifeworld

Trevor Hogan
Dept. of Computer and Information Sciences
University of Strathclyde, Glasgow G11XH, UK
trevor.hogan@strath.ac.uk

Eva Hornecker
Dept. of Computer and Information Sciences
University of Strathclyde, Glasgow G11XH, UK
eva.hornecker@strath.ac.uk

ABSTRACT
This paper introduces a new approach to classifying the way in which data visualizations mediate our experience of the world. In doing so we will use the concept of human-technology relations as developed by Don Ihde, a phenomenological philosopher of technology. Following a synopsis of Ihde's four human-technology relations, each is then developed in the context of specific data visualization technologies/artefacts.

Keywords
Data Visualization, Design, Experience, Theory.

1. INTRODUCTION
In contemporary society, data visualisations, in the form of demographic statistics, financial reports, economic trends and others are now been disseminated through many forms of media, which compete for people's attention, contemplation and comprehension. To date, research has mainly focused on *effectiveness* and *efficiency* as the main factors for assessing the value of data visualisations. The purpose of this paper is to look beyond these criteria and focus on evaluating the way in which our world is mediated by data visualisations. In order to do this, we have used the concept of human-technology relations as developed by Don Ihde in his book *Technology and the Lifeworld: from garden to earth* [1].

2. IHDE'S HUMAN-DATA RELATIONS
Ihde asserts that when we think about how our everyday experience is mediated by technology we can characterize this by placing four unique relations along a continuum of human-technology relations, each of which positions us in a slightly different relation to the technology. He classifies these as: *Embodiment Relations, Hermeneutic Relations, Alterity Relations* and *Background Relations*.

According to Ihde, *Embodiment Relations* are characterized by a "partial symbiosis" of a person and a technology during which the technology in use is "embodied" and becomes "perceptually transparent" [1]. An example given by Ihde is eyeglasses or a telescope, where one looks through rather than at the technology. *Hermeneutic Relations* involve reading and the interpretation of the technology. Although one might be focused on the technology, what one actually sees - immediately and simultaneously - is not the technology itself but rather the world it refers to. An example would be a thermometer; we must interpret the output on the display before we can apply it to the world it refers to. Ihde calls the third type of relations *Alterity Relations*. In this case, technology is experienced as a being that is otherwise, or as Ihde describes, a "quasi-other". An example would be an intelligent robot. Ihde's argues that the first three relations differ from the last one as they are classified as technologies that require direct and focal attention. The final category is located at the periphery of human attention. *Background Relations* is understood as "present absence", as something not directly experienced yet giving structure to direct experiences. For example, an automated home heating system does not require daily attention, however, it continues to shape the inhabitants' experience by providing a warm and comfortable environment [1]. Now that we have briefly summarized Ihde's four human-technology relations the next sections will focus on these relations in the context of data visualizations, presenting a specific real-world example for each of the four relations.

2.1 Human-Data: Embodiment Relations

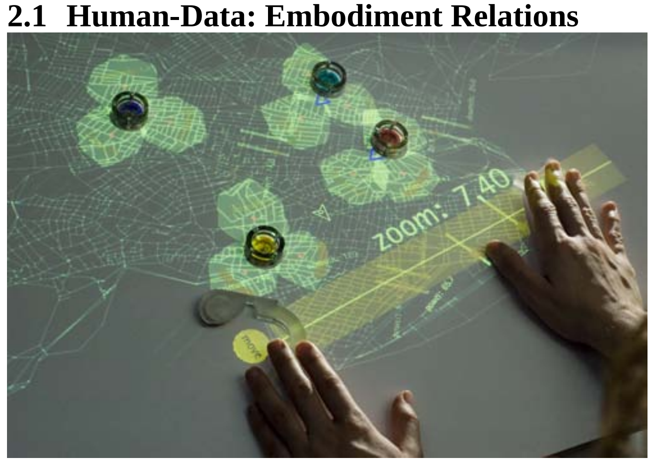

Figure 1. SenseTable (with kind permission of James Patten)

According to Ihde an embodiment relationship with technology involves the technology being transparent or withdrawing from our perceptual awareness. The focus of the human is not on the technology but on the content that it is referring to. To describe this further using a real-world example we have chosen SenseTable [2] as shown in Figure 1. Designed as a learning application, SenseTable utilizes physical objects, projections and sensory feedback in order to visualize a set of complex phenomena that would otherwise be difficult to comprehend using other modalities such as mathematical descriptions and formulas. When students interact with SenseTable they see *through* the physical and virtual objects that make up the interface to what is being visualized, the principles of System Dynamics and Chemistry. It is important to note, however, that the degree of perceptual transparency one experiences is dependent on a number of factors, including: the familiarity with the application and domain. For experienced users, SenseTable offers directly experience of the phenomena by manipulating the physical interface, they *embody* these objects and their focus is now on the results of their actions (the visualisation). It is acknowledged that some people may see SenseTable and other such applications as being on the periphery of what is generally recognised as a data visualisation. Arguably such applications may be defined as simulations and not visualisations. However, it was decided to include SenseTable as an example of embodied relations as it possess many features that are typically associated with data visualisations. This open issue will however be addressed further in future research.

2.2 Human-Data: Hermeneutical Relations

Arguably, the predominant relationship that humans have with data visualisations is a hermeneutical one. If we broadly define data visualisations as artefacts that represent data in a certain modality and which requires interpretation in order to form some insight into the data, then perhaps we maintain a hermeneutical relationship with all data visualisations. As one of the aims of this research is to help contextualise the practical work developed in conjunction with this research, we will use one example, Vessels of Ireland's National Debt (1910-2010) as shown in figure 2 to discuss hermeneutical relations with data [3]. Each of these vessels were created by inputting data that represents the national debt of Ireland since 1910 into an algorithm which processed this data and outputted 3D hollow vessels. These were then printed using a 3D-Printer. The purpose of creating vessels from the dataset was to encourage people to reflect on the economic, social and cultural implications that surround the conceived dataset in an interesting and unique manner. It was intended that the vessels themselves would be the immediate object of interest; however as the audience touch and caress the uneven and pointed edge of the vessels they would think beyond these on the topic of national debt. This process of mediation typifies the hermeneutical relations as declared by Ihde.

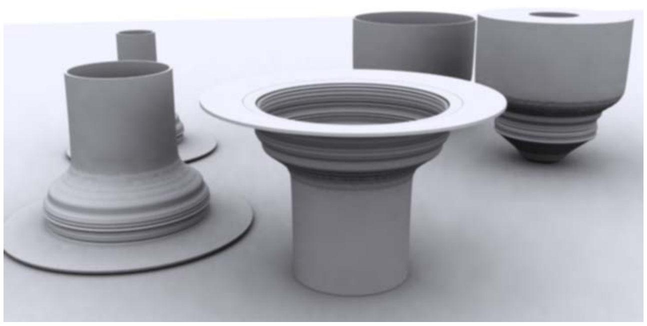

Figure 2. Vessels of Ireland's National Debt (1910-2010)

2.3 Human-Data: Alterity Relations

As noted by Ihde, *alterity relations* emerge in a wide range of computer technologies that display a *quasi-otherness* within the limits of linguistics and, more particularly, of logical behaviours [1]. Arguably, no other technology exemplifies these characteristics more clearly than in-car satellite navigation systems (SatNav). Once you have programmed a SatNav it becomes the centre of attention, as a *quasi-other*, to which we relate by obeying intelligent directions verbalised by the device. When describing alterity relations, Ihde also discusses the fascination humans have always had with the *quasi-autonomy* of technology. This fascination is very evident with the SatNav, however, with this also comes a degree of trust involved in this relationship. When this breaks down (we reach a dead-end) this fascination and trust turn into frustration and even rage, not with oneself but with the *quasi-other*.

2.4 Human-Data: Background Relations

Ihde states that "background technologies, no less than the other focal ones, transform the gestalts of human experience and, precisely because they are absence presences, may exert more subtle indirect effects upon the way the world is experienced" [1]. This account may also be used to describe the concept of *ambient visualizations* or *ambient displays.* These technologies are generally defined as a category of data visualizations that convey time-varying data in the periphery of human awareness. One such example that occupies a background relation to its near audience is the eCLOUD as shown in Figure 3. The eCLOUD [4] is an ambient data visualization sculpture inspired by the volume and behaviour of an idealized cloud. On permanent show at the San Jose International Airport, the patterns of the artwork are transformed periodically by real-time weather data from around the world. Within the environment which it is placed (5 meters above the floor) eCLOUD has a background role, it does not occupy the focal attention but nevertheless, as a piece of architectural art, it still conditions the context of its environment.

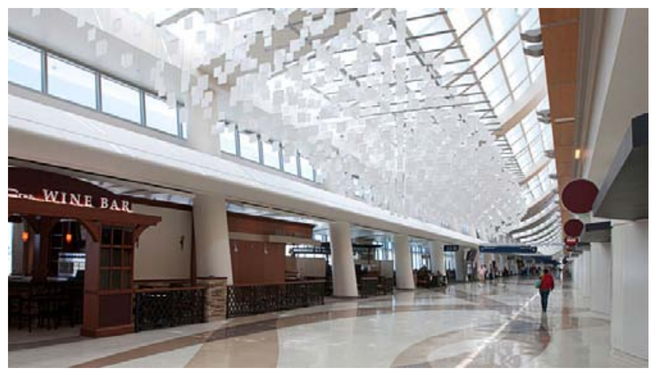

Figure 3. eCLOUD, San Jose International Airport, USA.

3. CONCLUSIONS

This paper presented Don Ihde's four human-technology relations and developed these in the context of data visualisation technology. Due to space restrictions only one example was presented for each relation. However, these examples not only show that our *Lifeworld* is mediated by data visualisations in education, public art and driving, it also demonstrates that data visualisations occupy each region of the continuum of human-technology relations as described by Don Ihde.

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Speech Recognition for Media Controls: The Impact of Accent on an English Engine Recognition Accuracy

Kestutis Igaris
University College Cork
Cork
Ireland
ki1@student.cs.ucc.ie

Aidan Kehoe
Logitech
Cork
Ireland
akehoe@logitech.com

ABSTRACT
Speech technology has potential for use in living rooms scenarios for control of home entertainment equipment. This poster reports on an initial exploration of the impact of regional accents on speech recognition accuracy.

Categories and Subject Descriptors
H.5.2 [Information Interfaces and Presentation] – User Interfaces

General Terms
Measurement, Speech Input, Human Factors.

Keywords
Speech Recognition. Controls.

1. INTRODUCTION
The paper describes some of the work being performed in the initial stages of a project that explores the use of speech for the control of media systems (TV, hi-fi) in the context of living room usage. Such usage scenarios have also been consider by many other researcher, e.g., [4, 6]. The project involves prototyping and usability testing of various elements of a "10-foot user interface" incorporating speech. This paper is concerned with the speech input portion of the system.

In the system, speech input is being used for command and control of media equipment; using commands such as play, pause, etc. Speech input is also being used for more general purpose text entry; for example, speaking the name of a TV program, a TV channel, a song title, etc.

The project is using already existing "off the shelf" commercial speech recognition engines (development of new speech recognition algorithms is not part of the project). The primary focus is on Western European languages; specifically English, German, French, Italian and Spanish.

This paper reports on one of the initial studies that explores recognition rates associated with non-native English speakers when they attempt to utilize a very basic command-and-control vocabulary in conjunction with an English speech recognition engine.

2. SPEECH IN LIVING ROOM
Many of the common implementations of speech recognition systems today involve a one-to-one scenario. In this scenario, one speaker is interacting directly with one speech-enabled system; and often that speaker-system interface has been optimized or tuned (through a speech training or enrolment process, or at least setting of appropriate input signal levels). In these situations, even while using only basic command and control settings, recognition error rates continue to remain a problem [5].

Speech in living room is different from the one-to-one scenario outlined above. In a living room multiple users can simultaneously share and use the same system. There is also a possibility of significant background noise. An example would be one person using the speech interface, while another person in the same room is talking on the phone.

Also in Europe, it is very common to have diverse regional accents. The study is an initial exploration of the impact of regional accents on recognition accuracy. For this study we recruited several non-native English speakers, to begin to explore the impact of regional accents on recognition rates.

2.1 Test Setup
As shown in Figure 1, the first step of the process involved making recordings of the speakers, and later these recordings were submitted (using a custom developed we developed) to the speech recognition engine for offline processing. The native languages of the seven study participants are listed in Table 1, as a reference one native English speaker (with an Irish accent) was included.

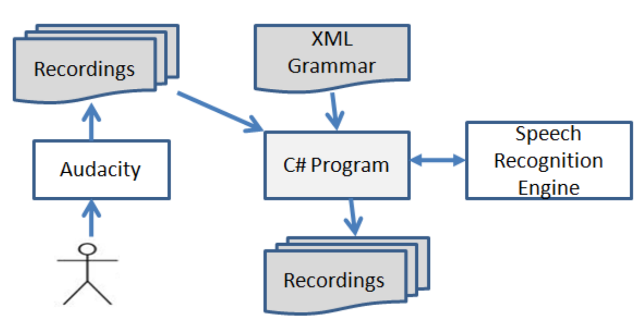

Figure 1. Overview of Process

An XML grammar file was created based on subset of ETSI standard [3], which includes recommended commands for media control in Section 9. The nine commands were: play, pause, continue, stop, fast forward, rewind, next, previous, details.

The speech recognition engine included in Windows 7 was used (it was "untrained" with no profile in use). This is considered a robust high-quality engine [7].

Good quality, high fidelity recording, with minimal background noise were required to establish a baseline, actual quality of the speech signal could be expected to be worse in a real living room, this will be explored later in the project. A Logitech G35 headset with 44.1K 16-bit audio recording, using in conjunction with the Audacity program (http://audacity.sourceforge.net/), was used for the recordings.

Each participant had to read through list of test commands 6 times, to allow for some variation in the user's speech. Thus for each participant there were 54 utterances to be processed (9 command x 6 repeats). The participants we instructed to leave a one-second gap between each spoken command, to make each command temporally distinct and avoid recognition errors associated with word boundaries. One observation during the recording was the participants read the list in a passive manner, and sometimes did not use the same phrasing or emphasis as would be typically present with a spoken command.

2.2 Results

The table below shows the results for each of the test participants. The 1st column lists the native language of the speaker. The 2nd column lists the average recognition rate for all the spoken commands. The 3rd column lists the recognition engine confidence level; the Microsoft Speech recognition engine returns a confidence level in the range 0-1 associated with each recognition event. The 4th column lists the standard deviation of the confidence level, giving an indication of the spread of confidence values for that speaker.

Table 1. Recognition Results By Speaker

Speaker Native Language	Average Recognition Rate	Average Confidence Level	Std.Dev. Confidence Level
German	100%	0.89	0.52
Chinese 1	77.77%	0.79	0.76
Lithuanian	100%	0.94	0.56
Spanish	94%	0.90	0.69
Chinese 2	100%	0.96	0.32
Italian	98%	0.93	0.35
English	100%	0.98	0.01

Average confidence level only indicates confidence level in the cases when the spoken command was correctly recognized. For these close to ideal condition, it is obvious that native English speaker has highest recognition rate, highest average confidence level and the lowest standard deviation. In the case of non-native speakers, confidence levels are lower, and the standard deviation of the confidence level is increasing.

Figure 2 shows an interesting improvement in the performance over time for most of the speakers. This could possibility to due to improvements in adaption of the recognition input engine to the input audio stream. Or perhaps the nature of the participant's spoken commands changed during the time?

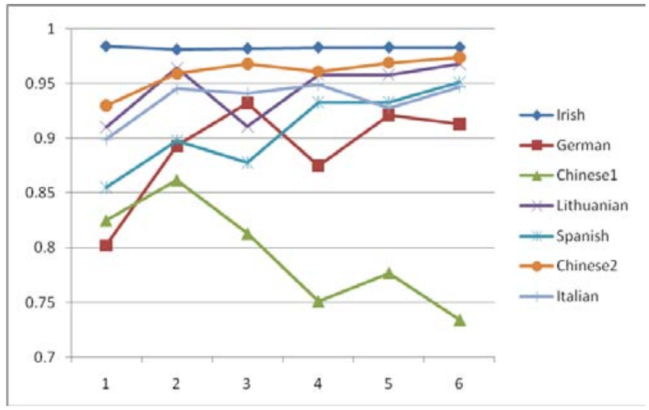

Figure 2. Avg. Conf. Level over Time

3. CONCLUSIONS

There are many potential reasons for errors in speech recognition applications. Those reasons can include items such as environmental noise, signal distortion and compression artifacts, etc. [2]. However, variation due to people is another potential contributor. For an individual person this could be as a result of changes in voice when a speaker is tired, or has a cold. When considering groups of people, it can be due to diverse accents of speakers sharing a single language speech recognition engine. This can be the case in living media control situations for our work.

Speech interaction of is not widely used in media control interaction today. There are social interaction issues that can limit the use of speech interaction [1], but there are also technical challenges to achieve high recognition rates with non-native accented speakers sharing the same recognition engine in a living room environment. Our future work includes evaluation with different recognition engines, and use of confidence measures to improve system performance [8].

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Sensor Information Interactive Systems (SIIS)

Kevin O' Mahony
NIMBUS Centre
Cork Institute of Technology
Cork, Ireland
+353 (0)86 368 4002
Kevin.omahony@cit.ie

Jian Liang
NIMBUS Centre
Cork Institute of Technology
Cork, Ireland
+353 (021) 433 5567
Jian.liang@cit.ie

Kieran Delaney
NIMBUS Centre
Cork Institute of Technology
Cork, Ireland
+353 (021) 433 5567
Kieran.delaney@cit.ie

ABSTRACT
Access to digital information from sensor networks is traditionally confined to common computer interfaces and interaction paradigms. New forms of novel Human Computer Interaction (HCI) paradigms are necessary to be applied for supporting how we engage with the collected sensor information. This poster introduces Sensor Information Interactive Systems (SIIS) that presents sensor information collected from a smart table prototype through a multi-touch screen interface. The demonstration system aims to exploit the capabilities of gestural technologies in supporting more efficient activities and presentation with digital sensor information, making sensor information more accessible and meaningful. SIIS is validated with both 2-D and 3-D applications to demonstrate the flexibility of multi-touch interactions and usability of multi-touch interfaces for engaging with real-time sensor information.

General Terms
Design, Experimentation, Human Factors

Keywords
Sensor Information Visualization, Multi-touch, Strain Mapping, Internet of Things

1. INTRODUCTION
The World Wide Web is currently being transformed with a fast maturing concept: the Internet of Things (IoTs). It aptly describes a world interconnected with people, environments and everyday objects embedded with sensing/actuation components, where autonomous communications exist between them. Therefore interesting sensor information can be attained and utilized effectively to improve our daily lives. However challenges exist in the way we present and interact with collected sensor information. Currently, the most conventional ways that sensor information is presented are through numeric methods, which include charts and tables of numbers, these methods are more acceptable for expert data analysts however comprehending such sensor information can be problematic for non-expert users. Traditional HCI paradigms of common desktop computers constrain users' interactivities with sensor information, as they are inherently designed for indirect single user/cursor interaction through peripheral devices such as mouse and keyboard. The way by which we control and monitor interesting sensor information requires more intuitive interaction paradigms and appropriate interface platforms. Multi-touch interaction can potentially reduce the limitations by which we currently interact with sensor information as it provides more degrees of freedom.

In this poster, we introduce a Sensor Information Interactive System (SIIS) [1], which utilizes a new mechanism to interact with sensor information collected from a wireless sensor network, rather than conventional HCI paradigms, such as clicking a mouse and reading numeric data from a desktop computer screen. SIIS provides us with a platform for more meaningful visualization and intuitive interaction to deal with real-time sensor information harvested from a smart object through a multi-touch interface.

2. RELATED WORK
Our preconceptions of digital information being constraint within the boundaries of computer screens and PDAs are changing as gestural interaction technologies have enabled digital information to be accessed from walls, tables and other surfaces. Popular surface computing technologies such as Microsoft's Surface [2], Perceptive Pixel [3] and Sixth Sense [4] have effectively demonstrated this. These projects show how people use more natural forms of gesture interactions to directly interact with accessible and flexible digital information. However they have not exposed where multi-touch interaction could also facilitate monitoring and interaction with real-time information collected from practical deployed sensors; especially where the information is crucial in exploiting the inner or outer properties of the sensed objects. A mechanism of intuitive demonstration and simple interaction is quite necessary and feasible for efficiently handling sensor information based on multi-touch technology.

3. SIIS IMPLEMENTATION
SIIS consists of two tables (Fig. 1); one is a multi-touch screen table; the other is a smart dinner table; the two tables are connected through the Internet.

Fig. 1. Multi-touch Screen Table (left) and Smart Table (right)

In the experimental environment, the smart table consists of a wireless sensor network connected with dozens of sensors (Strain, Temperature, Load cells), which are mounted on the top surface.

SIIS's multi-touch interface application is developed with Unity3D game engine using script languages. The application consists of a 3-D virtual environment containing a model of our smart table, and a 2-D heat-map of real-time strain distribution over the surface of the actual smart table.

4. SYSTEM VALIDATION

Validation of SIIS consists of 2 sets of experiments: firstly, functional experiments and secondly, information visualization and sensor data acquisition experiments.

Functional experiment involves all non-informational operations on the multi-touch interface.

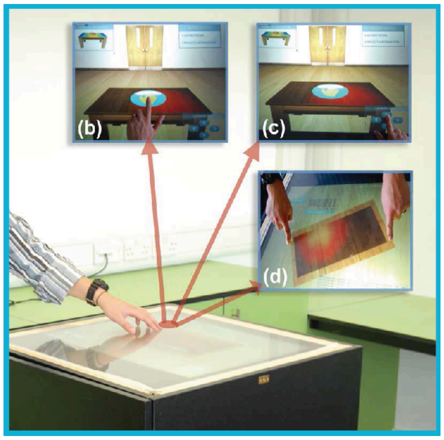

Fig. 2. Functional Experiments

- User switches from the 3-D scene to the 2-D top view of the smart table's surface by directly touching on the table in the 3-D scene. In the 2-D scene, user switches back to 3-D by touching a functional button (Fig 2(b)).
- First-person-view controller navigation in the 3-D scene. User navigates around the smart table in the virtual environment (Fig 2(c)).
- Basic multi-touch interactions in the 2-D scene, which are virtual object moving, scaling and rotating (Fig 2(d)).

Informational experiments have been done to validate real-time information visualization and customized information acquisition.

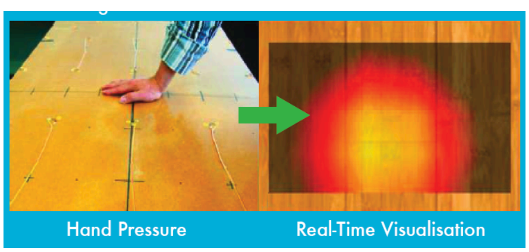

Fig. 3. Information Visualisation

- Weight/hand pressure is put on the surface of the smart table. The position of the weight/hand on the surface of the smart table is displayed on the multi-touch screen. Visualization of real-time sensor information in both 3-D/2-D environments as demonstrated through a heat map of strain distribution (Fig 3).

By directly touching multiple points on the real-time heat-map visualization component, users can retrieve multiple sensor information from those points simultaneously. These sensor information points are relative to the actual smart table's strain distribution.

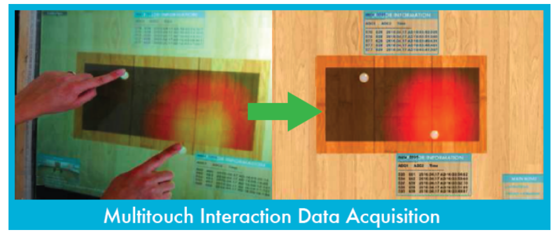

Fig. 4. Information Visualisation and Data Acquisition

- Single or multiple touch acquisition of customized sensor information related to the active sensing area of the smart table in the virtual 2-D environment.

5. CONCLUSION AND FUTURE WORK

In this poster, we presented a novel architecture and implementation of a system enabling real-time visualization and touching interactivities with sensor information on a multi-touch interface. SIIS takes advantages of multi-touch technology and changes the way we access information collected from networked sensors. This system is validated through scenarios of experiments on aspects of real-time visualization and customized multi-touch gestures to review numeric information simultaneously. Experimental results illustrate that in both 3-D and 2-D environments, real-time visualization is achieved. Multiple sensor information can be acquired at the same time according to coordinates of touches. More smart objects are being integrated; and actuations will be enabled to allow smart objects to be reactive to instructions initiated from the gestural interface. Portable devices like iPhone and iPad are also being used for supporting SIIS applications such as providing cross platform web based applications for enabling users with a method for real-time information profiling for smart objects [5].

6. ACKNOWLEDGMENTS

This work is partially supported by the Irish Higher Education Authority.

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Performance of QWERTY versus Alphabetic OSKs

David O'Sullivan
University of Limerick
Limerick
Ireland
0882259@studentmail.ul.ie

Aidan Kehoe
Logitech,
Cork,
Ireland,
akehoe@logitech.com

Damien O'Sullivan
Logitech
Cork
Ireland
dosullivan@logitech.com

ABSTRACT

The vast majority of people have QWERTY keyboard skills from regular use of physical keyboards. These keyboard skills are transferrable, and are of benefit when using an OSK (on-screen keyboard) with a relative pointing device. while using a precise relative pointing device, a regular physical QWERTY keyboard user will be significantly faster inputting text with a QWERTY OSK (e.g., 14.7 WPM), rather than an alphabetic OSK (e.g., 8.5 WPM). The participants in the user study also preferred a grid OSK layout over an offset OSK layout.

Categories and Subject Descriptors

H.5.2 [Information Interfaces and Presentation] – User Interfaces

General Terms

Measurement, Text Entry, Human Factors.

Keywords

Text Entry.

1. INTRODUCTION

OSK (on-screen keyboards) are widely used to support text entry on a range of living room devices that do not have a physical keyboard, e.g., WiiMote, PlayStation3 Gamepad, Xbox 360 Gamepad, Apple TV Remote, etc. With these systems, the user is sequentially selecting one character at a time, i.e., a very different use case from use of multiple fingers on a touch screen. Software is very flexible, and while implementing an OSK a designer has opportunities to consider possibilities beyond the offset QWERTY configurations that have been the predominant physical keyboard form factor over the past 50 years.

There are several alternative non-QWERTY OSK layouts that have demonstrated significant performance advantages, but none have gained widespread acceptance [2, 7]. Most commercial products incorporating an OSK continue to use designs that are recognizably linked to popular physical keyboard form factors; this is a very conservative approach that leverages consumer's familiarity with popular QWERTY keyboards or T9 keypads.

While taking such a conservative approach to design of an OSK for use with a remote pointing device, two of the most significant design choices are:

- Should the layout be QWERTY or alphabetic?
- Should the layout be offset or grid? The primary difference between these options is aesthetic; they are functionally equivalent.

This poster reports results from a user study conducted on several OSK configurations considering QWERTY versus alphabetic, and offset versus grid layouts. The study considered several OSK options used in conjunction with a relative pointing device (a mouse). This initial study did not consider the impact of prediction and auto-completion functionality that is obviously an important part of a more complete OSK solution.

2. QWERTY VERSUS ALPHABETIC

In spite of performance concerns, the QWERTY layout is still the predominant form factor for physical keyboards. Today the vast majority of people are familiar with the QWERTY layout. This layout-specific knowledge is acquired through extensive use of QWERTY devices over a long period of time; this knowledge is re-usable and transferrable when a person uses an OSK.

Mackenzie's [3] study of initial use of a variety of OSK alternatives demonstrated significant skill transfer (from use of a physical keyboard) while using a QWERTY OSK. Users of an alphabetic keyboard could be reasonably expected to improve their performance over time as they get familiar with that layout. However, the studies show that there is no performance benefit associated with the alphabetic keyboard layout over QWERTY, even when users do finally become expert [3, 5].

3. MOUSE AND FOUR OSK OPTIONS

A user study was conducted to explore performance of a four possible OSK options while used in conjunction with a mouse to point and click. Twelve people participated in the study; none were touch typists. The participants were sitting at a desk in an office-style setting, using a mouse on a table as shown in Figure 1.

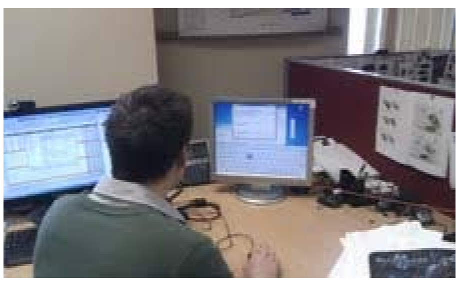

Figure 1. Test Setup

3.1 Test Setup

The "Comfort Keys Pro 4.3" [1] software running on Windows 7 was used to create custom keyboard layouts. Four OSKs were created: QWERTY-offset, QWERTY-Grid, Alphabetic-Offset, Alphabetic-Grid. Figure 2 shows an example of the alphabetic grid layout created.

The OSKs were sized to be 1280 x 1024 pixels and a Logitech G500 mouse was used for pointing and clicking on the OSK. This configuration of large targets and a precision pointing device was used so as to minimize the difficulties associated with key selection while pointing.

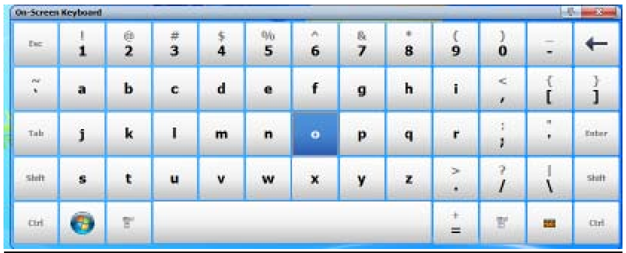

Figure 2. Alphabetic Grid Keyboard

All participants used all four keyboards configurations; the order of presentation of the OSKs was counter-balanced to minimize learning effects. The participants were asked to copy 10 phrases as quickly and accurately as possible. The phrases were selected from the set proposed by Mackenzie [4]. A custom developed piece of software was used to present the phrases to the user, and to record the entered text [6].

It is important to stress that this very short duration test looks at initial usage, with the intention of being close to "out-of-the-box" text entry performance. The duration of the text entry task was about 8 minutes per configuration, and consisted of entering 10 sentences and a total of 268 characters, i.e., about 54 words, or 8 "three word search" terms.

3.2 Results

As expected, based on studies quoted previously, there is a higher WPM for the QWERTY keyboard as shown in Figure 3. QWERTY layouts had an approximately 70% better WPM performance. In addition to having a lower WPM, the alphabetical layout required a lot of mental effort to use. All the participants expressed surprise at how difficult it was to use in comparison with the QWERTY layout; it was much more challenging to use than expected.

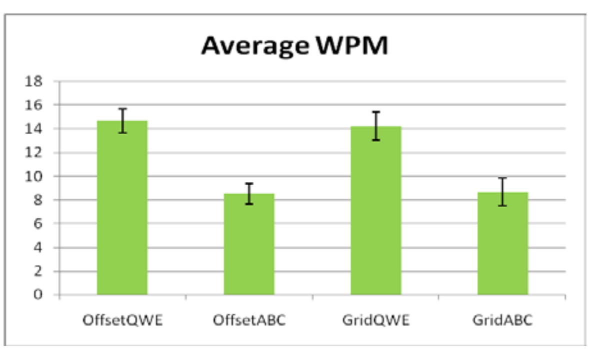

Figure 3. Average WPM for OSKs (Mouse)

As shown in Figure 4, there was no very dramatic improvement in the WPM rates within the short duration of the test (approximately 8 minutes for each condition).

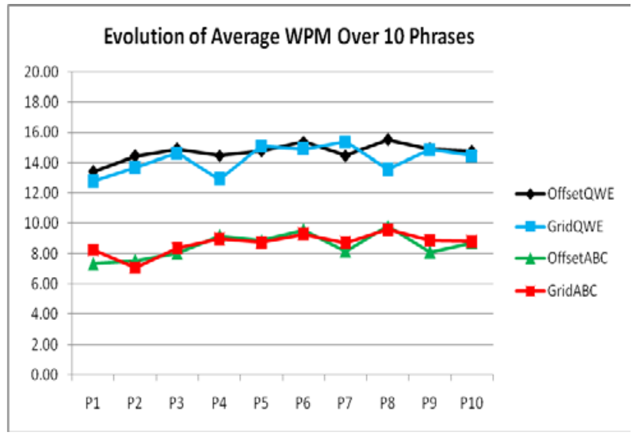

Figure 4. Looking for Improvement over 10 Phrases (Mouse)

At the end of the test sequence, the participants were asked to express their preference for either the offset or grid layouts. 11 of the 12 participants preferred the grid layout. Unfortunately, during the study participants had not been asked to provide a reason for their preference, and this is something that should be considered in future studies.

4. CONCLUSIONS

Regular users of a physical QWERTY keyboard transfer that knowledge while using a QWERTY OSK. This results in the QWERTY OSK having a higher WPM, and subjectively being much easier to use, than alphabetic keyboards. The performance of users of an alphabetic keyboard can be expected to improve over extended use and approach that of a QWERTY OSK; but we do not know how much usage will be required to achieve a comparable level of performance.

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Community participation in Online Social Media Networking

Barry Gettings
Nimbus Centre for Embedded Systems Research
Cork institute of technology
Cork, Ireland
0860784504
barry.gettings@cit.ie

ABSTRACT

Community Social media is about sharing information and content within a community. However few communities wish to share all that information with everyone all the time. There is a fine balance between making some information public and keeping other information private. This paper introduces the strategy design and development of a social media site for a community with a low online presence. Overall the project will endeavor to provide a customized group centric, social networking service that will also provide for future groups' requirements

Categories and Subject Descriptors

D.3.3 [**Social Media Networking**, **Design, Service, Community**]

General Terms

Performance, Design, Reliability, Security, Human Factors

Keywords

Community, Social Media, User participation, Human Centered design

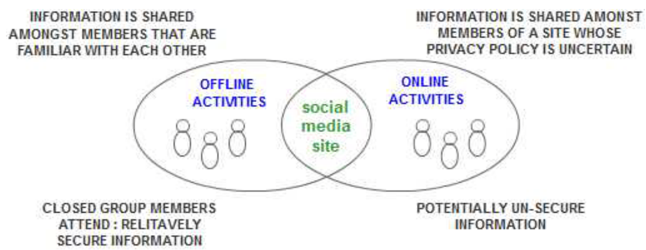
1. INTRODUCTION

This paper follows the design process undertaken from the point of view of a case study for an industry based social media project that is under development at the Nimbus center CIT. The projects' aim is to design and develop a secure online presence for communities and groups. Current Social media networking habits are redefining the way communities are able to interact with each other. Some communities are feeling pressured into having an online presence to take advantage of the clear benefits offered by online facilities. However the main providers of traditional online Social media products such as Facebook and Twitter have not yet sufficiently addressed community needs for online security and privacy. Boyd [1] stated: '*in a social network site, privacy is a function of ones disclosures, and the disclosures about one's self by others in the site. No one can fully control the content concerning him / herself that is being shared'.*

1.1 Communities & communication:

Traditional offline communities generally determine how the information generated within the confines of that community is viewed and who can view this information. This raises issues when the online and offline world of communities collide and their activities overlap. In an online social network service people need to cope with the co-presence of others that usually belong to separate social circles such as friends, family and associates. This can lead to less relevant and less secure information.

Table 1. Online and offline activities overlap



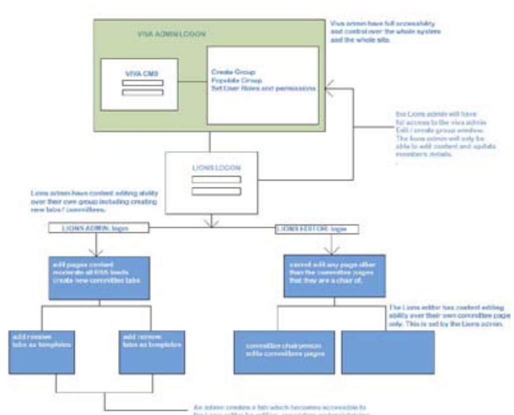
2. RESEARCH

The current research is being undertaken with a Lions Group community. This community is part of a wider network of individuals that makes up a national and international Non-Profit Organization (NPO). The Lions have a web presence but have a very low social media presence due to the need for privacy of information and a need for security.

2.1 User participation

During the design and development of the project the group administrator of the Lions group actively engaged with the design team in regular meetings which led to a participatory role in the development of the user interface. [2] *Active user involvement – representative users should actively participate, early and continuously throughout the entire development process and throughout the system lifecycle (Nielsen 1993, Gould et al. 1997, ISO 13407 1999.*

Table 2. Prototyping and workflows



2.2 Initial research
Current popular online social media sites such as facebook and google+ were examined from the point of view of the test group and the Lions' group administrator was regularly interviewed about the their current use of online social media. The research and feedback from these interviews revealed that there was a need for a more group centric, secure approach for these communities. Interviews with several other communities and clubs such as sports clubs revealed that they also had issues with security and privacy.

2.3 Multi-disciplinary team
A multi-disciplinary design team was employed this included a usability designer (Goransson and Sandback 1999), [3] to work on the process alongside a project manager, back end developer and two front end developers. The development team regularly participating in project meetings. Discussions between the development team were held to keep activities co-ordinated and to produce innovations for the project where it was found to be necessary. Brainstorming sessions were held to collaborate and co-ordinate the tasks to be applied to the project. This involved all stakeholders in the project at one time or another. Semi structured interviews were conducted based on open ended questions to receive qualitative feedback.

2.4 Personas and scenario development
The development of personas and scenarios was employed to define user activities and paper based prototypes were developed to define workflows for the interface development. User models, or personas, are fictional, detailed archetypical characters that represent distinctive groupings of behaviors, goals and motivations observed and identified during the research phase. Cooper (1999), [4] describes personas as: *A tool for communication and design within the group of designers, software developers, managers' customers and stake holders.* Once this workflow was clear story boards, wireframes and high fidelity prototypes were developed.

2.5 Wireframes and high fidelity prototypes
Wireframes and high fidelity prototypes are a valuable part of the process and are effective communication tools which were developed as a tool for visual communication to allow team members, users and clients to easily visualize current or potential design problems and consequently solutions early on in the process. Sketches and wireframes were effectively used as a means to make exploratory moves and assess the consequences of those moves.

Table 3. Sketches and storyboards

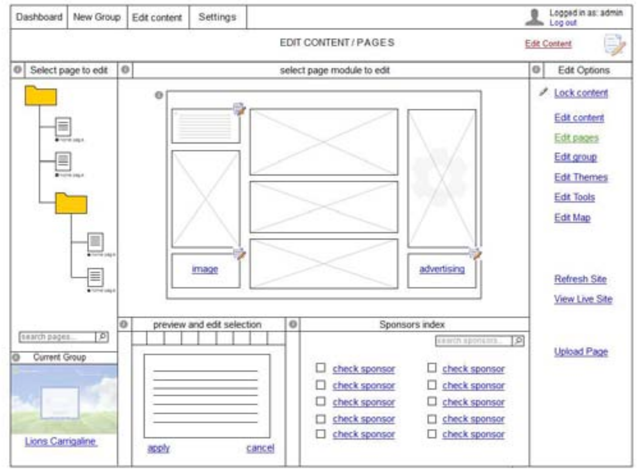


Table 4. Wireframe prototyping.

3. CONCLUSIONS
Once the research & design has been completed this model will be applied to other groups and clubs. Various organizations and clubs such as sports, NGOs and Charities and any group that has a particular interest driven population /membership will be able to avail of a secure, private social media network. Future implementations of this group centric design can and should lead to a desirable networking experience for a number of membership based clubs and communities. Further development of the project will eventually include an Enterprise Management System, multiple groups support and service. Also the project will continuously encourage user participative feedback in groups' activities and usage of their individual networks to iteratively improve their sites based on user participation and feedback.

4. ACKNOWLEDGMENTS
Thanks to Paul Green, Trevor Hogan, Kieran Delaney, Kevin O'Mahoney.

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Designing for serendipitous encounters

Ken Keane
M-ITI
University of Madeira
Funchal
+351 910204396
Ken@m-iti.org

Valentina Nisi
M-ITI
University of Madeira
Funchal
+351 291 70 5191
Valentina.nisi@m-iti.org

ABSTRACT
This research focuses on the potential of technology in fostering serendipity and sense of discovery in public physical spaces. We present our methodology in using experience prototyping to capture users' exploration of public space. The process and insights are driving a working prototype and focused user studies and offer a basis for discussion on how to co-design technologically mediated experiences together with the user of such spaces.

General Terms
Social media, Design

Keywords
Technologically mediated physical environments, Participatory Design, Interaction Design, Experience Design.

1. INTRODUCTION
Dourish states "The fundamental character of ubiquitous computing research is not computational, but spatial." […] not "merely geometric" but that "inhabit the space as we do, and they structure it and organize it in much the same way as our own activities and movements do. Here the concerns of computer science and technological design intersect with those of geography and urban studies to produce an immensely generative new research area". [4].

As part of the "Madeira life" project, this research investigates potential interaction design spaces that arise while capturing and sharing encounters between tourist's, seeking authentic local experiences, and locals of Madeira and asks how these events can encourage communication both culturally and socially.

2. OBSERVATIONS AND MOTIVATIONS
Insights gained from fieldwork have highlighted ad-hoc behavior and serendipitous discovery as strong components to people's experiences while discovering new spaces.

Figure 1. Observations of tourists

Tourist's often encounter intriguing spaces and stumble across information, historical or otherwise, which was not originally been sought. The feeling of serendipity that one gets through these events can offer interesting design opportunities.

Figure 2. Observations of local residents

Parallel to this, locals are a precious source of information, stories of the communities and neighborhood they spent their lives in and tourists appreciate these culturally rich exchanges. However residents are often uninterested in interacting with tourists (see figure 2) except through commercial exchange. Using serendipitous moments as a way of creating touch-points between people and information (tourist's, local resident's and culture) we aim to observe the experiences that these moments create, if they generate opportunities for social interaction and the role that technology plays in supporting these events.

3. RELATED WORK
Considering the role that spatial settings play in shared encounters, Goffman [5] states that our communication and interactions with others can be considered as situated in that they are shaped by both the physical setting and the social situation and that we behave differently accordingly to the degree of both. Meyrowitz [9] says that communication technology now undermines the impact that physical setting has on how we perceive experience in space. McCullough [8] reinforces this by stating that ubiquitous technologies "require new ways of grounding digital information in that they do not undermine ways of acting in the physical world."

Jacucci et al. [6] suggest that the vision of Ubiquitous Computing from Weiser [12], Abowd and Mynatt [1] have not materialized; that social implication has driven technological innovations rather then making social use the target of design [1]. They focus on materiality that ties together the physical artifacts and embodied interaction and discuss how digital objects and interfaces become social props, rather than just media to be consumed.

When considering how to examine and design around such complex topics as serendipity, non-traditional techniques are required. Paay [10] demonstrates an empirical user-centered approach in studying sociality in the city. She examined aspects of the physical and social context of environment that impact people's experience of place, their interaction with their environment, technology and each other and designed, and evaluated a context-aware pervasive computing system.

Diamantaki et al. [3] outline a theoretical framework relating activity theory, actor network theory and embodiment theory.

McCarthy and Wright [7] state that experience is becoming central to our understanding of the usability of technology. They developed an intrinsically connected framework for analyzing experience with technology consisting of four intertwined threads of experience and six sense-making processes.

4. METHOD

This research uses the breadcrumbs application (see Figure 3) to focus on the history or timelines of experiences, memories, conversations, interactions, and stories, people experience, create, and attach to places and artifacts.

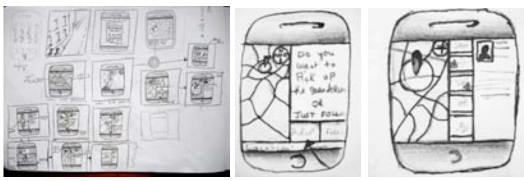

Figure 3. Breadcrumbs concept

Trails of information and media (virtual breadcrumbs) left while exploring spaces can be picked up when found by others, exposing them to serendipitous events through sharing of experiences left by others. This prototype explores how people like to explore and the role of both the physical setting and the social situation when serendipity occurs.

4.1 Focus on social context before technology

Inspired by the methods above this research-by-design project set about using experience prototyping to observe people's accounts of memories and stories, relationship to routes, physical locations, and one another and how the sharing of these can be used to facilitate serendipity while discovering urban spaces. Insights are informing the development of artifacts and tools that offer exploration and reflection on the social, spatial, cultural, and interpersonal dimensions of serendipitous encounters.

4.2 Experience prototyping

We performed five experience prototype exercises (see Figure 4), each refined and re-arranged on the basis of the lesson learned from the previous one.

Figure 4. Experience prototyping

The results enabled us to understand the users' real world activities and insights are informing the way content should be presented within the application and focused user studies. Buchenau et al. [2] describes this technique as "brainstorming that occurs either during or between scenes in response to problems uncovered..."

4.3 Focused User studies

Insights gained have informed user studies to look specifically at areas such as; what makes information serendipitous? What role does previous knowledge play? Can serendipitous encounters be fostered to create opportunities for social interaction?

5. CONCLUSION

New forms of locative media are bringing experiences back into physical spaces. Non-traditional techniques can establish an understanding of the social, spatial, cultural, and interpersonal dimensions of use, within physical spaces, and inform technological innovations. The methodology discussed here engages users by having them enact the process that new technology might incur. We expect that this approach will inspire novel and user centered design.

6. ACKNOWLEDGMENTS

Our thanks to ACM SIGCHI for allowing us to modify templates they had developed.

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Close Connection

Raymond O'Neill
Cork Institute of Technology
Rossa Avenue, Bishopstown,
Cork
+353 021 4294489
Raymond.oneill@mycit.ie

ABSTRACT

The concept for "Close Connection (abbr. CC)", suggests a more natural means of communicating with a partner over a long distance than the current existing communication technologies. Two prototypes were proposed and developed to using new media to help main couples maintain an intimate relationship with they're loved ones.

General Terms

Interaction design, Industrial Design, New media.

Keywords

Ambient media, computer mediated communication, tangible user interfaces and intimate technology

1. INTRODUCTION

CC is an exploratory look at how emerging technologies can utilised to maintain intimacy in long distance relationships regardless of geographical distance.

The intention for CC was to suggest more natural means of communication that one would have with a partner and try to recreate intimate moments in their relationship as if they were together.

2. RELATED WORK

There are a number of projects that CC shares common ground with SmallConnection[1] – Designing of Tangible Communication Media over networks(Ogawa, Ando & Onodera) attempts to convey faint information such as light, wind and touch through robot technology. Similarly, Mutsugoto (Tomoko Hayashi, Stefan Agamanolis, Matthew Karau. "Mutsugoto." (2005).Web.http://www.mutsugoto.com/)A project that almost mirrors the objectives of CC is Chris Dodge's project: "The Bed: A Medium For Intimate Communication." Here, he provides "a new form of abstracted presence for intimate, non-verbal communication" [3]. Dodge outlines that present communication technologies that exist focus more on the quantity of information, rather than the quality of Information being communicated).

3. PROPOSED ARTIFACTS

3.1 Comfort Cushion

The 'Comfort Cushion' concept enable couples to send intimate messages to their partner simulating the subconscious messages that are communicated when a couple is together. When one of the cushions is squeezed it causes the partner's cushion to vibrate gently and emit and ambient light accordingly. This enables the couple to have a new medium for communication, which they can use along with existing technologies to help, stay connected.

Figure. 3.1 – Cushion Prototype

3.2 Night Lamp

Night Lamp was the second prototype developed for CC. It's purpose was similar to the one of the Comfort Cushion but with a different application.

Figure. 3.2 – Night lamp prototype

This artifact, which was, designed a interactive candle light, allowed the couple to send an intimate message by blowing into the top of the lamp which would cause the light to flicker and in return cause their partner's lamp to flicker in real-time.

Although the application was an extremely simple, the effect that the lamp on the couples relationship was extremely positive and succeeded in it's aim to help the couple feel close despite the geographical separation [2].

4. IMPLEMENTATIONS

The technology used in CC is very much in the realm of new emerging technology. The use of open source hardware and software was critical to the project the projects development. Experimentation with new technology was apparent in CC with open source technologies prevailing.

4.1 Technology

Technology using sensors, actuators and network technology will evident in CC.

4.1.1 Open Source Hardware and Software

For the development of both CC's prototypes Arduino microcontrollers were used. Processing [4] was the programming language used for both the digital artifacts.

For online communication, Pachube [5] was used to allow me to have the two pairs of artifacts communication data in real-time.

Figure. 5.1 – Xbee wireless chips

For mobility, wireless Xbee chips were used in the Comfort Cushion prototype.

5. CONCLUSION AND FUTURE WORK

The aim of CC was to investigate whether the using haptic and visual feedback for ambient communication in long distance relationships was feasible. From testing CC with couples in real long distance relationships it became apparent that ambient media is welcomed as another medium that they can use to stay connected. Although CC was very much an experiment project it gives way for producing more commercial products in the future.

6. REFERENCES

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