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The European Assistive Technology Information Network

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Background

Information on Assistive Technologies (AT) plays a key role at various levels. It is instrumental to the empowerment of people with disabilities and their families; it is required by health care professionals when helping users choose AT devices that fit their needs, when training users in their use, when designing rehabilitation, education or social participation programmes; it is vital for AT suppliers and manufacturers to better know the market, to discover opportunities, to find out ideas for development, to disseminate awareness on their products; it is important for policy makers and officers involved in public service delivery systems (insurances, Health Authorities etc.) to efficiently allocate resources in AT provision; researchers and developers also need access to information that helps know what already exists, what users' needs are still unmet, what AT areas are admitting of significant developments.

In many Countries national information systems have been created to respond to these information needs. Some of them have over 20-years history, such as the Italian SIVA, the English DLF-Data and the German Rehadat.

The importance of ensuring adequate AT information to citizens was acknowledged by the EU several times: a major initiative was the Handynet project (1988-1996) that attempted to gather all data from the national systems into a common European multilingual database. The Handynet database was released in various Cd-Rom editions since 1993 to 1997. Although it was unable to take wing as a self-supported product – and the project was greatly criticized because of the huge financial investment involved – it generated standards and a common thinking that were later taken

up by most national systems, both those that were in existence at that time and those that were established later. In the meanwhile, the need for AT information at EU level continued to be advocated in projects and studies [1].

This heritage was certainly one of the factors that made it possible – years later – to think about the possibility to create a trans-European information system on AT. Another factor was the move of all systems towards the Internet. This new technical environment offered new avenues for international integration of information, in terms of a networking systems rather than building new databases.

In 2003 the institutes responsible for 7 major information systems throughout the world founded – through the signature of a Memorandum of Understanding - the World Alliance of Assistive Technology Information Providers. In such “Memorandum” the members committed themselves to work together as a network in order to capitalize on each others' experience, improve the content of all information systems, extend the user base internationally, achieve best practice, offer the best service to the systems' users. Now the Alliance (www.ati-alliance.net) includes 11 partners from Europe, the Americas and Australia.

The EASTIN system and website

The EASTIN – which stands for *European ASsistive Technology Information Network* – was the first concrete project generated within the Alliance. It took shape first within the framework of eTEN, a EU programme designed to help the deployment of telecommunication networks based services (e-services) with a trans-European dimension.

Now it is operated by the EASTIN Association, a legal entity based in Italy supported by its partners through their annual membership fees. The current partners are:

- Fondazione Don Carlo Gnocchi, Italy, running the ‘SIVA’ database (www.portale.siva.it)
- Institut der deutschen Wirtschaft Köln, Germany (‘REHADAT’ www.rehadat.de)
- Danish Centre for Assistive Technology, Denmark (‘Hjælpemiddelbasen’ - www.hmi-basen.dk)
- Disabled Living Foundation, UK, running the ‘DLFdata’ database (www.dlf.org.uk)
- Hacavie, France, running the ‘Handicat’ database (www.handicat.com)
- CEAPAT, Spain, (‘Productos de Apoyo’ database - www.catalogo-ceapat.org)
- VAPH, Belgium, running the ‘Vlibank’ database (www.vlibank.be).



Picture 1: the EASTIN home page. The website works in all EU official languages

The core of the network is the EASTIN website www.eastin.eu. This website provides – in all official languages of the European Union – information on almost 70.000 products available on the European market and over 5.000 manufacturers / suppliers; it also includes related info such as fact sheets and suggestions on assistive solutions for daily living. EASTIN is not a database itself: it is an engine. It aggregates the contents of seven independent national databases, each running on a different technological platform; it includes a purpose-made search engine able to perform AT prod-

uct searches across all these databases in all EU languages; its embedded automatic translation facilities allow to display the search results in all such languages (excluding free-text descriptions, that are automatically translated only in English).



Picture 2: an example of search results across all databases taking part in the EASTIN network.

Each of the seven EASTIN partners act as National Contacts in their Countries; in other EU Countries, agreements are underway with national agencies able to serve as National Contact. National contacts have been established so far in Finland, Estonia, Lithuania, Latvia, Slovenia and Slovakia.

The EASTIN impact

The EASTIN network is becoming the “golden standard” of AT information in Europe for end users, health care professionals, industrialists, policy makers and researchers; it is having a significant impact on the partners’ activities at national level, on the national AT service delivery systems, on the AT industry.

First, the EASTIN network has led its partners to harmonise the classification systems and the contents of their national databases; it is a permanent forum where the partners exchange information, know-how, expertise and

strategies to improve effectiveness and sustainability of their national systems.

Second, the possibility to jump from the national to the international system allows for comparisons across different countries, and make it possible to find out products not available in the national market.

Third, citizens from EU Countries that do not have any national information system have the opportunity to know what AT products are available in Europe (the seven Countries participating in EASTIN can be considered representative of almost the whole EU AT market). In parallel, the existence of the EASTIN is stimulating such Countries to establish their own information system following the EASTIN standards.

From the **end-users perspective**, the EASTIN network contributes to the empowerment of people with disabilities (access to information on assistive solution is acknowledged as a right by art.4 of the 2006 UN Convention) [2].

From the **professional perspective**, the EASTIN network provides a common framework for AT knowledge and makes available a huge amount of information that is instrumental to individual AT assessment.

From the **industrial perspective**, it makes it easier for small and medium enterprises to make their products quickly known all over Europe by any people who may need them.

From the **policy perspective**, the EASTIN network provides a comprehensive and transparent market observatory that helps improve the development of national AT service delivery systems.

In the following chapters, two national cases are described in relation to partners of the EASTIN network. A third case (Italy) is described in a separate paper.

National case 1: United Kingdom

For nearly 40 years the **Disabled Living Foundation (DLF)** has been the national provider of impartial information on daily living equipment. The DLF uses this wealth of exper-

ience and expertise to compile and maintain the UK's only comprehensive database of daily living equipment – **DLF Data**.



Picture 3: the DLF home page.

Though essential, this database alone is often not enough. An older person, or the parent of a child with a disability, or a family carer frequently wants and needs expert advice too. This is where DLF's advice, written by our expert team of occupational therapists, available in **Living made easy (LME)**, and from our helpline advisers, comes to the fore.



Picture 4: searching the 'DLF Data' database.

LME was launched in November 2008 and received a yearly total of 381,502 visits. It was built on the foundations two existing web services, 'Bathing made easy' (BME) and 'Telecare made easy' (TME), together with additional new information sections.

'Living made easy for children' builds on the success of LME, and makes freely available on the internet for the very first time the advice and information on children's equipment that DLF has built up over its long history. The aim is to eventually bring together information on every product for children and young people with disabilities into one place, helping parents

and carers and healthcare professionals to easily compare products and make informed decisions about what might help them.

National case 2: Denmark

The *Danish Centre for Assistive Technology* started creating a national database with information on AT products in 1989. Through the nineties, information from the database was published in printed catalogues. Electronic versions were sent to a growing number of municipalities and hospitals, that used the data in their computer-based administrative systems. In 2000, the database was published on the Internet (www.hmi-basen.it).



Picture 5: the HMI-basen homepage.

Today it provides information on about 20.000 products from over 900 suppliers. Suppliers can add products and update information on their products through a web-interface.



Picture 6: searching the HMI database.

The website offers an advanced search engine with an intuitive Google-like search interface. Similar products can be filtered by the user by specifying technical data; from each product group it is also possible to look for similar products in other European databases through

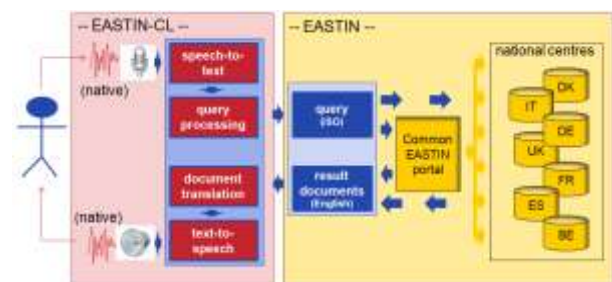
links to specific pages in the EASTIN portal.

The website also includes a recently opened forum and a growing amount of related information such as literature references. Both the forum topics and the related information are mapped to the various product groups through the product classification.

HMI-BASEN has about 50.000 visits per month, mainly by end-users and their relatives, health care professionals, industrialists, suppliers, policy makers and researchers. An additional English version is under development and is expected to be published next year.

Future developments

The EASTIN network is committed to continuously evolve to keep the pace of technology advancement and to better meet the information needs of end-users, professionals, industry and policy makers. A significant ongoing development – carried out within the EASTIN-CL project (www.eastin-cl.eu), a EU-funded initiative within the ICT Policy Support Programme – is related to the adoption of advanced language technology to make the system easier to access and fully working in all languages. This project involves some EASTIN partners and two companies specialising in automatic translation systems (Linguatrec, Germany, and Tilde, Latvia).



Picture 7: crosslingual and multimodal search tool that will be developed through the EASTIN-CL project.

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The benefits and potential pitfalls of user monitoring

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Motivation

It has long been the tradition in the medical community to monitor patients and plot their condition to allow better understanding not only of what condition they have, but how severe the symptoms are and how their treatment is progressing. As a variety of people use computers the same process of monitoring can help track users' progress and allow assistance to be provided, increasing the usability of the computer system for all users and potentially allowing IT to be used where traditionally its use is abandoned.

User monitoring is already used to great financial success by the ecommerce community, by tracking user interactions, profiles are built up allowing targeted marketing of potential purchases to increase customer spend^[3], the same techniques can be used to allow potential improvements or customisations to users improving their interaction experience. The arguments presented here are intended to stimulate discussion.

Personalisation

The principle benefit of monitoring for the user is the ability to use the data collected to provide a personalised experience^[1]. As opposed to designing an interface as a compromise between the needs of all potential users, hence meeting the needs of none, adaptive interfaces allow the interaction to be provided for the specific user, and all of their needs are met. Traditional user requirements capture methods are effectively creating a user profile through techniques such as interviews, prototypes and structured walk-through, providing a personalised interface in this way would be impractical due to the high cost and resources needed.

In a system with an adaptive interface a profile is created, maintained and the information stored can then be used anywhere that adaption is possible reducing the time to

personalise new software and assist in the decision to buy new hardware.

A user profile is only valid to the last moment it was edited, to stay accurate it has to be constantly updated, this is a substantial job and can be accomplished with automated user monitoring. The variance of user circumstances over time also identifies a need for constant user monitoring to allow for changes that the user may require allowing continued IT use and an acceptable interaction experience^[2].

Just as a static interface cannot accommodate users with different needs, a static interface is also unable to accommodate a single user with needs that vary over time. The New Dynamics of Ageing, Sustainable IT (Sus-IT) project is researching ways to keep people using IT as they age. Ageing and the decline associated with it is one of the biggest reasons people give up using computers, as people age they find themselves more isolated, in worse health, with less income and lower mobility.

Ageing is not however the only reason that people change, events through-out their lives result in very gradual changes that can often go un-noticed but have profound effects once a critical point is reached. Users also have more dramatic changes that occur after events, such as accidents that result in injury, impairing computer use.

Automated monitoring allows a profile to be constantly updated ensuring that changes can be made when necessary. There is potential for behaviour that indicates the need for an assistive technology to be identified, that a user doesn't realise they are exhibiting.

Overheads

Data resulting from user monitoring allows many benefits but does come at a cost, as systems get more complex, they become more expensive to build and run. Monitoring requires resources; processes are needed to collect data as the user is using the system,

storage is required to store the profile and internet bandwidth may be needed to allow for updates and comparison with data already collected to allow inferences to be made. All of these costs impinge on the resources a user has available, potentially affecting their user experience.

Control

The issue of control over the profile is raised, it is interesting to think that a user profile could be created without the direct input of the user. This brings up an interesting question: “who controls what information is stored in the profile, when it can be collected and who can use it?” Can it be justified to deny the user editing rights to the profile, edits could potentially be made that impact the interaction experience and services that are offered, if the profile is inappropriate, the information it provides may lead to the wrong decisions being made. Many people choose not to wear glasses as they feel it affects both their appearance and their social standing. This could lead to a very dangerous situation if glasses were required for driving, similar situations occur with accessible technology as older people especially avoid technology that emphasises their decreasing abilities due to the ageing process.

If not the user then control of the profile could be given to accessibility experts, however as already discussed; it is impractical for staff to be involved in the monitoring process. This would leave control of the profile in the hands of the user's system with data taken from the user's interactions with the system. Whomever the profile is controlled by, if it is not the user, the user will need reassurance that their data is safe, and that the drawbacks of handing over control of personal data will yield appropriate benefits of an increased user experience.

Trust

Trust is an important boundary to pass before user profiling becomes acceptable, in order to gain the trust required to profile a user, we have to prove that the data we are collecting is collected appropriately, accurately and once we have it, it is stored securely and destroyed in a timely manner. The user will find it very difficult to trust a system that will not allow

them to directly edit the data it is collecting. Resistance to monitoring may occur as many users interpret the collection of data relating to their computer use a dangerous invasion of privacy, especially if they don't perceive it to be of direct benefit due to being unaware of a need. If the system does expose an otherwise unknown need for assistance the user may find the situation embarrassing.

The benefits and pitfalls described here present various arguments for both sides of the discussion on user monitoring. We are keen to encourage discourse in the wider accessibility community as well as specific ‘experts’ like BCS HCI and AAATE.

Obtaining and preserving the user's trust is important to the success of a monitoring system, the key to managing it is an adherence to good ethical practise. The discussion of ethical considerations will be facilitated by another short paper.

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An overview of user requirements specification in ICT product design

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Introduction

The success of an assistive technology is defined on how well it suits its purpose and meets the needs of the intended users. New product development often requires the involvement of users to specify the user requirements. In good design the latter is the systematic process of discovering the purpose of a technology, by identifying the relevant stakeholders and their needs, and documenting these in a form that is amenable to analysis, communication, and subsequent implementation[1].

The above process should forge a link between the real-world needs of users and others affected by a system, and the capabilities and opportunities afforded by the assistive technologies. The importance of this is demonstrated by the observation that the lack of user involvement or incomplete user requirements, are the main reasons for the failure of ICT system developments[2].

Assistive technology ought to be designed in consideration of the users, needs, abilities and constraints. However, when it comes to specifying the user requirements for a new assistive technology, how should a developer go about specifying these and what formalised approaches are available. This paper presents an overview of the approaches that may be adopted to involve users to define the user requirements for ICT based or electronic assistive technology.

Specifying user requirements as part of human-centred design

Human-centred design (HCD) (Fig. 1) is the process which end-users influence how a design takes shape and it places the user at the centre of the design[3].

The ISO 9241-210 standard on human-centred design process for interactive systems[4] defines four linked activities which are conducted during a system development lifecycle:

- Understand and specify the context of use;
- Specify the user requirements;
- Produce design solutions;
- Evaluation.

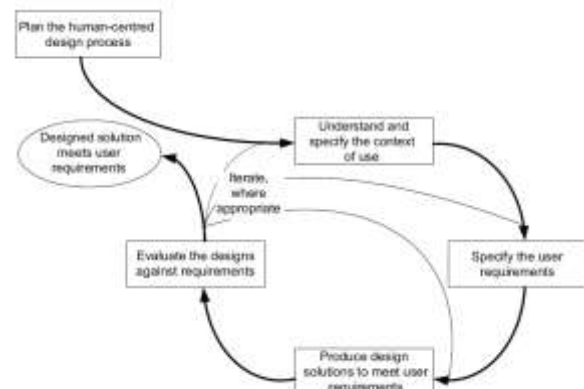


Figure 1. ISO 9241-210 standard on human-centred design process for interactive systems

Specifying robust system requirements within HCD will increase the likelihood that the system will be successful and meet the needs of the user. ISO 9241-210 defines the following principles of HCD. It should:

- include clear understanding of user and task and environmental requirements
- encourage the early and active involvement of users
- be driven and refined by user-centred evaluation
- include iteration of design solutions addresses the whole user experience
- encourage multi-disciplinary design

User requirements specification is essentially a multidisciplinary and human-centred approach, requiring effective communication with a range of stakeholders and system designers. It should be undertaken during the initial stages of design and be constantly reviewed throughout the development process. As such, the whole process should facilitate participatory design, involving and empowering users in system design and

development. A relevant and useful guideline for involvement of users with disabilities in assistive technology development projects is the *FORTUNE Guide*[5].

Requirement Specification Models

User requirements for a system or product are derived from the identified user and stakeholder needs, and the context of use. Although, there is no standard way to undertake the user requirements process for assistive technology, Sommerville and Sawyer[6] identified a number of distinct activities which form a general user requirements specification framework. These activities are:

1) Requirements elicitation: The stakeholders, their needs and tasks, and the product's context of use are discovered through observation and/or consultation with stakeholders. There are many methods used in this process, including user surveys, ethnographic techniques, interviews, focus groups, use cases and task analyses. This can also include the evaluation of prototype iterations to inform the user requirements process.

The choice of data collection method depends on the development phase, available resources and expertise, and the time required to undertake.

2) Requirements analysis and negotiation: user requirements are analysed and modelled to represent the real world context.

3) Requirements documentation: a user requirements specification document is produced to inform product design.

4) Requirements validation: the requirements document is checked for consistency and completeness through prototype evaluation and stakeholder consultation.

5) Requirements management: systems will evolve as the environment in which these systems operate changes and stakeholder requirements change. Managing changes to requirements specification is essential.

There are several user requirements specification models. The following is a summary of some of them:

CORE (Controlled Requirements Expression)

CORE[7] defines the tasks of the users groups and structures the communication between these groups. An incremental examination of information flows, activities and process limitations from a number of different viewpoints can be achieved using CORE.

Userfit Tool

Userfit[8] is a methodology and design tool specifically for the assistive technology sector. It comprises seven summarising tools to describe and document the whole system user requirements and product evaluation. It has previously been used in a number of large projects, eg the ACTION project in Sweden[9] and for the ARTEMIS videoconferencing system that aimed to support the provision of Assistive Technology for accessing IT[10].

RESPECT

RESPECT [11] is a comprehensive methodology for defining and documenting user-centred requirements over several iterative design phases, comprising: 1) Understanding user context and early design; 2) Prototype development and user test; and 3) documentation of user requirements.

Previously used on large-scale technology development, such as the user interface for an Ministry of Defence unmanned underwater vehicle for a European wide climate change monitoring and prediction system[12], and for customised mobile services that can be realised on next-generation mobile networks[13].

Joint Application Development (JAD)

JAD[14] is a popular method used in the development of large computer systems. It involves all stakeholders and developers working together in a series of highly structured and focused meetings during the design phase to develop a joint requirements specification. This technique can accelerate design, promote joint working and create user ownership of the product design.

Quality Function Deployment (QFD)

QFD[15] sets out to convert user needs into design features. The technique produces graphs and matrices (referred to as the *House of Quality (HoQ)*) to weight the importance of

user needs to establish design parameters. QFD also sets product development targets and test methods.

Discussion

User requirements specification models exist but it appears that few assistive technologies are developed using them. Currently, there is no single 'gold standard' method for specifying user requirements and one could argue that many developers follow the 'common-sense' approach (which generally follows the ISO 9241-210 standard) to find out what users need, produce a prototype and evaluate the prototype against the original requirements.

The *RESPECT* and *Userfit* methodologies both provide a complete framework for the gathering, specifying, documenting of user requirements as part of a human-centred design approach. These approaches encourage the involvement of end-users throughout the design process, where possible.

Overall, there is a lack of objective evidence regarding the use and effectiveness of some of the more recognised user requirements frameworks in the development of assistive technologies. Indeed, assistive technology user requirements elicitation and specification can often be unstructured, lack robustness or be underreported.

Part of the reason may be the time and effort required to undertake a comprehensive requirements process. Conducting multiple focus groups with a range of different user groups, for example, can be very time-consuming and require expert facilitation in order to reduce any bias. Transcription and qualitative analysis of the data can also be a lengthy procedure. The current frameworks can produce large amount of data and documentation, making it sometimes difficult to manage and prioritise requirements.

One obvious issue is when the population of end users is relatively small, which can be often the case with assistive technologies. The scientific, or at least statistical, robustness of the gathered data may be limited and the user requirements may be based on a handful of individuals.

Another reason is the often diversity of

users' functional abilities and their corresponding needs, particularly with user testing or other quantitative-based requirements. Typically, to perform robust statistical methods relies on a well formed population with reasonable expectation of similarity of interaction and intervention across the sample population. This is not the case when a specific condition population is diverse, e.g. degenerative conditions, or where a technology has widespread potential across many conditions.

It also is arguable whether the current models are able to translate all the relevant needs of different user groups into user requirements. For example, the *CORE* focuses only on particular user tasks relating to the proposed product. It does not generally translate the user's wider needs and constraints, such as psycho-social and well-being needs, which may be addressed by the new technology if identified.

The ability to verify and revise user requirements through the development process is a crucial phase. Requirements can change or new ones may be identified as users are presented with product iterations. Few of the recognised frameworks allow for this. In contrast, the *RESPECT* tool does provide an iterative methodology for defining, redefining and prioritising user-centred requirements through user testing of product prototypes.

Finally, academic or health-based assistive technologists often collaborate with commercial manufacturers to develop products. This can lead to a dichotomy between the desire to conduct robust user requirements research and the shorter term commercial needs to get products to market. Product iterations could be, in principal, evaluated with users *ad infinitum* before a final user requirements specification is produced. Therefore, a balance needs to be achieved between the identified (and sometimes aspirational) user needs and the practical issues of what may be feasible and realistic to develop a product within available timescales, resources and costs. It is interesting to note that no authoritative mapping of where the more rapid development is effective has been published.

Conclusions

This paper has provided a general overview of user requirements specification as part of human-centred product design. The elicitation and specification of user requirements is an integral and vital component of assistive technology production.

Consideration ought to be given to the level of resources and time that are available to conduct the user requirements. Although there are standard user requirements frameworks available that may assist in this process, their use for assistive technologies is generally frequently underreported and further research is required into their effectiveness in developing new products.

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The CARDIAC Project: Creating a Roadmap for successful Technology Transfer in Accessible and Assistive ICT

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ABSTRACT

The CARDIAC Project is an EU funded co-ordination action which aims to create a platform that can bring together the various stakeholders in the area of accessible and assistive ICT with a view of identifying R&D gaps and emerging trends and generating a research agenda roadmap. It aims to identify examples of best practice and to disseminate the collective wisdom of all the relevant stakeholders across the range of EU member states.

The project is scheduled to run from March 2010 through to 2012, with its first significant event, a workshop focussed on identifying success factors for Technology Transfer, scheduled for the end of October 2010.

Attendance at this workshop will be by invitation from the consortium and seeks to have a wide range of participants representing the breadth of stakeholders in the Assistive and Accessible ICT industry. The workshop will employ a novel and unique methodology, using Structure Dialogue Process to establish a consensus on creating a roadmap for successful future technology transfer.

This short, paper will outline the background to this proposed workshop, the methodology employed and will present some of the anticipated output that may be generated from this event.

Contrasting mainstream- and assistive technology- technology transfer

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Abstract

Examples of technology transfer, a summary of observable common (but not universal) features that have led to positive outcomes, and a discussion of the issues that these raise will be presented.

The authors bring two perspectives together. That of a Medical technology transfer agent – Medipex – and that of an academic and health technology researcher. Both have involvement in Assistive technology projects – past and present. While many studies – mostly sociologically based – have been conducted in mainstream innovation and or technology transfer these are almost non-existent in the field of Assistive Technology. And yet there seem to be significant and common difference between the two markets. This suggests there is potential for at least a lack of insight in this area – indeed there are few centres where the process of Assistive Technology – technology transfer is actually systematically studied (Joe Lane and colleagues in New York being perhaps the main obvious exception). Perhaps a view endorsed by the lack of paper submissions to the workshop across the spectrum of suggested topics that impact or are part of technology transfer.

One question that will be included is, should the social and or moral and hence financial support given to Assistive Technology innovation be different, better or indeed changed in any way?

The authors presentation is aimed at prompting thought and discussion throughout the workshop.

Technology transfer of a software application - Maavis

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Introduction

Through collaboration with care providers the Advanced Care Technologies programme¹ identified a high priority unmet need for many older people. In care homes and in the community older people can lead relatively socially isolated lives^{2,3}. Increasingly inclusion in society requires use of Information Technology and IT has become dominant in communication and entertainment. However amongst the current over 70's, only a small percentage have experience in use of IT, and some people in all age ranges can struggle to work standard IT interfaces leading to their exclusion⁴.

Entirely inclusive IT and the Internet requires design-for-all approaches. Examination of current widely available operating systems soon shows that the greater diversity of functional ability and, by correlation, interaction requirements of the whole population, is currently met by attempts at design-for-all through users having to select usable interfacing from a 'spectrum' of discrete elements⁵. Managed Access to Audio, Visual and Information Services – Maavis, was and is the first part of an exploration into how successful can an approach of "Use of IT without understanding it" be in producing e-inclusion for people who : see learning about IT as too tiresome or difficult; don't see the benefits of IT for themselves; have functional impairments that result in barriers to effective use of existing IT (due to interpretability of the interface and/or need to use a single limited movement as input).

The ACT programme project had the goal of developing new products and services in a limited time frame. To achieve this with the Maavis concept a rapid user centred design

approach was employed working with care providers and service users in care homes. This comprised a six month study using a prototype system (called 'SIMWIN') and a mixed methods protocol that started with verification of service user desire, and then followed up with simultaneously exploring: usability; dynamic bespoke design; identification of both common and individual design features; and, service implementation issues. From this information a specification for Maavis was drawn up and a commercial programmer recruited through a tendering process to code it. Two screen shots of Maavis can be seen in Figure 1.

The current Maavis's implemented primary accessibility features are: operation through any pointing device and some forms of single and two switch scanning, small selection sets of large items on screen, control of choice – the number and type of controls, the amount of content, control of presentation of items - optional highlighting, audio prompts, use of images and/or text for on screen items. And a key feature for care home use, it is easy to change settings and content.

Technology transfer considerations occurred throughout this period and indeed is an ongoing process

Approach to technology transfer

The ACT programme's approach to technology transfer was pragmatic and initially at least 'traditional'. A summary follows that describes a sequence of processes, as the reader progresses through them it should be assumed that the idea or concept continues to be found novel, useful and viable. Starting from a priori knowledge of care providers of generic user needs and of researchers about available tech-

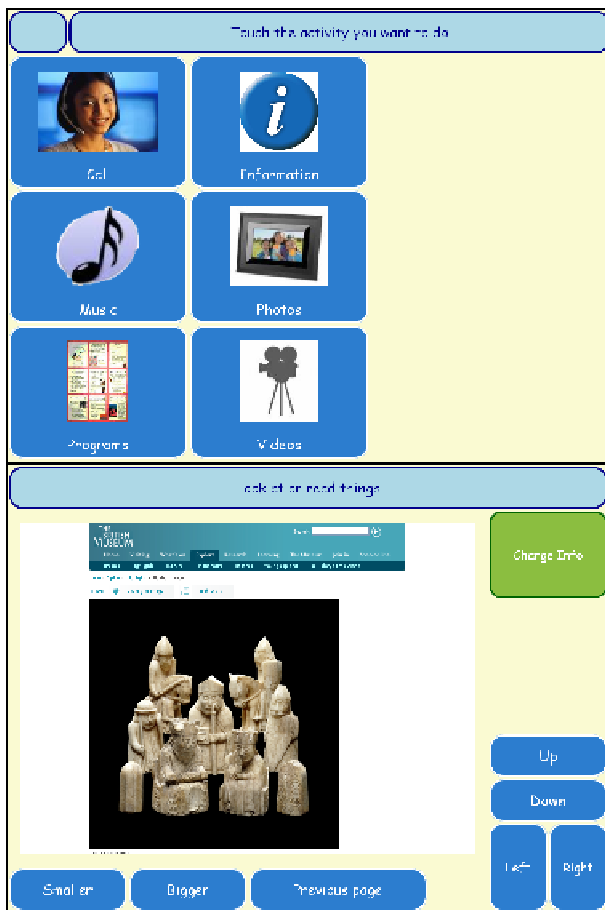


Figure 1 : Maavis screen shots

nology, ‘solutions’ are proposed. Verify and if necessary refine ideas by consultation with multidisciplinary teams – comprising colleagues and immediate collaborating stakeholders (still based on a priori knowledge). Search all published material to identify if the idea is novel, is appropriate (possibly finding further refinements) and is achievable. Design a user requirements study that will explore user desire for the ‘idea’, help specify particular user requirements, and related deployment issues. Demonstrate the idea can be made into a ‘product’. Based on the information collected develop a business exploitation model. Work with businesses to reach markets.

It should be noted that as long as the project continues, checking of the published material to monitor for competing technology becomes an ongoing necessity. The obvious places to start are on-line search tools such as Google and formal publication resources such as ‘web of knowledge’.

Throughout the process, critical appraisal of the findings in all strands of work by an executive of team stakeholders decides the future activity. In practice this meant the lead researcher doing day-to-day critical appraisal from data collected by any of the team, and then key decisions being discussed at ad hoc meetings or at convenient regular project management meetings.

Results

Previous work and the Competition

The search for relevant work found that attempts to make human computer interfacing straightforward focussed around single solutions in one of two contexts. The first, for the majority population and use of numerous applications and contexts, such as readily seen in Mac OS or Windows to date. The second for individual application scenarios that involved use by the general public, e.g. in information terminals or automatic telling machines. The former strategy evidently always involved assumptions that either the user was motivated to learn new concepts and skills. The second was clearly closer to the concept of Maavis, albeit typically at least requiring the user to be able to read text.

The publication searches up to September 2008 of past and current attempts at generically easy to use interfaces, that use symbols and/or text embedded within the interface, revealed surprisingly few exact or near competitors. These included a smart house controller requiring high IT technical skills to install and support, GRID 2⁶ which required patches to get close to the required functionality and a days training to use, and Switch access to Windows⁷ on which the received advice was that it was more complicated to set up to achieve the desired functionality.

Participation of end users

As the target end users were naive to IT, or had very limited IT skills the options were to, ask potential users what they wanted generi-

cally and therefore abstracted away from the form of solution, or, to give them an experience of an IT based system that would inform their answers. The limited time resulted in the latter being chosen. The design process was divided down into two phases, a verification of ideas as desired by target end users (n>25), and, simultaneous user requirements gathering and evaluation (n=18). Both phases, as intended, used a demonstrator prototype and also contributed qualitatively to an understanding of deployment issues within care homes. The details of the evaluation are the subject of another publication in preparation. But to summarise, an application design specification was established and a better understanding of end users and care home deployment was achieved.

After the research team left the care homes because the study was completed continued use of SIMWIN occurred for over a year in the three care homes. Eventually a lack of sustained motivated staff presence and management investment resulted in this coming to an end.

Transferring the technology

During the development and execution of the study the principle of direct collaboration with commercial organisations in a closed innovation approach was considered. However in the case of the best option the funding restrictions prevented this. In three other possibilities the barriers were lack of capacity to become involved at that time or the business focus of the companies.

The application specification was used in a tendering process to contract third parties to program the software. Again time constraints impacted the approach to the project and only part of the specification was actually developed in Maavis.

Discussions with care home providers and observation in participating care homes confirmed the information in the literature that while investment in care and nursing homes is

substantial, publically funded care is needs assessed and largely dictated by cost effectiveness. This results in a severely limited human and financial scope to change. Hence a part of the specification for any solution is low cost and easy to implement. The care providers believed that the best opportunity would be through on-going charges rather than one-off purchases.

Open source software(OSS) development was adopted as the logical choice in the circumstances. OSS can help achieve early adoption through non-commercial exploitation by end-users, i.e. free access to and use of Maavis. The fact that Maavis only met some of the specification also suggested Open source development as an effective approach to achieve the longer term completion and survival of Maavis and the desired benefits for people who are e-excluded.

Adopting an OS approach meant that an on-line community needed to be created. This has been started but is an on-going process. Currently there is a website, a developers wiki, and a distribution list. Links to the wiki and the list can be found on the Maavis website⁸.

The wiki is intended to be used not just by developers but by end user groups/individuals who want to report bugs or new ideas for Maavis. Currently Maavis is being employed in care homes, special needs schools and adult education services. In the latter case, as a life skills educational tool and not just for access to IT.

Discussion

Since the time of the study and release of Maavis there are now many more 'simple to use' IT solutions. None parallel the form of solution Maavis operates⁹. Currently there is rising national and international interest in Maavis.

After base software features had been specified by expert and care providers a paper was published that had looked at the needs of and expressed by people with dementia¹⁰. This pa-

per identified a prioritised list of 11 needs, 8 of which SIMWIN addressed. Therefore from comparing the findings in the two studies, it seems the more traditional approach employed in the ACT programme was essentially equivalent to the one that started by directly consulting end users. The consultation with and guidance from the stakeholders in the authors approach was reflected by confirmation from end users involved in user requirements, evaluation and post study continued use of SIMWIN. Proof of the ‘best’ or better methodology or tools to use remains a complex and an unresolved issue.

Adoption of an open source approach was new to the ACT programme team. There have been advantages and disadvantages reported¹¹. The positives are : more and fuller exchanges with experts and stakeholders resulting in more rapid feedback and opportunities for ongoing validation and review of ideas; and, better survival of the project when new competing closed innovations appear. Forming the community is a slower process without specific funding and hence limited resources. The negatives so far are : many researchers, innovation services and funders, and businesses have the incorrect idea that open source implies free and no business opportunities; and, it has become evident that encouragement and support of the open community and indeed the software maintenance and development still requires resources in an open community.

Maavis is well suited to not just open source but would also be highly suitable for open content/media. However it also seems that an open development community and open source philosophy for some types of AT may be in appropriate. Examples would be where : making changes to the ‘product’ or ‘concept’ was expensive and/or very slow to do; the experts in the specific design process do not have a common set of tools for that purpose; situations where added value cannot generate a viable income stream(e.g. through supporting advertising of third party services/products or

providing the product on the basis of selling regular support .

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JISC TechDis toolbar enhancing Web page browsing

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Introduction

If you wish to view web pages you have to use a browser application and not all is as easy as it would appear for the older or disabled user. You not only have to get to know the operating system on your computer but also the various choices of browser available. There are at least five well-known browser applications; Microsoft Internet Explorer, Mozilla Firefox, Google Chrome, Opera and Safari. Each browser has a different way of supporting users who wish to change the look and feel of a website or access it in a different way. You not only need to know about these options but also to appreciate their differences. Internet Explorer version 8 offers these extras under the 'View menu' with the ability to zoom, change text size and allow for caret browsing, in other words a movable cursor is put in web pages that allows the selection of text via the keyboard. Other options are available under the 'Tools menu' for changing the colour, font sizes and styles. The problem is the user needs to know that there are two areas to change settings and if the same applies when required to use another browser on a public computer such as Mozilla Firefox or any of the other browsers. In the case of Firefox the ability to use cursor keys to navigate within web pages can be found under the 'Options menu' and advanced section. Google Chrome and Safari do not offer such easy keyboard access and there are very few user preference options. Opera offers access with mouse gestures, voice control as well as the keyboard, but once again these options are not always obvious to the user. There is also the issue of new versions that bring a collection of new features. The skill of the user to find the options is also pitted against the developer who fails to understand the importance of accessible web pages. Pages that respond, for example to the use of a screen reader program or keyboard only access and allow for text

resizing and colour changes.

During the JISC funded LexDis project, based at the University of Southampton, it was clear that participants were often unaware of the many options that could assist their web page browsing. Those that were more technologically aware had often chosen browsers for specific reasons such as the opera mouse gestures to aid dexterity difficulties or voice commands to help with navigation (Seale, J et al, 2008). Some students, who did not own a computer, found the fact that they could not use any other browser other than that offered by the University was a distinct disadvantage when it came to choosing preferences to suit their needs. At that time Internet Explorer 6 did not have a zoom function that was found to be helpful for some individuals with visual impairments. The University did not at that time allow any downloads of extensions to browsers or the ability to change the desktop settings for the Windows operating system.

These difficulties made the authors realise that there needed to be an alternative to what was on offer as built-in options for user preferences as well as those that might be offered through specific add-ons provided by developers for the various browsers as additional toolbars. These work in a similar way to the Google Toolbar that works within the Mozilla Firefox and Internet Explorer browsers and offers a spellchecker, dictionary, word highlighter and many other buttons that can help with web browsing. However, as with other add-ons the toolbar requires downloading which is not always possible in cyber cafes or other public spaces such as libraries as has been mentioned in some universities and colleges. So it was decided a toolbar developed for all browsers would provide the type of support that many of

those participating in the LexDis project¹ had mentioned.

Issues for the elderly and disabled users of Web browsers

As has been mentioned many surfers of the Web are unaware of the user options that are provided by most browsers and they fail to search for suitable add-ons if they are permitted to download them. There is also the use of assistive or access technologies that are vital to those who are blind or have vision impairments and use screen readers or specific magnification programs that allow the cursor and web content to be enlarged with additional colour changes. There are also those with physical disabilities who may require keyboard only access. However, some students in the LexDis project, in particular those with dyslexia, admitted that they failed to use their assistive technologies when surfing the web, read e-mails or interacting with Web 2.0 technologies such as Facebook. They felt that setting up the assistive technology took too long and was perhaps too heavyweight for the task despite the fact that many found spelling difficult and did not appreciate the fact that most browser spellcheckers were not as good as their assistive technologies. There are also those users, who do not have access to assistive technologies and may also want support when using interactive web pages,

Users seem to want instant access to a spellchecker for forms, blogs and wikis, the ability to change background colours and font styles plus some text enlargement without the need to enlarge the graphics on a page which usually means a considerable amount of scrolling both horizontally and vertically. Additional items often discussed by LexDis participants included the use of dictionaries and issues with providing citations for academic papers.

Toolbar development

The aim of the toolbar project was to produce an application that would take the place of the original JISC TechDis user preferences toolbar that only worked in Internet Explorer 5/6. The latter was similar to Accessibar that was developed for Mozilla Firefox and the more recent RNIB 'Surf Right' toolbar bar also for Internet Explorer, both of which have to be downloaded onto the user's computer.

The new JISC TechDis toolbar works with the most popular browsers, it does not need to be downloaded, so that it can be used without administration rights and acts as a bookmark. This 'lite' version works with the page that is being viewed time and has to be reloaded as a new page is reached. The process is very quick and easy with the bookmark always available and the user can choose when to have the features available. The full version of the JISC TechDis toolbar is a 'Grease Monkey'² script extension. Running the toolbar in this mode enables it to be available automatically all the time, even when a web page is refreshed. It is also possible to navigate to a new website and open a new tab whilst the toolbar remains in situ. The third version available is designed for web developers who may copy a small section of JavaScript into the source code of their website. The button that appears on the web page allows users to use the toolbar as if it were a 'lite' version.

The toolbar is a freely available open source application which it is hoped will go on to have several iterations as features are added over the coming years. The first version of the toolbar allows users to increase and decrease the size of text on most web pages although those built in Adobe Flash prevent accessibility. There is a Font Settings button that allows users to choose from a wide range of font types as well as to increase the character size and allow the line spacing. The spellchecker will work in most plain text forms and produces a series of suggestions below the text area whilst writing. Nowadays most rich text editors have their own

¹ <http://www.lexdis.org.uk>

² <http://www.greasespot.net/>

spellcheckers although they are not always the best, as has been mentioned. On the toolbar there is also a dictionary button that provides a definition from Wikitionry once a word has been highlighted. The next menu button working left-to-right is a text-to-speech feature which uses the free Festival voice, sounding rather Scottish and allows for a whole page to be read or a section at a time. Then there is the References menu button where the toolbar scans the page for any referencing information and will collect authorship and dates as well as the title or name of the website and URL. Once these items have been collected it is possible to highlight them and copy them into any word processor. The final button for user preferences is one that allows you to change the look and feel of a page with high contrast mode or various other colour options and it is also possible to change the colour of the toolbar itself. At the far right-hand side of the toolbar there is a help button with instructions and the chance to restore the whole web page to its original style. There is also an exit button for the toolbar.

Development issues

The toolbar is at present available from JISC TechDis as a beta version (<http://www.techdis.org.uk>) and the University of Southampton carries the software configuration management (SCM) website for the submission of bugs, comments and requests for new features (<http://access.ecs.soton.ac.uk/ToolBar>).

During the last year all the browsers have been updated and this has required updates to the toolbar, which occur automatically in the 'Lite' version. However, when web pages are developed using Adobe Flash technologies, as has been mentioned the toolbar is unable to access the content and at times the actual Flash elements override the toolbar, making it inaccessible. There does not seem to be any way to avoid this situation.

There are also issues with spellchecking in some forms and rich text editors, where some are developed in a way that makes them inaccessible to the toolbar. They may also be

inaccessible to the keyboard which affects screen reader users as well as those who find using a mouse difficult - this has nothing to do with the toolbar, but rather their design. Internet Explorer seems to cause particular difficulties with text only enlargement on certain sites: there are times when only the menus enlarge and not the content. These and other issues can often be fixed with a specific change in the toolbar code, but it is hard to continually make fixes for individual sites.

As with all applications maintenance is essential, but it would appear that browser-based toolbars require more attention compared to most desktop software applications, as not only does the version of each browser need to be taken into account and users are often using different versions but also the fact that web page development can be done in many different ways using not just the simple Hypertext markup language but a variety of increasingly agile and interactive coding systems.

Aims for future development

It is hoped that in the future as this is an open source project, a community can be built around the toolbar that will support and provide ideas for further development. At present the toolbar has a GPL compatible general public license³ and it is hoped that new versions can branch from the original JISC TechDis funded toolbar.

Since the initial Toolbar development the University of Southampton student services and others have requested that language translation options are available from the toolbar and it is hoped that these will be added. There is a problem with offering text-to-speech in different languages as the costs are high for the various voices. The present text-to-speech is an open source project from the University of Edinburgh and it is hoped that more voices may come on stream in this way in the future.

Toolbar Menu translations to allow users, (for

³ <http://www.gnu.org/licenses/license-list.html>

whom English is not their first language), to have easy access to the main features is planned with a simple text file providing the words for translation, so that should the team be unable to find speakers in some languages, others will be able to provide support. There will also be a menu button that will allow for webpage translation, based on that offered by the Google Toolbar.

Conclusion

To date the JISC TechDis toolbar is approaching 250,000 downloads and is available on many university, college and charity websites. It can be seen as a button above web pages and offers basic accessibility options. It does not claim to take the place of any assistive technologies. It should be seen as a lightweight method of achieving user preferences on accessible web pages and an alternative for web page developers who have not developed their own accessibility options which are often limited to increased font sizes and colour background changes although a few offer full text-to-speech options.

Other web accessibility options include the ability to copy a web page URL into WebAnywhere⁴ to have the content read back from their server. There are some web pages that have their own text to speech reading options and the ones that have the option of a human having read the pages as a recording of the text content. Finally if available, there is the user's own assistive technologies that may provide the best access available as long as the web page is accessible. Ultimately, it is the accessibility of the web page and the way it has been designed that allows users to configure content to suit their needs. So it has to be accepted that although the JISC TechDis toolbar can enhance web browsing for many users, there will be times when it is unable to work on some web pages and like all assistive technologies it is not the panacea for every users accessibility woes. However, it does provide additional support to those who either do not have access to specialist technologies or

are working in a public area and need that extra feature to make webpage reading easier.

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⁴ <http://webanywhere.cs.washington.edu/>

Avoiding abandon-ware: getting to grips with the open development method

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Abstract

Open source is more than a style of licence. While it's true that the formal Open Source Initiative (OSI) definition lists a number of licences and distribution-related points, the big picture summary on the OSI's homepage paints a rather different picture:

'Open source is a development method for software that harnesses the power of distributed peer review and transparency of process.'

This definition puts a different slant on the distinction between open source and proprietary (or closed source) software. By highlighting the social manner in which software is actually created (the involvement of a wide range of people, including software developers, researchers and users, and the public way in which they work) it moves the focus away from licensing and distribution. As open source becomes increasingly popular, with more and more people wanting to label their software as open source, this distinction is important. It is becoming necessary to return to the founding principles of open source in order to explain the original vision more completely.

Introducing the Open Development Method (ODM)

'Open development is an emerging term used to describe the community-led development model found within many successful free and open source software projects.'

-- OSS Watch wiki

The term open development method (ODM), or sometimes community-led development, has been coined to describe this collaborative way of working¹. In this model, there is

primary emphasis on collaboration and the role of a community. Gianugo Rabellino, former CEO of SourceSense, a leading European open source services company says: 'To me, open development really is what open source [has always] been. So, open source was intended as a development methodology, as a way to build artefacts, which happen to be software, in a collaborative way which is based on transparency, on meritocracy and on neutrality [over ownership] and you need all of them.'

In fact, some researchers argue that open source projects can be placed on a continuum that stretches between 'fully open' and 'fully closed', based on an evaluation of the project's management and governance styles and an appraisal of the 'openness' of the project itself rather than the software produced [1]. ODM-based projects sit at one end of this.

This view is backed up by practitioners actually working on open source software, some of whom argue that a distinction between what are loosely called 'open source' and 'open development' projects is beginning to emerge. Developers involved in the former remain focused on licensing and distribution issues, while in the latter it is the processes of the project that matter. Justin Erenkrantz, President of the Apache Software Foundation, says: 'You are really starting to see perhaps not a split but kind of two camps: you have the open source but on the other hand you have the open development.'

Justin cites the fact that all the work takes place in public as being the important distinction. He says: 'What we are seeing is some projects and entities who are saying here is the source code, it is under Apache

licence or GPL or whatever, but the decisions about how the code got to that state are behind some wall – it is not in public.' This, he argues, is detrimental to the process of coding. Although the end product might be formally classed as open source, it is not a good way to develop sustainable products. He says: 'You can use it and you have all the rights, but what you don't have as a developer is an understanding of how the code got that way. So you run into some bug and you say, "Why is the code this way?" There is no historical context or archiving or rationale.'

For Gianugo, this public way of working means that ODM represents a re-balance of the power between developers and users. He says: 'I am not going to collaborate on something that I don't feel any sense of belonging to ... There is no open development if I cannot influence and have my say in what we do and what we are trying to build. That is not open development, that is free labour!'

The author, Manager of OSS Watch, believes that ODM can be formalised by looking at a number of key attributes that characterise an open development community, namely:

- a deep level of user engagement: if you don't have users then there is no point having a project.
- transparency: being open in what the community is undertaking and the way decisions are made.
- collaboration: a means of working within a diverse group of people, something that the Internet has obviously made easier.
- agility: once work begins and there is a serious engagement with users, ideas and plans may need to change.
- sustainability: having the capacity to keep developing an application solution over the necessary period of time.
- tools: wikis, bug- and version-trackers and email lists to support the development of the community and keep track of intellectual property rights, if relevant.

For Gianugo, agility is an interesting issue with regard to open development. He thinks that on the surface it does not look as though agile development methods and open development work together very well. He says: 'If you think that one of the key ideas of agile is the unity of time and location – you need to be in the same place at the same time and doing a lot of discussion face-to-face – and then you have open development which is based on asynchronous, distributed working, etc., then it looks like oil and water – they don't mix.' He says this is an ongoing issue for developers and that SourceSense is working to find a set of common practices that might make open source more agile and agile development methods more open.

ODM and the Apache Software Foundation (ASF)

Many people cite the importance of the ASF to the emergence of the open development method and Gianugo, an Apache member, concurs. He says: 'I believe that Apache is a sort of poster-child when it comes to open development, but this is not to say that there are not other organisations doing it - for example, Eclipse, and Mozilla to some extent. But if you look at Apache, what we want is really durable communities because we know that durable communities will keep on producing code.' He likens these communities to diverse ecosystems whose survival is in part guaranteed by the very diversity of developers, service providers, technical writers, users and researchers involved in a typical, large Apache project.

Justin Erenkrantz traces the beginnings of the ODM back to the earliest days of the Apache webserver, which was to become the foundation's first open source product. An early webserver being built at the National Center for Supercomputer Applications (NCSA) in Illinois was left unsupported when the staff moved to Netscape and the server's technical users were left stranded. Informally, a group of concerned users started to share problems and fix bugs by email. Justin recalls: 'They started trading patches and stuff. Independently all these guys were trying to maintain this kind of ball of mud. So they said

let's work together so that we can make something better than each one of us individually could make on our own.' Making decisions and documenting them in public became a very important part of this ethos, as the developers wanted to make sure that the same thing could never happen again.

Education and the ODM

What are the implications of the ODM for higher and further education? At first it may seem that its most likely impact would be on the way in which e-learning, research and business systems software is developed. But the ODM way of working can be expanded beyond software. Juan Mateos Garcia and W. Edward Steinmueller, from the Science and Technology Policy Research Unit at Sussex University (SPRU2) at the time of writing, note that: 'The broader relevance ... is the possibility that it might be a model that is applicable to a much broader range of activities involving the creation of common or public information goods' [2]. They argue that the Internet provides the capability to assemble large virtual communities that can support collective endeavour and that these endeavours need not be limited to software. They suggest different ways in which open development methods can be used for collective authoring, research projects and collaborative collection of information. This takes open source beyond the crafting and distribution of code and into the realms of new ways to undertake innovation.

For Gianugo, the ODM presents a significant challenge to education, which he argues is in danger of missing out on the opportunities offered by the open development method. He agrees that this goes far beyond the way in which software is developed for research, e-learning or administration projects. It also has implications for the ways in which universities create new knowledge.

A new research model

Gianugo points out that the existing research model of dissemination through peer-reviewed journal-paper publication (and academic reward schemes based on these outputs) may need to be reviewed in the light

of recent developments. He says: 'The problem is that this research model is clearly colliding with what the collaboration world is telling us. There is a risk of becoming less relevant.' Universities have to do much more to encourage reach-out from their research work, to engage the wider public and, most importantly, to allow others to build on what they have achieved. Continuing with traditional communication routes means that important research material may not see the light of day, experimental data may not be shared and software projects might become what he calls 'abandon-ware'. This is especially true of research projects that make use of code, which should be developed using the same development environments and source code versioning systems as open source code anyway. It is a short step to opening this up to others. He says: 'I can't imagine anyone doing any serious [software engineering] work without software configuration, versioning tools and so forth and so at that point, since you need it anyway, why not do it using the open methods?'

A way forward?

For Gianugo, there is merit in exploring ways in which experimental data and early research results could be shared before formal publication. If this is seen as a bridge too far, then he suggests that institutions experiment with an internal community of researchers that uses the open development method. He goes further, though, arguing that this needs to be tackled strategically and that the way in which academic reward is distributed needs to be rethought. There should be more interest in widening the peer-review process to reach out from the university world. He says: 'On the strategic side, if the whole rating system, star ratings, is broken, well let's fix it. The Internet is paving the way for an entirely new recognition system, an entirely new ranking system. I don't see why the Internet shouldn't be harvested to sort of rate whether a researcher is doing a good job in terms of out-reach.'

Gianugo also argues that researchers need to make more use of the tools and techniques that are now common in open source development. He says: 'Forums, mailing lists, the whole idea

is that here is the source code, here is the repository, so everything goes there and by the way here is a Wiki attached to it and a mailing list. It doesn't really matter if no one subscribes to it [at first], but eventually there will be someone willing to do that and I would say education needs to make more use of these tools.' **Andrew Savory**, Open Source Manager for the LiMo Foundation, warns, however, that the quality of this kind of support infrastructure has to be high. He says: 'I've worked in some environments where the checklist had been done - licence, wikis, mailing lists, code repository, issue tracker – but the infrastructure put in place was simply not up to scratch. This can kill a community before it has a chance to start!'³

Towards a long-term solution

Introducing the ODM to the education world may, however, be a significant challenge. Andrew advises that education needs to understand the benefits and drawbacks of the ODM and to work hard to determine when and where it's most appropriate to use it. He also notes that: 'It takes a particular type of person, and not everyone can cope well with the mindset required.' Gianugo thinks that this will require long-term thinking and he argues that the key might be to focus efforts on training the next generation of researchers and education-based code developers in the new techniques. He cites the Google Summer of Code initiative as one example to follow. The Open Development Method offers a new way of developing both software and other knowledge-related products. Its focus on openness and community should chime with the general ethos of education and it presents a significant opportunity to develop more sustainable knowledge products and avoid 'abandon-ware'. But changing the requisite educational working practices is a long-term process that requires commitment and planning. Even when education really wants to change it will need help in understanding the lessons learned from open source software development. It appears that the challenge is as much to the [open source community](#) to offer this kind of help as it is to education itself to change.

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Explanatory Notes

1. Open Development Method or Community-led development should not be confused with the Community Source Development model (a specialised solution commonly found in HE, in which an initially closed group of universities collaborate on a software application and then choose to open it up at a later point).

2. <http://www.sussex.ac.uk/spru/>

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The SIVA Portal – the Italian information portal on Assistive Technology

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The SIVA Portal

The SIVA Portal (working both in Italian and English language at www.portale.siva.it) is the Italian web portal providing information and guidance on assistive technologies for independence, quality of life and participation in society of persons with disabilities.



Figure 1 The Portale SIVA homepage.

The SIVA portal stems from the previous experience of the SIVA assistive devices database, the oldest European database on AT (first published in 1981). Over the years the database changed its form several times, keeping the pace of the evolution of information and communication technologies. In 2003, thanks to the support of the Italian Ministry of Welfare, it was completely re-designed for the Internet and became the current SIVA web portal.

Now the Portal includes six databases:

- Assistive devices: including over 8400 records with detailed products description;
- Companies: including over 1400 AT manufacturers and suppliers;
- Centres: including AT assessment and research centres in Italy and abroad
- Ideas: including hints and simple

solution to overcome daily living problems;

- Experiences: case studies where AT have been successfully used to overcome individual disabilities;
- Library: fact sheets and scientific documents related to AT.

A set of interactive services (a guide to AT, a form for online questions, a news section, and a forum) are also provided. An advanced search engine guides the user in retrieving information on AT in the different databases.

The product data in the AT database portal are updated on-line by their manufacturers, and validated by the SIVA Portal editorial team.



Figure 2 The online system for updating product data

The impact on the national AT service delivery system

The SIVA Portal has been designed to support the AT delivery process, from the definition of user needs to the assessment of the most appropriate AT solution.

The portal is currently used by four main categories of users throughout Italy:

- End-users of assistive technologies

(persons with disabilities, their family members, their caregivers);

- AT professionals (such as physicians, physiotherapists, occupational therapists, etc...);
- AT Manufacturers/suppliers;
- Local health authorities;

For professionals working in AT assessment centres, the SIVA Portal is a useful tool to improve the quality of service they provide to their clients. Physicians and their teams can use the AT products database to find out the most appropriate solutions available on the Italian market for each individual client.



Figure 3 An example of search result in the product database

It is also an educational tool to improve the awareness – among professionals involved in disability issues – of the importance of AT within the rehabilitation process. In the latest years this contributed to the birth of several AT centres throughout Italy that recently joined in the SIVA network: a network of specialised services that provide information, guidance, consultations and individual assessment on AT.

By promoting dissemination of awareness, information and knowledge on AT, The SIVA portal contributes to the empowerment of people with disabilities. End-users of AT can for example browse the *ideas* database and find out useful information on simple solution to overcome daily living problems, or explore the *library* database to search fact sheets related to AT product groups. The *on line*

questions area – that gives the opportunity to put questions to AT experts through an online form – currently receives over 200 requests per month.

Recently, on request of the Italian Ministry of Health, a new feature has been added that supports physicians and their teams in preparing the medical prescription of assistive devices. The prescriber may use the facility in two different ways:

- From specification to prescription: select the appropriate prescription codes from the national list of types of products eligible for prescription, check whether any products exist in the SIVA Portal that meet such codes, decide “the most appropriate” one, eventually compile the prescription;
- From product to prescription: identify an appropriate product, find out the prescription code for such product, check whether other products exist that meet the same specifications, decide on “the most appropriate” one, eventually compile the prescription.

Manufacturers and suppliers of AT devices can use the SIVA portal for market surveys, for increasing the visibility of their products, and better reaching the intended audience.

The Portal can also support AT developers and Researchers to better know the market, to discover opportunities, to find out ideas for development, to discover what users’ needs are still unmet.

By providing a comprehensive and detailed overview of the assistive devices available in the Italian market – independent on any commercial interest – the SIVA Portal contributed to the improvement of market transparency. Policy makers and officers involved in public service delivery systems (Insurances, Local Health Authorities, etc.) use the Portale to efficiently allocate resources in AT provision, for example when preparing tenders or prices negotiation for AT products.

Creating communities of support via the ACTION service

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Our presentation focuses on the theme of user involvement within the research and development work of the ACTION service (Assisting Carers using Telematics Interventions to meet Older people's Needs). The novel contribution of our presentation lies in the ways in which we have developed and extended upon our original design model to include research and development work with older people with early stage dementia and their families and, more recently, the creation of blended learning networks supported by accessible Information and Communication Technology (ICT). Our user focused work spans a thirteen year period and involves a range of key stakeholder groups within care for older people. Namely, older people with long-standing, chronic conditions, their family carers, representatives from voluntary and pension organisations, practitioners, care managers, politicians, business representatives and researchers.

We begin our presentation by outlining our user centred design process that was developed in the original EU project (1997-2000) and elaborated on in Magnusson's doctoral thesis (2005) following further R & D work in Sweden. Key focal points are its iterative, pluralistic and participatory approach (www.actioncaring.se). Of particular note, is

the ways in which we have actively engaged older people with early stage dementia in our R& D work which has led to the 'ACTION Living with Dementia' service. We will focus on our most recent research work with blended learning networks in which service users, practitioners and decision makers have come together in a learning project to develop a communication plan which aims to find creative ways of reaching out to the main actors involved in the mainstreaming of the ACTION service. Our model for educating and supporting care practitioners and decision makers involved in implementing the ACTION service in the participant municipalities with the help of ICT will also be outlined.

We invite the audience to compare and contrast their own experiences of user involvement in the successful transfer of ICT based services with due attention given to the role played by context and culture.

Devices for Dignity; A Healthcare Technology Co-operative

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Introduction

In 2003, the UK Healthcare Industries Task Force (HITF)⁵ was established to identify opportunities where closer co-operation between Government and healthcare companies would bring about benefits for patients and service users, the NHS and social care, whilst also helping to improve the industry's performance.

The vision was *'to capture the best that the NHS, social care and industry together can provide for the health of the nation'*

One of the outcomes of this extensive review was to establish two pilot Healthcare Technology Co-operatives (HTC's) funded by the National Institute for Health Research (NIHR), the Technology Strategy Board (TSB), the Engineering and Physical Sciences Research Council (EPSRC) and the Medical Research Council (MRC).

In 2008, Devices for Dignity HTC was initiated led by *Sheffield Teaching Hospitals NHS Foundation Trust*.
<http://www.devicesfordignity.org.uk>

Enteric HTC was initiated led by *Barts & The London NHS Trust*
www.bowelfunctionhtc.org.uk

⁵Healthcare Industry Task Force "Better Health Through Partnership – A programme for action",
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Devices for Dignity was established to

“Deliver innovative medical devices to support patients with long term conditions, which preserve their dignity and independence“

Almost one in three people in England suffer from a long term condition and in those aged over 60, this increases to three out of five. With an ageing population and the expected increase in these figures, D4D's work is crucial in ensuring a better quality of life for many people.

Hosted by Sheffield Teaching Hospitals NHS Foundation Trust, D4D is a national consortium with the following partners:

- [Barnsley Hospital NHS Foundation Trust](#)
- [Leeds Teaching Hospitals NHS Trust](#)
- [North Bristol NHS Trust](#)
- [Sheffield Children's NHS Foundation Trust](#)
- [Sheffield Primary Care Trust](#)
- [University of Cambridge](#)
- [Coventry University](#)
- [University of Sheffield](#)

This large collaboration benefits from ready access to a wide range of experts, skills and resources making D4D capable of creating and developing solutions to a wide-range of unmet clinical needs.

Critically, these unmet clinical needs are identified from a front-line service perspective, and D4D works to deliver solutions on a

national basis which can be distinguished by the emphasis they place on engagement with users or patients.

Our approach ensures that new technology is developed that not only address the key requirements of clinical efficacy but also address patient acceptability including privacy and dignity.

D4D have focused on areas of research which are typically underfunded. Our chosen themes are:

- **Assistive Technology:** D4D’s approach to assistive technology is quite broad, which means it can consider a range of ideas, whether they are technologically advanced, or a change to an existing assistive device
- **Continence Management:** D4D is focused on improving both diagnosis and quality of life for those experiencing voiding difficulties and also with urinary continence issues
- **Renal Technology:** D4D is focusing on the development of systems, devices and service to assist renal patients' independence and help achieve better outcomes

Current Portfolio of Activities

D4D has an active portfolio of 20 collaborative R&D projects delivering high quality solutions to important unmet clinical needs. D4D’s unique approach can be summarised as

“D4D’s work is underpinned by a unique, clinician led working relationship between, patients, healthcare professionals, academia and industry – that discovers, defines, develops and disseminates new technology”

Acknowledgements

Devices for Dignity are funded through the [National Institute for Health Research Intervention for Innovation Programme](#), the [Technology Strategy Board](#), the [Engineering and Physical Sciences Research Council](#) and the [Medical Research Council](#).

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BCI research and user involvement: the role of independent AT centres in the TOBI project

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The TOBI project¹ aims at developing brain computer interface (BCI) controlled applications in the Assistive Technology (AT) and Rehabilitation Technology fields that are functional, reliable and evaluated positively by end users (people with disabilities and patients in rehabilitation). Although BCI technology is developing rapidly, this is a challenging task because not many research centres have tested applications with significant numbers of end users outside labs or clinics.

In their contribution to the workshop, the authors focused on the role of the two independent AT centres involved in the project and their approach to user collaboration in the development of applications for communication, environmental control and entertainment.² The involvement of users in other TOBI application fields such as orthosis for people with spinal cord injuries and post-stroke rehabilitation, remain outside of the scope of this paper.

This paper will describe some of the characteristics of the AT centres and discuss how these features have impacted on the contribution they have made to the project as it has developed thus far. Both centres are fully integrated members of the consortium and play a notable role in WP “User evaluation”, but the project is only in its second year which means that what is presented here has to be read as *work in progress*.

The NPISH AIAS Bologna is an organisation of people with disabilities and their carers which has a 30 year history in AT service delivery. Its AT team operates an independent and public AT resource centre in Bologna (IT).

The BUK centre for AAC forms part of the large Kreuznacher Diakonie care institute in Bad Kreuznach (D). Both centres advise and support people with disabilities and are engaged in identifying and personalising appropriate AT based assistive solutions. To this end they employ multidisciplinary teams composed of professionals with backgrounds in education, health and ICT/AT. Their work can involve intervention in the domestic environment or in clinics in case of particularly severe pathologies. The aim of intervention is to enable people to increase their levels of participation and to improve their quality of life. Technology is thus regarded as constituting an environmental factor with an important social impact and not merely as a collection of medical devices. The relationship between Centre clients and the assessment team may be long term with the latter intervening, upon request, at different moments in order to support the technological needs of the person as they develop over time in different areas of autonomy and life. The centres have displays of a wide range of AT devices for communication, pc access and environmental control and adhere to a non commercial ethos with regard to the AT device market. This means that different solutions can be tried and tested in a context of complete transparency concerning prices and funding, after which the person and his/her carers can make a fully informed choice.

In accordance with the project’s objectives, the two centres have sought to move away from a “medical” approach that distinguishes between “healthy” and “unhealthy” subjects to a “psycho-social” approach - inspired by the ICF model - that distinguishes between

“researchers”, “professional users” and “potential end users, beneficiaries or clients”. *Professional users* in this case are AT experts at AT centres who have a comprehensive view of user needs and available solutions and who see themselves as working together with clients in order to help them improve their lives through the adoption of assistive technologies. *Potential end users* are people with functional limitations who are seeking enabling solutions for their activities and participation. Models such as the Matching Person and Technology model³ are built on this collaborative approach and provide the instruments necessary for the identification of tools and solutions that are perceived as really useful. The evaluative process in the TOBI project reflects this model: professional users and people with disabilities collaborate in providing feedback to the researchers so as to ensure the development of new assistive technologies that are perceived as useful. “End users” are both “potential users of BCI technology” and subsequently “future clients” once these technologies are available on the market.

The AT centres have emphasised how important it is that they be involved at an early stage in the testing of applications with end users. In order to enhance the project’s potential in terms of technological transfer it was felt that research in the BCI field should draw on AT concepts, skills and competences as early as possible rather than develop prototypes far from the real life situations of potential users. Thanks to their experience, their technological resources in terms of alternative technologies, their possession of the necessary infrastructure - such as smart homes - and their established relationships with potential users of BCI technology, AT centres have much to contribute.

Regarding the selection of the potential end users of these new technologies, the centres have recommended moving away, at this early stage, from those groups that are typically considered potential BCI beneficiaries, for example people with Locked-in syndrome and ALS patients for whom the BCI could provide the only possible means of communication.

Although it remains a long term aim of the project to provide these groups with functional solutions, it was felt that for many reasons of an *ethical*, *political* and *practical* nature it would be better to privilege experienced AT users with severe motor disabilities but at least one other communication channel (body signal) in more stable physical conditions.

The *ethical reasons* here concern the management of expectations and frustration, including the emotional stress that could arise from the product not being immediately available in case of positive results, as well as other considerations such as lack of choice and lack of balance in the relationship of power between the researcher and the patient.

The *political reasons* concern the difficulty of creating the conditions for an early and full involvement of these groups in all phases and aspects of the project. Such involvement is necessary in order to make the design process as user driven as possible and requires users who are fully aware and able to choose, consent, agree or disagree.

The *practical reasons* involved concern the need to reduce disturbance arising from those non BCI related factors that often characterise hospitals or other institutional care settings (noise, the presence of non relevant people, prevalence of a medical approach, shortage of time, life support equipment, etc.).

A survey of potential BCI users was conducted during the first year of the project in order to determine their satisfaction with the AT solutions they were currently using and what they would require of any new piece of technology.⁴ The findings were too numerous to report here, but three significant outcomes are worth summarising:

Most participants were satisfied with their current AT solutions, although participants using communication devices were less so than those using other devices such as those for the enhancement of daily life activities, environmental control, computer access or mobility. Furthermore, participants using communications aids were significantly more likely to indicate a need for

improvement in “decision making about own situation” and “relationship with family/friends/caregivers”.

Considering the adoption of new AT solutions, participants rated “functionality” as the most important aspect followed by “possibility of independent use” and “ease of use”. These results were underlined by the reasons given by the participants for their dissatisfaction with their current AT solutions which concerned functionality/effectiveness and ease of use.

The survey also asked participants whether they were interested in further participation in the project. A selection was made of those who responded in affirmative as possible candidates for the testing of prototypes.

Payment (or reimbursement if preferred) and employment on a contractual basis are envisaged in order to encourage the involvement of potential BCI technology users at the AT centres. Those selected are expected to participate individually in test sessions and in focus groups, discussions and presentations. User participation is designed in accordance with the Living Lab model. Living Labs are “permanent” communities of users who are involved on an interactive basis in product innovation at various stages in the design/development/validation and marketing process. Their feedback is collected by means of various socio-ethnographic research methods (focus groups, surveys, testing, polls, etc.).⁵

The features of Living Labs are:

- different stakeholders working together for innovation;
- an open innovation concept: sharing and spreading;
- a real life testing environment: seamless and spontaneous interaction between people and technologies (+ environments);
- a user centric approach to innovation: people’s feedback is put at the core, especially at the beginning.

The Living Labs concept is particularly appropriate to AT centres, which, to a certain extent, can be considered permanent Living

Labs in AT for inclusion and participation - especially where more established and formalised relationships between clients and AT have been developed. Involvement in the TOBI project has thus turned out to be a learning process for all.

A wide range of internationally validated scales have been selected to measure different parameters. Following the classification of AT device outcomes proposed by the Consortium for Assistive Technology Outcomes Research (CATOR), these refer to the outcome areas “effectiveness”, “social significance” and “subjective wellbeing”.⁶ They include different scales that measure subjective workload and user satisfaction, such as the NASA TXL⁷, the MPT – “Assistive Technology Device Predisposition Assessment” (ATD PA, both consumer and AT expert form)⁸, the Tübingen User Evaluation of BCI use Satisfaction (TUEBS 1.0.), which is an extended version of the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST 2.0)⁹, the “Assessment of Life Habits” (LIFE-H)¹⁰, a well validated questionnaire that measures the social participation of persons with disabilities i.e. the performance of daily activities and engagement in social roles.

In addition to these validated scales the AT centres use focus group techniques, case histories and interviews to collect feedback from the participants. These techniques offer more opportunities to interpret the input of BCI users and to collect information on the expected benefits of BCI compared to other technologies.

The first users were selected in July 2010, put under contract and introduced to the project. They have started using BCIs and are enjoying an experience that they feel concerns their own future and that of future generations.

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Maavis@School – Developing an open platform for computer accessibility.

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Abstract

A highly intuitive software application, Maavis, has been specifically adapted for use in schools. It aims to increase independent access to IT for some people who struggle to use computers effectively because of physical and/or learning disability. It is noted that such people often have to rely a great deal on their family, teachers or carers to choose and control their activities. The Maavis@School project aims to collect the first measured evidence of what changes occur with the use of such software and of any impact on the general health and wellbeing of Maavis users.

The Maavis implementation within a web platform and through technology transfer in an open development approach was carefully chosen. It is suggested that this has offered the most flexible and extensible solution.

Background

People with severe physical and learning disabilities can meet with significant barriers to their daily living. Assistive Technology aims to reduce, if not remove, these barriers using technologies which address the individual's functional limitations and thus provide a gateway to increased independence. This can have lifelong benefits, including optimisation of educational potential, increases in well-being and greater social interaction. The UK government supports effective deployment of Assistive Technology to reduce the potential for additional lifelong impairments and thus, reduce the long-term cost of care [1,2].

Governmental desire to show value for money in its spending is reflected in recommendations to use open source software. Open source software is defined as software where the source code that makes up the software is made freely available.

The project outlined here focuses on enabling

children with severe physical limitations and those with learning disability to optimise their potential through the use of moderated computer access. Such activity is also strongly supported by government [3].

Children with severe physical limitations are recognised to be at risk of underachieving in their cognitive and psychosocial development, because the restrictions of their physical status reduce their ability to explore and respond effectively to objects, events and people in their environment. In a similar way, children with learning disabilities require special support for cognitive, memory and language development. While assistive technologies, including Augmentative and Alternative Communication (or AAC) devices, may enable some children, many of the current devices are too complex for younger children to manipulate independently. Recent research in the USA [4] has demonstrated that adapting AAC devices to provide simpler modes of access and allow wider elements of choice can enable these children to develop more age appropriate cognitive, language and interactive skills and become more able and autonomous interactors with their immediate society.

Inclusive Design and User-Centred Design (UCD) are now well established [5,6]. Yet, a search of the literature reveals there continues to be a limited amount and quality of UCD, user-involvement and evaluation. In particular leading here to a failure to meet more holistic end-user needs in use of IT.

The deployment of IT-based solutions for people with physical or learning disabilities is recognised as a key component of the Environmental Factors domain of the World Health Organisation's International Classification of Functioning, Disability and Health [7]. The adaptability that software gives

means in principle that, as an individual's abilities change the interaction can be readily modified; the solutions put forward can fit within a regularly used and familiar care provision pathway that fits many clients rather than one or a few. Many services and activities can be accessed through a single IT system and, in a well designed solution, make life easier both for the users and the people supporting them.

Many computer based applications have been developed for school children with physical and/or learning disabilities. Few of these systems support more than one activity or service. In consequence, the student can become totally reliant on a carer to change activities – thus losing independence - or they become defeated or confused in trying to navigate the operating system, which can result in frustration, loss of motivation and reduced use of the functions available. The consequence of educational software falling within this group is restricted opportunity for students to learn to exercise independent effective choice and 'work' discipline.

Managed Access to Audio Visual Services (Maavis)

Maavis is an open source application that has been developed through the ACT programme – a regional development funded project (<http://www.actprogramme.org.uk/>). Maavis is designed in a way that makes it as easy as is possible for the client to switch between activities, while at the same time allowing the clients access to the supplied applications/services.

The Maavis system was developed with the participation of older people who had no previous experience of using computers and has proved to be effective for a range of capabilities through the use of a touchscreen or a pointing device. The current version of Maavis offers access to videoconferencing, playing music or videos, visiting Internet sites, and viewing of photo albums.

Maavis Development Rationale

The choice of implementation of this application was driven by: accessibility through low cost; creating standards;

flexibility of the application framework and sustainability. The possible platform choices were, developing a standalone application (be it hardware specific or independent), creating an operating system variant, or, using an existing web content framework (developing a browser plug-in). The browser plug-in provided the closest fit: many of the application services involve delivery of web content; availability of an open platform-independent browser and well defined standards for web content (i.e. web languages); inherent ability to develop a flexible application to deliver a range of services; and, potential for simple installation alongside standard software or across a network, to build on an existing open development community, and to ensure compatibility with future media and content formats.

Approach & Example Software	Benefits & Disadvantages
Develop operating system variant	+ Fully integrated into operating system so can easily run other processes - Requires existing operating system to be replaced or run as dual. - Deployment likely to be tied to hardware
Standalone Application	+ Deployment potentially simple - A lot of development will be in making existing services (e.g. web browsing) - Not easily extensible as not based on existing framework
Web framework plugin	+ Can benefit from all services provided through framework (browser) + Easily extensible with other plugins + Based on open standards + Development can concentrate on novel interface + Potential to make simple remote configuration, through web service - Deployment may require a number of steps

Table 1 : Comparison of implementation

Since starting this project other software has been developed to meet similar needs using

some of the other possible implementations. Table 1 presents an analysis of the Maavis approach as compared to other options.

Maavis@School

Through the reprogramming Maavis can now be used with switch based access, which is considered more appropriate for people with severe physical disabilities.

The core principle of Maavis design, which is to enable people to use IT without understanding it, has been successfully trialled and audited within the normal bespoke assistive technology service delivery, but with only three children with physical disabilities in one school, and only in terms of directly observable obvious outcomes.

Maavis@School Study Methodology

A non-interventional process of scoping visits, brainstorming ideas for use of Maavis, adapting Maavis and agreeing to take part, has been completed before ethics approval. Ethics approval has now been obtained.

Contact with the two schools to initiate school and teacher familiarity with Maavis will occur in a two week period. The observations will then be carried out over 6-8 weeks with each participant during a fixed 10 week window, starting in October 2010.

Inclusion Criteria / Sample Size:

Potential participants will be sought from special schools within South Yorkshire. Potential participants will be identified by class teachers as those who have:

- physical and/or learning disabilities
- are currently unable to independently access or make effective choices of computer activities
- are able to use switch or pointing device or other assistive technology to access IT
- are able to indicate their willingness to take part through their available and known communication channels (e.g. through eye blinking, verbal assent, etc.)

Four or Six pupils will be recruited in each school, thus between 8 and 12 children will be recruited in all.

Recruitment:

The project investigators will liaise with

schools over recruitment. At the request of the schools the investigators will review the suitability of the children proposed by school before the child and/or parents are approached – this is because the school staff do not feel they have the expertise to ensure selection of appropriate children. This will help avoid disturbing parents and school children when the latter is unlikely to benefit from use of Maavis. Clearly this is at the cost of potential bias being added BUT it is intended that this project will learn from this process to provide future guidance on identifying end-users.

The agreed suitable participants will dictate which teachers take part in the consideration of how they can use and manage Maavis in the class. They will have two weeks for this.

The school staff will make the initial contact with pupils and parents using provided information sheets. Parents and students will have at least 48 hours to consider if they are interested in finding out more.

The researcher(s) will contact the school staff to arrange meeting those who have expressed an interest to be potential participants. The meeting will discuss with the potential participants and parents/legal guardian(s) participation. For those who subsequently decide to take part verbal agreement from the student and formal permission from the parents/legal guardian(s) will be obtained.

Process (interventional)

The Maavis system will be installed on the class computers of identified teachers of recruited participants in two schools. These teachers will be asked to share their findings and observations using the normal pedagogical review of innovations of the pupils' enabling technology. The following aspects will be recorded by the researcher both pre and post intervention (installation/use of Maavis):

- The teachers whose classes will include the participants will be asked to report on the management of Maavis within the class and for the individual pupils, and, the nature and content of the activities that they can apply Maavis to.
- The teachers and staff involved in supporting/providing IT related

technology will be interviewed to synthesize an overview of the participating students' current access to and use of computer resources, and observed consequences. The latter may include anecdotal evidence reported by parents to the school.

- Each student's current interactions and functioning in the classroom will be recorded on video, to provide data for analysis, to be used as an objective baseline (descriptive) measurement.
- A number of assessments will be carried out with the student participant.
- Follow up visit in next term, open interview with staff involved with use of Maavis. To collect information about using Maavis after a break and to ensure where needed action is taken to allow continued use of Maavis.

An overview of the measurable aspects of the study and the ensuing analysis are listed below, aspect of assessment Test/measure/ approach to be used :

- Identification of likely management of and purposes of use of Maavis : Interview with/information from class teacher
- Identification of participant's current educational functioning : Interview with/information from class teacher
- Identification of participant's current physical functioning : Quest [8].
- Assessment of level of language functioning : Clinical Evaluation of Language Fundamentals - Fourth Edition UK (CELF-4 UK)
- Computer /Assistive device control-skills? : Video of child accessing /using a device for 5-10 minutes.

Between the pre and post intervention measures the researcher will support the participants/schools/ teaching staff in using the MAAVIS system. Some further videoing of the participants using the system will be taken during this period. The researcher will take field notes.

Analysis:

- Qualitative Analysis will be used to

analyse information from interviews before and after the deployment, comparisons will then be drawn

- Case studies of recruited student participants, using comparisons of baseline and post- intervention performance, recorded on video (the case study methodology is widely accepted by researchers in Assistive Technology) as a means of accounting for individual differences among the heterogeneous population of people with physical and learning disabilities [4,7].
- Comparative analysis of the results of the standardised tests, pre- and post-intervention.

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Knowledge Transfer Using Living Lab Method – Case Healthy Sleep

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Introduction

Living Lab (LL) approach responds to the challenges of user-driven product and service development by empowering the end user actively in the R&D&I activities. In LL the development work is conducted in real-life settings openly with different actors: end users, research institution, and public, private and third sector organisations.

The aim of this paper is to describe how Living Lab method can be used in assisted technology product and service development. Case Healthy Sleep shows how TEMPUR Ltd's product and service development was conducted together with a Finnish rehabilitation center and its customers.

Living Lab

Living Labs are open innovation environments in real-life settings, in which user-driven innovation is fully integrated within the co-creation process of new services, products and societal infrastructures [1].

The definition of Living Lab consists of four different elements: user-driven approach, open innovation environment, co-creation process and real-life settings. User-driven approach signifies active empowerment of the end user in research, development and innovation operations. Instead of being an object, the end user is an active part of R&D&I process and equal with the other LL actors. In open innovation environments, organizations co-operate with other actors of LL instead of leaning only on their own R&D&I activities. The actors in LL vary from test users (end user, inhabitant, citizen, employee, student, visitor, tourist etc.) to researchers, specialists, enterprises and public actors. Real-life settings on the other hand refer to everyday living and working surroundings where one works and lives. In the LL project the test user is living or

behaving as normally as possible. [2]

Living Lab approach manages methods, tools, infrastructures and practices and utilizes its actors' adequate know-how to develop products or services in different product life cycles. In an ideal LL, the development work is continuous and each actor benefits from the co-operation.

Case Healthy Sleep

The aim of this Living Lab case was to study how people with rheumatic diseases experience TEMPUR pillows and mattresses and how these products affect their sleep quality and symptoms appearing in the morning. Several sleep disorders are known to be connected to rheumatic diseases, e.g. disturbed sleep and waking up too early in the morning, which lead to daytime fatigue, tiredness and decrease in alertness. [3,4] Even when 60 % of people with rheumatoid arthritis feel pain during the night, there still is too little attention paid to their sleep [5]. In addition to physical illnesses and mental factors, the sleeping environment and related factors affect the quality of sleep. Checking of sleeping ergonomics (mattress, pillow etc.) can be considered as one approach in improving the quality of sleep. Good pillow can significantly reduce neck pain and headache [e.g. 6]. The connection between the quality of mattress and back pain is also been proved. [7]

There were 80 participants diagnosed with different rheumatic diseases who used individually conforming TEMPUR pillows and mattresses during their rehabilitation period (2-3 weeks) in a rehabilitation center. The mattresses and the pillows were selected to fit participants' individual parameters (e.g. sleeping positions, body shape & weight etc.). The study was conducted by Univ. of Tampere and Tampere Univ. of Applied Sciences. After the rehabilitation period the participants filled

in a questionnaire where they estimated their sleeping and symptoms appearing in the morning by comparing their sleeping in their own bed at home. In the questionnaire the end users were able to give feedback what things helped and what disturbed their sleeping. According to the results the participants slept better during the rehabilitation than home because of better sleeping ergonomics. The most important thing they pointed out was the mattresses and pillows which the participants find reducing the symptoms they normally reported appearing in the morning.

As a result of this process, the participants experienced how meaningful part the quality of mattresses and pillows are in their sleeping and therefore as a part of their quality of life. They also learned that even when it is mostly the illness that causes the pain and other symptoms that affect their sleep, they still can improve their sleeping significantly by improving the sleeping ergonomics. People sleep approximately one third of their lifetime, so the meaning of good night sleep cannot really be underestimated.

In addition to the benefits of the results of this study for the participants, the rehabilitation center received new insights to improve their services concerning accommodation and sleep. Although the study took place in a rehabilitation center, the results can be transferred to different sleeping environments to benefit all end users. TEMPUR Ltd took advantage of the participants' experiences in product development and enlarging marketing sectors from private customers to health care sector and specific target groups. For the research institutions involved this was a great opportunity to create new information together with essential co-operating partners and enlarge network concerning healthy sleep.

Discussion

A benefit of Living Lab approach is definitely the co-creation process in product and service development. Each LL actor profits from co-operation as it's been described in this Healthy Sleep case. LL differs from traditional research in emphasising usability and customer satisfaction. End users are active part of

development process and not just object of observation. Knowledge transfer among LL actors can also be considered as an advantage of LL approach. When a starting point of a development project is common to all partners and actors from the very beginning, the need for the research is genuine and the results will benefit all actors equally.

Continuation of the co-operation in the development can be considered as a challenge of Living Lab. Instead of carrying out just one LL project, continuous co-operation and partnership would always be even more productive. This described Healthy Sleep case was a continuation to earlier studies been made of different groups of end users concerning their sleeping (e.g. young athlete swimmers, people with sleeping disorders etc.) together with co operating partners. And now the latest challenge of this area is a development project concerning multifaceted facilities of healthy sleep.

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Work life, new technology and employment of disabled people – a twenty- year programme, and a success story from idea to viable international business

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This paper depicts a technical development programme carried out by the Swedish government and the Swedish Labour Market Administration (AF) over a period of more than twenty years. In addition, an illustrating business development case originating from the programme is summarised. The latter started with a limited undertaking as a tender to an inquiry from AF and then over some fifteen years led to a high-tech viable enterprise with international presence.

The rationale for the programme was the advent of micro-computers in the early 1980s, realised both as personal computers and in embedded systems at workplaces everywhere. It was understood that people with disabilities were to suffer on the job market if the potential of the new technology was not properly observed and if no active measures were taken. Technology, not least the ICT, offers opportunities for many disabled and impaired jobseekers, albeit concurrently, technology mounts obstacles to many individuals as well. Processes are changed; jobs to which you feel accustomed disappear. At the time this was the case not least for disabled people, who often found themselves vulnerable on the current job market and experienced difficulties in finding suitable jobs, and still it is so due to the never-ceasing development of the technology.

In a traditional farming society there are tasks to be done also for persons with limited faculties of different kinds. The industrial society creates new norms and the requirements on the individual become standardised; exceptions are not acknowledged. Thus, it took long time before a disabled person was accepted to a job in industry, in office or in business generally. ICT

changed the conditions once again – however, this time society was, at least to some extent, better prepared.

Government report 1983

It became obvious that the computer was to become a reality on everyone's desk, in workshops and offices, and in schools. The Swedish Government took several initiatives in the beginning of the 1980s. A government report was published on information technology procurement for the public sector. Its aim was to apply (precompetitive) procurement as an instrument to increase the competitiveness of the Swedish industry by benefitting from important needs in society [1].

One of the ideas in the report was to develop new equipment based on micro-computer technique and software in order to support disabled persons at work. The idea was implemented when the Swedish Labour Market Administration (AF) was commissioned for the task. The programme was called TUFFA.

The TUFFA programme

In 1985 specifications groups were established, staffed mainly from the AF's organisation, to develop the requirements for a subsequent tendering process. Each specification group was dedicated to a particular disability: vision impairment, deafness and hard of hearing, motor disability and cognitive impairment, all related to tasks in work life. Within the AF expertise of different impairment and functional disorder were employed, high-skilled and with many years of experience helping people to workplace adaptation, depending on the kind

of job, work requirements and available technology. A comprehensive functional specification was compiled and sent out for tenders. It consisted of generic specifications for a variety of impairments.

In order to proceed from word to deed, also eighteen work places were specified for tests at real work sites, with disabled individuals at work.

A specific requirement was that the tendering organisations was to sign a long term commitment with the AF to offer subsequent adapted workplaces on request, and to be the principal responsible contractor for each delivery also when several subcontractors were engaged. AF in its turn was to provide successive inquiries very much exceeding previous levels of work place adaptations for disabled and impaired job-seekers. A contract with a subsidiary of a large telecom concern as the principal contractor was signed in 1987.

The initial adaptations turned out well for the individuals. Adequate funding was provided for further purchases and work adaptations on a larger scale. Thus, the development of assistive technology for work life proceeded. The undertaking did not halt as a single achievement; the development of the ICT technology and its applications in work life in general were accompanied by technical developments directly addressing the needs of the disabled. After an introductory period of time, the inquiring/tendering/delivery process was opened up for any company that could offer an adequate solution for the individual in question and take full warranty for the required function.

TUFFA became a success. The original assistive devices and software improved, were simplified and became cheaper. In many cases, the technology constituted the decisive means for a disabled person to get employed. In 1990, work place number 1000 within the TUFFA project was established. When the planned five-year period was summed up in 1993, more than 4000 work places were equipped with some kind of IT support provided within the realm of TUFFA. These positive results

depended very much on the funding available for continued deliveries within the framework of the project and the AF as a competent buyer.

The ILO (1992) investigated a number of countries engaged in IT services to the disabled at work. With regard to TUFFA the report concluded, "that any country or, for that matter, any agency that seeks to install an IT device to promote employment would be well advised to read and study the Swedish contribution thoroughly" [2].

Development continued

After these first five years the programme was transformed into ordinary procurement within the AF as planned. As a *development tool* the programme was continued still another fifteen years, with a budget of 0,5-1,0 M€ a year. The ICT development showed no signs to halt. Part of the funding was directed to education of AF's own staff as lacking knowledge of the new technical opportunities was found to be a significant obstacle to their full exploitation to the benefit of the target groups.

Different impairments were continuously addressed; in the beginning visual impairment dominated the target group together with a variety of assistive technology devices for individuals with physical impairment. Later other groups of disabled people gained ground. Hearing problems were recognised as a severe handicap for large groups of the work force, e.g. teachers approaching their retiring age. Dyslexia and other kinds of cognitive or psychological impairments were successively identified as major obstacles in order to acquire a job or to keep it on a more and more demanding job market.

Technology offered a range of generative options, often waiting to be applied in solutions beneficial for people suffering from functional impairments in their jobs. Sometimes the application was quite easily conceived and engaged only a single company for the intended achievement; at other occasions a complex project structure was required in order to attain the goals. It was important for the procurer that the enterprises involved (generally SMEs) saw their projects

as a starting platform for further development. The projects were to include the potential of leading to products or services on the open market, which, however, was not always achieved, or achieved only after further engagement by the procurer in follow-up projects.

The Comfort Audio case

Although the principle rationale for the programme was to support the disabled and impaired to good and sustainable jobs, the possibility to foster new businesses within the field of assistive technology was very much in focus. If new technology can be transferred into regular business, it will benefit the chief target groups and procurers as well in the long run.

A success case is Comfort Audio AB. The company was started in 1994 by two young entrepreneurs just graduated from a small town university in south Sweden. The background of the initial undertaking was the prevalent inadequate conference equipment for persons with hard of hearing. It was considered troublesome at the time and too disturbing for the other participants in the meeting. A functional requirement specification was produced by the AF expertise. A wireless solution was fore-seen. A major requirement was that no disturbing measures to other participants in the meeting should be necessary; still it should allow the impaired person to participate fully. Other important requirements were to identify and suppress noise from fixed frequencies, e.g. from fluorescent lamps, and likewise to prevent transient high peaks to propagate to the ear. A typical example mentioned was the sound from the drop of a pen or a key on the conference table.

AF announced an open call for tenders. Out of six received tenders, only one seemed to fulfil all requirements. But was the solution achievable? Independent technical experts, also highly reputed, were in doubt. However, it was based on new digital components, in fact at that time a technology not fully conceived by other companies in the market. The cost to produce two prototypes was reasonable, around € 35.000. The AF decided to accept the

offering. The project was completed successfully in due time, and the production of the so called Comfort Conference started on a small scale. Both IR and radio transmission were applied, however, short range radio became dominant with time. This became the start of a successful business development in a segment of assisted devices for people hard of hearing. By participating in the EU project FUSE 1997-98, the original product was improved by further integration of circuits (ASIC) and physically downsized, which made it still more apt to the end-users.

In year 2001 an important step was taken by the company. At the time it employed seven people including the founders. The yearly revenue approached one M€. It was realised that further expansion must include significant organisational reshuffle. The founders desired to return to their core interest, i.e. development, and management and especially the marketing and sales activities were to become a full time undertaking. Thus, a managing director was recruited externally. More thorough planning for the next few years began, based on different pending ideas for new developments.

In the following years on the average two new products per year were developed or considerably improved and launched on the market. One of these products was the "Selecta BT" (BT for Blue Tooth), which was not only a wireless transmitter but also a hands-free unit integrated with the mobile phone through Blue Tooth short range wireless transmission. Competitors were stunned when the new product was presented already in 2003. For this development additional funding from AF was instrumental and AF contributed also with comprehensive testing of the prototypes.

In 2006 a sales company was established in the US, at first in California, later it was moved to Chicago. The market for hearing aids in the US is very different from that of the Nordic countries, as the individual has to pay for them himself. In Sweden, e.g., insurance or other public funding very often is available. As the Comfort Audio high quality product line generally is found at the upper price segment the competition from low end products

becomes especially intense in the US. Obviously, many do not get what they really need.

Sales companies were further established in Denmark (2008) and in Norway (2009). Distributers are found all over the world. Now (2010) the organisation employs about 60 people with a revenue of some 10 M€ a year.

The latest project together with the AF was carried out 2006-2008. The objective was to develop a product “Earset” within the new product line “Digisystem”, a revolutionary wireless set of a transmitter and a receiver and to deliver two Earset proto-types. Based on a functional requirement the receiver should be attached directly to any ear. According to the functional specifications developed by AF specialists the units should be easy to use with a nice design and an extra-ordinary good quality of sound, without any noticeable time delay and with a coded transmission, a requirement in many job situations.

The project consisted mainly of the delivery of a technical specification, design of the receiver, field tests of mock ups for the receiver, development of the transmitter and the receiver and finally field tests of the prototypes. The field test, where a group of hearing impaired persons tested the prototypes, was carried out in the beginning of 2009. The result of the project turned out very successfully. The prototypes were further developed. The products were launched in the autumn 2009 in Comfort Audio’s product line Digisystem.

The present challenge

TUFFA started as an important pre-competitive procurement project with the public sector as the initial buyer. The intentions behind the project have been fulfilled over the past twentyfive years. Foresighted policy makers saw the potential value of such an undertaking and the importance of perseverance over the years. Now it is encouraging to observe that EU, in its new “Framework for Research and Development 2007-2013”, highlights “pre-competitive procurement” as an instrument for meeting

important societal needs [3]. TUFFA was an important concerted national effort 25 years ago in Sweden –similar ideas are now applied in the European context.

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From Problem Identification to Solution Validation: An Operational Model for Translation & Transfer

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Abstract

Assistive Technology devices and services arise within the context of three related economic sectors: government, academia and industry. Technology-based knowledge exists in three successive states, with each state resulting from a method-based process: 1) Discovery state from research methods; 2) Invention state from development methods; 3) Innovation state from production methods. Knowledge Translation is a means for communicating the value of technology-based knowledge to stakeholders, while Technology Transfer is a means to shift ownership and control between stakeholders. To effectively and efficiently translate and transfer technology-based knowledge as a viable solution to a validated problem, one must consider the absorptive capacity of the organizations involved, as well as the absorbability of the knowledge in each of the three states.

Background

Assistive Technology devices and services are intended to provide functional capabilities to end users or care providers. Successfully achieving this intent marks the culmination of a complex process involving multiple stakeholders, who collaborate to progressively transform knowledge about user's problems into knowledge embodied as technology-based solutions. The transformation processes involve the translation of user problems into specifications for solution, and the transfer of those solutions to the commercial marketplace.

Some successes result from the passive diffusion of knowledge from academia out to industry – the linear model of innovation. Other successes result from serendipitous contact between those with knowledge about a

validated problem and those with knowledge about a viable solution. However, neither of these avenues represents a systematic and deliberate approach to solving problems, nor do they offer sufficient structure to be replicable.

Consequently, the field of Assistive Technology devices and services – as well as other fields depending on technology-based innovations – still lacks an operational framework that is capable of linking the critical activities of all the relevant stakeholders. The presence of such an operational framework would facilitate long-term planning, resource management and performance evaluations, which are often lacking in government funded research and development projects [1]. Ensuring that such a framework is grounded in evidence from research and practice, would increase its acceptance among the government, academic and industry partners. Collectively these attributes could help agencies and grantees achieve the highest level of societal impact from a limited pool of public resources.

Rationale

Many government agencies fund basic or applied research projects that are intended to generate conceptual discoveries – one state of knowledge. These conceptual discoveries represent novel contributions to the global base of knowledge. They are typically documented and disseminated through conference presentations or scholarly publications, with their main audience being other basic or applied researchers.

By definition, the conceptual discoveries generated through applied research are expected to be put into practice by members of some associated stakeholder group. For example, stakeholders in laboratories or

individual entrepreneurs work with technology-based knowledge. They may apply development methods to transform the conceptual discoveries into tangible prototypes. These proof-of-concept prototypes demonstrate feasibility of knowledge use as a product or service in whole or as a component. This is the invention state of knowledge since all inventions must demonstrate both novelty and feasibility.

One more transformation is required to create a device or service useful to society. The prototype invention must be transformed by people trained in business methods into a finished good or service that can be produced and distributed. The finished good or service represents the innovation state of knowledge. To generate economic value to the producer as well as functional value to the consumer, the innovation's design must include material, tooling and assembly specifications that can provide the required performance, durability, reliability and safety. To achieve some economy of scale, a device is designed to be produced in mass quantities while a service is designed to be easily adopted. Collectively these attributes represent the innovation's utility. The attributes of novelty and feasibility from the prior knowledge states, combined with utility from the current state, define the three value dimensions required of a technology-based innovation – novelty, feasibility and utility [2].

All of the above inputs, processes and outputs are necessary to achieve a successful innovation. They are assumed to be in play when a sponsor declares that new investments in "R&D" will create useful devices and services, which in turn will generate beneficial impacts for some target population. Despite the sponsor's declared intent, if the new investments are channeled exclusively to university-based researchers, the outputs will primarily consist of conceptual discoveries. These outputs simultaneously reflect the scholar's expertise in the methods of research, and their lack of expertise in the methods of development and/or production.

Federal investments in research and development for Assistive Technology have

repeatedly experienced such results in both Europe and North America. The projects generate many presentations and publications, contribute some new content to standards and guidelines, and result in a few proof-of-concept prototypes. Unfortunately there is scant evidence of such projects contributing to finished goods or services in the commercial marketplace.

The government sponsors and their grantees complain about a "valley of death" – the absence of additional resources to bridge the gap between their project outputs and the marketplace. They erroneously conclude that additional investment is needed above and beyond that already expended in their efforts. Scholars corrected this misperception by describing a "Darwinian Sea" teeming with resources to transform discoveries into inventions and inventions into innovations [3].

However, these resources are only available to technology-based projects which have carefully preserved the market value of the knowledge, and have properly communicated that value to investors able to complete the transfer of the associated technology. Those who complain about a dearth of available funds, need to recognize that their project simply does not meet the requirements to prompt additional funding.

Government sponsors have two options to increase the downstream success at transforming conceptual discoveries into prototype inventions and those inventions into device and service innovations. The preferred option is for funding agencies to share the available resources with those downstream stakeholders capable of transforming knowledge into the second and third states, and to require broad collaboration and planning among all stakeholders prior to the inception of any project. This approach would increase the likelihood of meeting the requirements for investment from other sources.

If this option is ideologically or politically impossible, the funding agencies could still require the researchers to ground their own contributions within the broader context, to

devise plans to preserve the core value of the conceptual knowledge, and to serve as custodians of that knowledge through the development and production transformations necessary to yield utility for the intended beneficiaries. This approach might not guarantee survival in the Darwinian Sea, but it would at least increase the odds of success against the competition.

The following framework is designed to support all of the stakeholders involved in either option.

“Need to Knowledge” Model

Knowledge Translation is the newest approach to efficiently summarizing and effectively communicating research-based knowledge to stakeholders positioned to implement it. The Knowledge to Action model is widely cited as a fair and comprehensive representation of this approach [4].

As explained above, technology-based knowledge intended to generate devices or services, involves three methodologies that output knowledge in three distinct states. An appropriate Knowledge Translation model needs to consider how to communicate knowledge in all three states. For devices and services expected to benefit society, the model should begin with an identified problem and end with a validated technology-based solution to that problem.

The “Need to Knowledge” applies a stage/gate framework to the three phases of research, development and production activity. The model begins by articulating a problem amenable to a technology-based solution, then determines what knowledge is needed to progress from problem to solution. The application of research, development or production methods is contingent on the requirements of the defined project. The needed conceptual discoveries may exist in published literature and patents, or they may be generated through the application of research methods. The proof of concept prototypes may not yet exist, or they may require refinement for this envisioned application. If all the necessary R&D is

completed, the project may need to move directly into the commercialization phase.

The “Need to Knowledge” model reduces a very complex process of Technology Transfer to three Phases and nine Stages, with each Stage followed by a decision gate (see Figure 1). Every Stage/Gate contains a nested set of Steps, then Tasks within Steps, and Tips for completing the Steps and Tasks. All of these elements are supported by hundreds of quotations excerpted from a scoping review of articles from research and practice literature. These primary sources yielded hundreds of references to additional publications. Users can use these citations and references to explore the supporting information in greater detail.

Phases	Stages
Research Methods	1. Define Problem & Solution 2. Scope Project 3. Conduct Research →
	<i>Communicate Discovery Output to appropriate Stakeholders</i>
Development Methods	4. Build Business Case & Plan for Development Phase 5. Implement Development Plan 6. Test & Validate Prototype →
	<i>Communicate Invention Output to appropriate Stakeholders</i>
Production Methods	7. Plan for Production 8. Launch Device/Service → <i>Communicate Innovation Output – Sales & Marketing</i> 9. Review Life Cycle

Figure 1 : Outline of Need to Knowledge Model

At the culmination of each phase of research, development and production, the “Need to Knowledge” model contains diagrams for conducting Knowledge Translation. The diagrams adapt the “Knowledge to Action” model to more accurately represent the communication steps required for each state of

knowledge. They include tables showing how to tailor knowledge to six different stakeholder groups: researchers; clinicians; manufacturers; consumers; brokers; policy makers [5].

The full “Need to Knowledge” model is freely available for public access and use at:

<http://kt4tt.buffalo.edu/knowledgebase/model.php>

Implications for Policy and Practice

Governments attempting to stimulate technology transfer need to shift policies so that the passive linear model of innovation, is replaced with an active collaborative model, where science and technology “R&D” are directly linked to industry production in order to achieve societal impacts.

The Need to Knowledge model demonstrates that the commercialization process is quite complex. No organization, investigator, or project can be held singularly responsible for completing the entire process. According to Dr. Gibbons [6]:

‘The once clear lines of demarcation between government, industry, and the universities, between science of the university and the technology of industry, between basic research, applied research, and product development, between careers in academe and those in industry no longer apply’.

Policy makers are beginning to embrace the concept of open innovation which permits governments to facilitate internal and external knowledge flows, and to support knowledge exchanges between any source and their various stakeholders [7]. Integrating research activity within a broader societal framework of dynamic problem solving would ensure that relevance, and permit industry to fulfill their critical yet missing role in transforming discoveries into inventions, and then on to innovations for the marketplace.

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Maavis-in-the-community.

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Abstract

Maavis – Managed Access to Audio, Visual and Information Services was developed for use as a simplified user interface in adult care home environments. However it has many potential applications as an access tool and was designed to be flexible. In a small project – Maavis-in-the-community - this capability is being extended through using Maavis to deliver adult education to users with learning difficulties. This project is in collaboration with Barnsley Adult Education Services (BAES) and University of Sheffield. Through a knowledge exchange process features of Maavis are being developed to enable adult education in the community. This paper reports on the first phase of implementation of Maavis-in-the-community.

Introduction

As each new application scenario for Maavis potentially requires development of new features this project is being done through a direct consultation with the BAES education delivery team. This is in order to specify required features and to provide feedback on the implementations and any changes that may be needed. This allows Maavis to be extended with features that are directly suitable for use in adult education and that the professional staff find most effective.

Discussions with BAES at the project formulation stage allowed the Maavis Team to introduce it's use and capabilities. From that process the first four new features below were suggested. At a second stage staff training based session the BAES staff were able to explore Maavis's operation, ask questions, suggest more features and suggest possible modes of use with their students with immediate feedback from the Maavis team.

New Features

As a result of the two way knowledge transfer a number of new features were selected and added to Maavis in order to support those educational requirements which emerged and were not already directly possible.

These new features included:

1. Working off a USB memory stick. This is required as BAES computers are reset to a default state at the end of each day and so any installed software will be lost.
2. Work without Internet access as there are service limitations in some locations, i.e. no Internet access.
3. Support simple question and answering activities such as quizzes.
4. Make the videoconferencing feature optional and allow it to be hidden when not required.
5. Add captions to photos in the photo viewer. To aid word recognition. The captions are also spoken on demand when selected.
6. Adding an option to speak labels on buttons when operated and before they invoke their actions. To aid correct selection.
7. Adding a simple AAC communication application through a new set of screens which provide sets of buttons that simply speak their label text when selected.
8. Provide a simple mechanism to control the order of buttons.
9. Update the settings selection feature. With all the new options the settings tool has become overly complicated.

Most of these features have now been added and BAES are about to embark on evaluation

and use with their students. During this stage they will be providing feedback and no doubt finding issues that need further attention.

Open Source and Open Development

Maavis is an open source project and so explicitly encourages the use of community development processes. This means that the health of the project depends on the number of active contributors in addition to those taking a more passive user role.

Accordingly, the BAES education delivery team will be increasingly encouraged to make use of the open development resources and approach by directly engaging with the project team. This allows them to experience the open development process and become part of the wider Maavis community as it develops.

Initially they are being encouraged to use the project mailing list in order to report problems and discuss ideas with the Maavis team. This will also be the preferred channel for discussion with each other, which has the advantage that others will be able to see the project history in the archive.

It is expected that as they become more familiar with Maavis and their confidence grows they will contribute configurations and other resources that can be shared. This will allow the user community to grow and will directly enhance the Maavis project and improve its health and sustainability

- BAES staff development
- Expansion of Maavis feature set with proven utility grounded in real world educational use.
- Larger community with associated project health benefits such as improved sustainability and shared knowledge
- Demonstration of the utility of open development of open source software and how it extends traditional knowledge transfer

Acknowledgements

The author would like to thank the University of Sheffield for funding this project under their Knowledge Transfer fund.

Summary

This joint project with BAES is expected to have a number of positive outcomes:

- Improved education experience for target students

PowerTalk – experiences from a small open source assistive technology project

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Abstract

PowerTalk is a simple example of open source assistive technology software which automatically narrates PowerPoint presentations. It was created several years ago in response to one person's request for a specific solution to their needs. Since then users across the world have found innovative uses for it education. This paper introduces PowerTalk, describes what has been learned and how innovation can be further improved by enhancing the open development.

Introduction

Innovation often occurs when someone is in the right place to put existing ideas together in order to create a new solution to a problem. Further innovation can occur when others take that solution and apply it other problems. This has been the experience with PowerTalk, a small Windows program that does nothing more than automatically narrate PowerPoint presentations as they are presented. It does this by combining the ability to control PowerTalk programmatically, along with Windows' synthetic speech system. Effectively, a small amount of code simply waits to be told some new text has been displayed and passes it on to the speech software to be spoken.

PowerTalk was created when the author read a request in Ability Magazine for help with giving a presentation. This request was from a presenter with aphasia who had difficulty speaking in such circumstances. Having just explored the relevant technologies it was a small step to combine them to create PowerTalk and solve the request in an innovative way. Since then PowerTalk has been used in other applications, such as audio book creation and reading children's own stories. This has been done by educators and support staff around the world.

PowerTalk as open source

The ease of adoption by others has no doubt been aided by the fact that PowerTalk is an open source program, meaning it can be freely downloaded, used and copied with no licence fees. These same benefits are also exhibited by so called 'freeware' software, which is quite distinct from open source. By being open source PowerTalk also provides access to the source code and so has the potential to be improved by others. It will therefore hopefully attract a community of users and developers collaborating in using and developing it in innovative ways. Further a diverse community working on open source allows the program to become sustainable, for example if the author no longer wishes to work on it, others can continue.

Such an open development community has not yet developed, other than the occasional private email to the developer with bug reports, feature request or 'letters of thanks'. Users have provided a download button for the website and some excellent enhanced instructions and the author is keen to encourage further contributions and collaborations.

After analysis, a number of possible reasons for the lack of community are suggested:

2. PowerTalk does one thing, namely speak a presentation as it is given, and is designed to be very simple to use. Thus users are generally happy with its operation and, in addition, the author resists adding features that would make it more complex to use.

However there is scope to improve its basic operation, for example in how it handles slide content and perhaps controls speech.

3. It is highly likely that the people using it do not distinguish between open

source and freeware. PowerTalk and other open source AT is effectively treated as low cost software that solves a need, and any problems or requirements require a passive request to be made to the developer. This misses the manifold potential benefits of becoming an engaged user actively participating in the project's community.

Addressing this is likely to be largely a matter of raising awareness and encouragement.

4. The author also works for OSS Watch, the UK open source advisory service for HE and FE, and has subsequently learnt much about open source and community development. It is clear that while PowerTalk was declared to be open source, in reality, little more was done than applying an open source licence, making it and the source code available for free download and creating some basic documentation. Community development is not easy and requires the provision of some basic 'tools' that help minimise barriers to entry for users, contributors and developers. None of these are complex or onerous to manage, at least while a project is small. Most of the tools are available in various project hosting systems and web services.

The next step is to provide these basics and hopefully allow more community action around PowerTalk.

Summary

While PowerTalk is a successful open source AT program with many happy users, there is room to improve the interactions with users and encourage others to contribute to it through open community development. Attracting a diverse community will also improve sustainability and should provide the conditions for more innovation in its use and design.

Open sources

- PowerTalk web site – <http://fullmeasure.co.uk/powertalk>
- OSS Watch website – <http://oss-watch.ac.uk>

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Student-based models for tiny-market assistive technologies: Early experiences and lessons learnt

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Abstract

This paper discusses the first-year experiences of assistive technology (AT) groups at the University of Toronto (U of T) in Toronto, Canada, and the Massachusetts Institute of Technology (MIT) in Cambridge, USA. Both groups are very new and evolving experiments, meaning that the viability of a student-group model for creating AT has not yet been proven. However, qualitative discussion of their challenges and successes to date could be relevant to students and faculty interested in similar groups elsewhere.

Introduction

For many people with a disability, gaps remain between their needs and what is available in the marketplace. Due to small markets and many other factors, commercially available AT is often unsuitable for many individuals – one systematic review showed that rates of non-use of recommended assistive technology was high across all studies, ranging from 35% to 87% [1].

Given these challenges, building student volunteer organizations that focus on appropriate assistive technology seems attractive – because economic incentives are not their primary focus, students could focus on tiny-market assistive devices. Many other groups that work on international development, education, and other socially important causes have been very successful in engaging students to make a tangible impact [2]. More broadly, student involvement in volunteer work during their university years has been shown to positively shape their sense of civic engagement over the long term [3]; working on AT, perhaps, could also spark their interest in disability issues while leveraging service-learning resources at many post-secondary institutions [4].

Student Group Profiles

Both groups described here are based in their respective universities' engineering schools, with slight differences in their structure and stage of development. Overall, they are inspired by community-based groups of volunteers that receive requests from people with disabilities and build customized assistive devices for people with disabilities, including the Tetra Society of North America [5], Remap in the UK [6], and TADVIC in Victoria, Australia [7].

Started in 2009, the student group at U of T is affiliated with the Toronto-area chapter of the aforementioned Tetra Society. Over the past year (September 2009-August 2010), the Toronto-area chapter has been involved in ten projects, ranging from a modified art easel to an adapted guitar. Students have been involved in some capacity in most of these projects, including as leaders in three of them [8].

Meanwhile, the MIT AT group launched in 2010, is currently independent of any external organization, and has two projects: adaptations to a cellular phone for a person with cerebral palsy, and an input device that will allow residents at a nearby specialized-care facility to access their environmental control facilities [9]. One goal for the coming year will be to enter these projects into the MIT IDEAS Competition, a year-long development and mentorship process to create and realize technological solutions that benefit humanity.

Key Successes and Challenges

The experiences of the U of T and MIT student groups have generally been positive, but not without challenges. These are summarized below, with planned courses of action.

Attracting Interest and Working on Projects

Both groups have attracted strong interest from

engineering students; after just a few weeks of existence, for example, the mailing list of the MIT AT group grew to 75 members. At both schools, meanwhile, a smaller, but significant, core of students (10 to 20) has actually become actively involved in projects. One illustrative success story at U of T was adapting an iPod to connect to a sip-and-puff switch; the project was completed successfully under the leadership of an undergraduate electrical engineering student. Similarly, the accessible cellular phone project at MIT has progressed rapidly with two graduate student volunteers as co-leaders. These projects have featured contributions and the close involvement of the end users themselves.

Key challenges to project completion include student inexperience with AT, the natural turnover of student groups, and hectic (albeit predictable) academic schedules at some points of the school year. To address these issues, U of T's group has benefited from the mentorship that the Toronto Tetra Society's volunteers have provided. The careful selection of project leaders, along with adequate support for them, seems to be a key element of the most successful projects so far.

An exciting development in both groups has been active volunteers who have a disability. The insights and experiences of these members have been valuable contributions to the groups. Qualitatively, they have helped volunteers to deepen their understanding of the issues and realities of disability and AT.

Engaging with Other University Groups

Both groups have found willing partners in other organizations with overlapping goals. The Tetra Society at U of T, for example, has had success in working with the Club for Undergraduate Biomedical Engineers – notably, an AT design competition in February 2010 raised awareness and attracted new volunteers. Along similar lines, the MIT Public Service Center has been an invaluable resource for finding volunteers, raising awareness, and funding projects.

Meanwhile, incorporating assistive technology into undergraduate engineering curricula is a longer-term goal of both groups. In these

efforts, practical considerations in terms of completing projects will be critically important. For instance, engineering courses often impose strict requirements, structures, or deadlines that may not match well with a request-based, user-driven model adopted by the two student groups. Careful project selection may be one approach that will overcome these challenges.

Conclusions

In their first years of operation, the U of T and MIT AT groups have begun work on customized assistive devices, attracting substantial interest and learning valuable lessons on how a student-group model can effectively serve people with disabilities. Both groups are still evolving, but these shared early experiences could be transferable to new groups at other schools. The progress of both groups can be followed online at www.tetragta.org and assistivetech.mit.edu.

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Ethical Considerations of How Monitoring Data Is Stored and Used

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Necessity and Importance

When new technology creates new capabilities of Information Communication Technology (ICT) products, the role of human users is evolving from a simple operator of a device or application into a participator during the entire operating session, whose real-time data is treated as input to the redesign of current system. Their private information some times is used to personalize a system (e.g. iGoogle), or as a reference for available services or those that might turn out to be potential interests (e.g. Amazon). Their habitual behaviours are used to rearrange the user interface (e.g. Microsoft Office). Even the content of their emails can be “helpful” to the system when generating sidebar advertisements (e.g. Gmail).

Adaptive interfaces supporting accessibility requirements is another example. One essential condition to be fulfilled to implement effective accessibility adaptations is accurate detection of a person’s accessibility needs [1]. Under this circumstance, users are actually treated as human subjects that are constantly monitored and analyzed.

Sus-IT is developing a semi-adaptive system automatically detecting and responding to changes in user capability. Acting as a helping hand for users with declining capabilities, it needs to have a more in depth understanding of its end user’s preference and capabilities, which means that potentially very sensitive data is gathered.

Monitoring Data for Semi-Automatic Accessibility Adaptations

For an automated or semi-automated adaptation system, it cannot be assumed that the content a user wishes to access has any meaningful accessibility information associated with it, and therefore adaptations must rely on measurements of user’s capabilities. There are standard models of

human capabilities [2], including some data on how these capabilities are affected by disabilities [3]. However there is currently a dearth of detailed and long-term studies covering the needs of people who may experience minor to moderate impairments (sometimes many simultaneously), and the effects of dynamic diversity on assistive technology effectiveness.

Our system collects users’ initial capabilities and preferences on interaction and detection routines via suitable questions and tests and monitors the changes of ambient parameters as well as user’s behaviour to determine which adaptations and further assistive devices may be required through time. Both of the initial and long-term information, if available to an individual, may adversely affect their personal sense of well-being and of independence, which in turn may negate the quality of life benefits provided by prolonged use of the Web supported by accessibility adaptations. Additionally, over time, a system that captures information about dexterity, cognitive capability and visual acuity may store data that could indicate a separate health issue unconnected with general age-related capability decline, or indicate that a person may no longer be safe to conduct activities such as driving a car. Though the purpose of the system is not trying to catch people out, but other parties might use these data to do such things. This raises many ethical considerations on the access and use of the data.

Storage of Monitoring Data

Ownership and life time

Holding portable data on users’ capabilities, preferences and performance histories allows adaptive system users to be quickly identified by any adaptivity-enabled device or service, and improves system efficiency and accuracy. Hosting information from a much larger

spectrum of end users also allows the system to provide suggestion and help to groups of users sharing similar profiles. However, how long and how well should both of the parties keep the data is a question to be answered when the user moves on to some other similar services. Should the system keep information on users that no longer use our service for the sake of reference accuracy? Can a previous user keep a record of activities including a list of suggestions generated by our system and provide them to other similar services/systems?

Access and maintenance

With sensitivity of data come security issues; and therefore an accessibility adaptation system that attempts to maintain an accurate profile of users' capabilities must do so in a way that shields the data from unauthorised access or use.

Monitoring data held by users could be made accessible to not only the users themselves, but other concerned parties, for example family members, carers and other supporting organizations. But does the fact that it is enabled necessarily mean it should? If not, would all of the above-mentioned parties be able to perform their roles adequately?

Data held by the system could be accessed by system technicians when additional analysis is required for decision making. Where do we draw the line so we can provide what is necessary at a certain stage without violating user's privacy?

Should logged data be made available to third-party systems our users may wish to access? Who should be responsible for any inaccurate or inappropriate decision made by that system but based on the data we provide? If that system discovers anomalies in the supplied data, should our system be informed and updated as well?

Use of Monitoring Data

In the current project

Adaptive systems make decisions based on logged data, regarding the user and context of interaction. Does the logged data belong to the system or the user? Should the user use the data under the system's consultancy? Should

the system use these data without informing the user? In addition, how much information is relevant and enough? Do we really need to know the user is travelling on a fast moving train with poor wifi to make some adaptation suggestion, or a bandwidth detection should be enough? Where do we draw the line between being helpful and violating their privacy? If a type of data is urgently required but quite private, should we still use it? What if it may not be immediately useful but might have future utility? If it turns out useless after all, what action should we take?

It is also possible for the system to analyze which device or application is suitable to purchase for the user or not. Do we have the right to negate third parties' work only because we believe we know users better and have their trust?

For other parties, projects and products

Should such an accessibility adaptation system have a responsibility to report this data to the user, and/or to other concerned parties? What if the data is used by them in a very different intention from the original system and in an entirely different manner [4]?

Since the system can detect the trend of the user's capability change, what if we decided not to inform certain parties for privacy protection, but it turns out that we should, because some serious health problem could have been noticed and treated in advance?

When these concerned parties use the monitoring data as secondary data, should they acknowledge us; make sure the use is acceptable by us, and not in breach of the original condition of collection? Should we be responsible to monitor the use of the data simply because our system captured it at the first place? If so, how far should it go?

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ACTION: why not in 290 municipalities in Sweden?

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Our presentation is concerned with the theme of commercialisation issues in the area of telecare services. The novel contribution of our presentation lies in our discussion of the main lessons we have learned regarding the transfer of the Information and Communication Technology (ICT) based system ACTION from a project to a mainstream service. There are still relatively few projects in the field that have achieved this transformation. We will give a short presentation of the key challenges facing the mainstream uptake of an ICT based service for older people with long-standing chronic conditions living at home and their family carers, called ACTION (Assisting Carers using Telematics Interventions to meet Older people's Needs) (www.actioncaring.se). ACTION arose out of an EU project (1997-2000) and became a service in Borås municipality in 2004. Currently there are 25 municipalities who are implementing ACTION. In total there are 290 municipalities in Sweden. In our experience the main challenges can be summarised as follows:

- Organisational complexity
- Attitudes of care professionals
- Support from all stakeholder groups
- Evidence
- Good business plan
- Policy
- Funding available

We will put forward the main lessons learned based on thirteen years of experience of working with the ACTION service. These insights will form the basis for discussion inviting the sharing of similar experiences or highlighting additional or different lessons learned from the audience. Our critical success factors can be summarised as follows:

- User-centred, participatory approach
- Research based service
- Ongoing support by all key stakeholders
- Commercialization of the service
- Innovative appeal and flexibility as a technology based service

Regulatory influences on assistive technology innovation: enabling or disabling?

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The Devices for Dignity Healthcare Technology Co-operative (D4D HTC) is an initiative supported by the English Department of Health National Institute for Health Research (NIHR) since January 2008. Its mission is to deliver innovative medical devices to support people living with long term conditions, which preserve their dignity and independence. To this end, the D4D HTC brings industry, academia, healthcare professionals and patients closer together. The Co-operative focuses on three areas, urinary incontinence, renal technologies and assistive technology (AT). Within its AT theme, there are ten AT-related projects underway or completed. Of these, five are developing products as a project output with three falling within the definition of being a medical device and two that are in the borderline area between medical devices and general assistive products.

When do EU Directives apply to assistive technology (AT)?

For the purposes of this paper, the definition of assistive technology used is that agreed by the King's Fund in 2001:

“Assistive Technology (AT) is any product or service designed to enable independence for disabled and older people”. (User group consultation at the King's Fund, 2001)

Many products to be placed on the EU market need to be CE marked. The CE mark gives the purchaser assurance that the product conforms to certain safety and performance criteria. The General Product Safety Directive (2001/95/EC) is the lowest level required. For more specialised products, or ones deemed to introduce higher risk, other directives apply. For example, electrical equipment operating between 50 and 1000 V for alternating current and between 75 and 1500 V for direct current,

the Low Voltage Directive (LVD) would apply (2006/95/EC), unless it was electrical equipment for radiology or other medical purposes for which other directives, such as the Medical Device Directive (MDD) apply.

Quite clearly with the broad definition of AT used above there will be many AT products that do not fall within the scope of the MDD. Unfortunately, there also many that fall within a “grey area” of uncertainty where it is not immediately clear whether the MDD applies or which alternative or additional directives are required. In the case of the five D4D projects introduced above, the three medical devices were: a wheelchair for paediatric use, a rollator and wheelchair accessory for applying traction when connected to a surgical halo.

Before a product can receive a CE mark, it must meet the “essential requirements” of the directive. In the case of the MDD this includes a clinical risk assessment. For all medical device classes (I being low risk and III high risk) there must be evidence to support the device's claimed performance and acceptable risk; this can be achieved either by critical evaluation of relevant scientific literature or, for novel devices or high risk devices, by a clinical investigation (i.e. a trial of the device). Where a trial is required, ethical approval is required and the trial conducted in accordance with the Declaration of Helsinki.

What does this mean for assistive technologies?

Generally, many of the assistive technologies that are also medical devices are in the low risk “class I” category. Here the manufacturer has the option to self certify CE conformance without the need of a Notified Body (accredited by EU member state approval body to assess conformance with standards). The manufacturer would need to have registered with the Competent Authority of its Member

State. In the case of the UK, this is the Medicines and Healthcare products Regulatory Agency (MHRA).

Where a class I device also has a claimed measuring function or needs to be supplied sterile then that element has to be assessed by a Notified Body. The recent recast of the MDD has new implications for Electronic Assistive Technology (EAT) or for tele-health or tele-care applications that are based on software.

EU Directive **93/42/EEC** is the Medical Device Directive which was amended by Directive **2007/47/EC**. The revised definition of a medical device is as follows:

5. 'medical device' means any instrument, apparatus, appliance, software, material or other article, whether used alone or in combination, **including the software** intended by its manufacturer to be used specifically for diagnostic and/or therapeutic purposes and necessary for its proper application, intended by the manufacturer to be used for human beings for the purpose of:
 1. diagnosis, prevention, monitoring, treatment or alleviation of disease,
 2. diagnosis, monitoring, treatment, alleviation of or compensation for an injury or handicap,
 3. investigation, replacement or modification of the anatomy or of a physiological process,
 4. control of conception,
6. and which does not achieve its principal intended action in or on the human body by pharmacological, immunological or metabolic means, but which may be assisted in its function by such means

The revision clarified that software placed on the market on its own could be a Medical Device if it satisfied the definition above.

In addition, a new Essential Requirement was introduced by 2007/47/EC from 21 March 2010: For devices which incorporate software or are medical software in themselves, the

software must be **validated according to the state of the art** taking into account the principles of development life-cycle, risk management, validation and verification.

This has led to the formation of a sub group of the EU Competent Authorities Borderline and Classification Working Group, the "working group on qualification and classification of software" to try to resolve uncertainties as to what is required and when it applies.

According to the MHRA (Gutowski, 2010), software that would fall under the MDD includes:

- *"Software that carries out further calculations or interpretations of captured patient data for a therapeutic purpose, e.g. radiation treatment planning, medication dosage calculations.*
- *Software that carries out further calculations, enhancements or interpretations of captured data for a diagnostic purpose, e.g. tele-health and remote diagnostics, mass screening and risk assessment tools, helpline/telephone services algorithms".*

When considering regulations, one of the first considerations for developers of assistive technologies should be: Does my product have an intended diagnostic or therapeutic purpose?

Traditional assistive technology (AT) includes wheelchairs, rollators and prostheses, where it is clear that the product has a therapeutic purpose. However, with emerging forms of AT, particularly within the field of tele-health and tele-care, the complexity of some systems and the potential for different means of usage has led to uncertainty as to which regulations apply, because often the intended purpose and usage of the product or system is open to interpretation. In addition, where telecommunications equipment is involved, additional EU directives will apply. The recent recast of the medical device directive has led to further confusion in extending the scope to include software in its own right. There is not a single standard but several that

impact on software e.g. risk management, software development, validation of software, device life cycle.

The Continua Alliance is working to establish a system of interoperable personal tele-health solutions and is collaborating with government regulatory agencies to “provide methods for safe and effective management of diverse vendor solutions”.

Case Study

Novel Dignity Bidet Commode

The Dignity Commode is a powered system that integrates a commode with a bidet unit (wash and dry capability) plus a heated seat. It is intended for those unable to self-clean independently due to disability or poor dexterity.

Is it a medical device?

The crux is in the definition of “therapeutic purposes”. Clearly the device is intended to compensate for a disability or injury. A recent MHRA (2009) guidance document states the determining factor to be “*whether or not there is a direct link between the corrective function of the equipment and the individual concerned and that there is a stated medical purpose*”. In this case, toileting and the compensation to be able to self-clean, was not interpreted as being therapeutic, and thus the commode is not a medical device, which was the final view from the UK Competent Authority, the MHRA, at the highest level.

However, EU Low Voltage Directive (2006/95/EC) does apply to the bidet commode system. Although it is not a medical device, it is also wise to apply standards such as **BS EN 12182:1999** (Technical aids for disabled persons. General requirements and test methods) to avoid issues such as genital traps or mechanical failure of the frame.

Standards Information

A useful source of information for potential relevant test standards is the International Standards Organisation web-site. Here the

standards are classified by technical committees (TC). There is a specific TC (TC 173) suitable for AT developers, the “Assistive products for persons with disability” TC and it encompasses 69 different ISO standards.

Developers of assistive technologies that seek to improve their products by involving patients and users may choose to incorporate user-centred design, which focuses on making products usable by putting users at the heart of the design process. This is one area where the need for ethical approval can impinge adversely. A manufacturer can ask users for their opinion on a device once it has been CE marked (i.e. it has been placed on the market) but this is too late if design changes are then identified. Ideally, users should be brought in to the design process early on. Care needs to be taken as users should be using a non-CE marked device or product. If it is a medical device, a clinical investigation would need to be registered with a Competent Authority (with ethical approval) to permit a non-CE marked device to be used. In these cases, structuring a study such that the product is not used for its intended purpose can permit aspects of the products (e.g. certain components) to receive user feedback on likely usability without the need for a registered trial. However, ethical approval would still be required if users were recruited through the NHS or Academia.

Conclusions

The regulatory influences are in place to protect consumers of healthcare products. Similarly, the use of standards and conformance with EU directives also gives manufacturers confidence that their products are fit for the market. However, in doing so, there are times where the regulatory processes, particularly those associated with ethical approvals, slow down innovative development.

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Knowledge Transfer for a Technology Based Intervention in The Self Management of Long term Conditions

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Introduction

Self-management encourages a person with a long term condition (LTC) to solve problems, take decisions, locate and use resources and take actions to manage their condition. It is perceived as being a significant way of achieving reduction in health care costs and promoting the quality life in people living with a LTC. The SMART2 (Self Management supported by Assistive, Rehabilitation and Telecare Technologies, 2008-11) project is developing a Personalised Self Management System (PSMS) for use in the home environment and in the immediate community for people living with the following LTCs: stroke, chronic pain and congestive heart failure (CHF). The PSMS uses mobile and sensor based technologies to monitor a person's activities and lifestyle, including: daily activities (through physical activity), vital signs and self reporting, and provides feedback regarding how they should make adjustments to minimize the impact of their LTC. In addition, the PSMS provides feedback about how well a user has achieved a set of target goals. These goals will have been established in conjunction with their therapist/healthcare professional. The core technology components of the PSMS consist of a touch screen PC which acts as the central home hub, a smart phone (HTC Touch HD), a web portal for healthcare professionals/therapists and a server to provide a central repository for data storage and processing. We are also investigating the use of pressure sensors in an insole to monitor balance and gait parameters, which can provide useful information for stroke rehabilitation. There is also the future possibility of utilizing sensors in the environment such as contact door sensors, bed pressure sensors and passive

infrared devices to provide contextual information in addition to devices capable of measuring vital signs such as blood pressure, heart rate and weight. Technology choices and interface design have been guided by systematic literature reviews and interaction with user [1, 2]. A mixed methodology for interacting with users has been adopted, which uses qualitative methods comprising focus groups, one-to-one in-depth interviews, non-participant observation and application of cultural probes [3]. The overall aim has been to gain an understanding of the needs and preferences of the potential users; both people with LTCs and health professionals. The approach allows the researchers to understand the users' motivations in performing a task [4].

Knowledge Transfer Between Domains

A significant challenge in the development of assistive technology within a multi-disciplinary consortium is the process of transferring knowledge from the domain specialists to the software developers and engineers. In SMART2 we have expertise across the clinical domain in three LTCs (stroke, chronic pain and CHF), and significant knowledge and expertise in human computer interaction, software engineering, multimedia design and use of assistive technologies. We have identified the following two components to building a shared knowledge for the purposes of this project:

1. The development of a technical/user specification, suited to users (both therapists and end users). Our methodology involved a number of steps: the development of 'scenarios' appropriate to the symptoms and management of each LTC, the establishment of a shared concept and philosophy document, the agreement on human computer interaction

principles, and the iterative development of conceptual and working prototypes honed by domain experts.

2. The acquisition and presentation of the knowledge for the delivery of validated therapy, remote from the therapist. This involves the identification of appropriate information and the delivery of this information in a way appropriate to the technology platform (fixed, mobile), user interface and preferences of users. The ability to make this information personalised and sensitive to context presents a further challenge [5].

Significant progress has been made on the first component and the approach may have wider applicability for other multidisciplinary research and development. The prototype development has been informed by therapists and end users, as part of a formative evaluation process. The final year of the project will involve a realistic evaluation [6] of a final prototype in people's homes. Some progress has been made on the second component and this will be further addressed, as the project continues.

Technical Specification

User requirements were elicited from focus groups with healthcare professionals from each of the three LTCs: stroke, chronic pain and CHF. Each focus group consisted of 5 to 11 healthcare professionals and patients. These groups were part of a three-phased iterative process consisting of assessing user needs, technical development and user evaluation [7].

Low Fidelity Prototypes

Initially we used paper prototypes in order to begin the process of achieving a common understanding of self-management issues pertaining to each LTC. At management meetings a parallel technical stream was organised to facilitate face-to-face interaction between the research assistants working on the project. Regular electronic communication was maintained using email, online document management systems and scheduling of meetings. These initial 'low fidelity' prototypes were complemented by more detailed computer based scenarios, one per condition, to provide common goals for the research team, but also to communicate

SMART2's objectives to the wider community. Mary's story, as depicted in Figure 1, highlights the potential use of the PSMS to provide rehabilitation for a person with stroke (e.g. sit-to-stand exercises to rehabilitate foot drop). This concept was realized as an interactive movie developed in Macromedia Flash [8]. Daniel's story illustrates chronic pain management by using the PSMS to facilitate activity pacing to smooth the common 'rollercoaster' profile of bursts of physical activity followed by inactivity, and hence accommodate the pain that should be endured in pursuit of agreed end goals. Albert's story provides a typical scenario for a person with CHF. In this case the PSMS includes devices for tracing vital signs, and thus attempts to prevent deterioration of the condition. SMART2 will also provide reassurance for people with LTCs, by using the mobile device to track location and duration of activities, and provide appropriate feedback and advice.



Figure 1: Example of user interaction in a Stroke scenario

A 'concept and philosophy' document was drawn up to provide a statement of the design philosophy and a definition of the functional and user-centred requirements. This included a statement of design principles and sources of evidence used for design decisions concerning the form, function, visual and interactive elements of the system. Top-level functions from the user perspective are: Install and set up; Enter/revise/review personal details; Define therapeutic programme; Undertake daily activity programme; Study information and education materials supporting therapeutic

programme; Periodically review progress through programme. The therapeutic programme comprises the determination of clinical needs, therapeutic model, life goals, and a programme of exercises. The daily activity programme may be subdivided as: enter health data, choose activities, carry out activities and receive feedback about progress, and review daily progress.

Human computer interaction principles

A number of usability issues were addressed.

- 1) Accessibility issues for user groups. These include age, eyesight and motor abilities. The diversity of users demands the adoption of system interaction, which can be tailored to an individual's accessibility requirements.
- 2) Digital literacy. The system is designed for a user who is not a computer novice but is someone who will never be an expert user.
- 3) Experience goals. To sustain self-management it is important that the system motivates the patient to engage with therapy and that it does not stigmatise the person.

A number of user goals follow from this. The PSMS should be easy to use, learn, and remember, be fun to use, and self-reinforcing. It should present only a minimum level of obtrusiveness into daily routines. Therapy content and interaction styles should be personalised, including, therapy exercises, symbols and displays, personalised input and output and messages.

Development of prototypes

The design methodology required three phases of real world prototypes, motivated by the human computer interaction principles, and user input from workshops. The scenarios were the result of in depth qualitative research using narratives of the chosen conditions. Each prototype comprises a number of interaction and feedback screens for each condition across both the home hub and mobile device platforms. Figure 2 illustrates the style developed for prototype 1 for the condition of stroke. The metaphor included a fingerprint to indicate that the user should touch the screen, a clockwise progression from end goals to progress screen, and a colour coding for each screen. This style was maintained across all LTCs. Based on user feedback, and the ability to develop effectively using computing

technology (Java, Flash for home hub, C# for mobile), a more geometric style evolved for prototype 2. Colour coding and circular progression were maintained, see Figure 3.

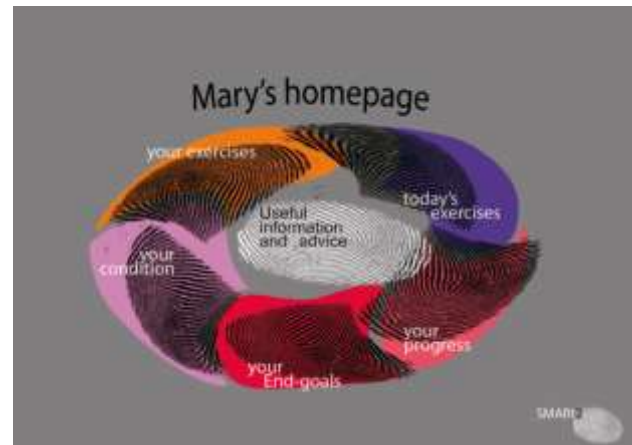


Figure 2: Stroke prototype 1 home screen



Figure 3: Prototype 2 home screen (home hub with mobile)

At present we are in the latter stages of development of the second iteration of a prototype for each of three conditions being addressed within the project. To date a user evaluation of the UI has been carried out to ascertain the usability of the stationary (touch screen PC) and mobile (Smartphone) components of the system. These will inform the final system which will undergo extensive user trials.

Acquisition of Domain Knowledge

The acquisition of knowledge from domain specialists to allow for the delivery of therapy, remote from the therapist, currently provides a significant challenge. In the stroke domain, the use of video provides obvious support for self directed rehabilitation. Video exercises of sit to stand for example, are complemented by

textual explanation. Figure 4 illustrates the use of a simple documentation management techniques using ‘track changes’ and ‘comments’, whereby information of sufficient clarity could be agreed between a domain expert and a multimedia author for computer delivery. The technology team and clinical partners carried out face-to-face paper based walkthroughs for each condition. This helped eliminate any misunderstandings within the development of the specification. Initial therapy content has been provided, but ideally this must be personalized and linked to context. The therapy content for Pain and CHF are currently under investigation.



Figure 4: Collaborative development for stroke therapy content.

In support of life goals, encouragement messages and feedback are provided to patients on both the home hub and mobile device. The feedback depends on acquired data: vital signs, activity monitoring and self report. Over a longer period of time a larger set of data can be analysed which will facilitate the accuracy and benefit of the decision support system and potentially contribute to domain knowledge.

Discussion

Research Councils are encouraging interdisciplinary projects. Multidisciplinary consortia are vital to the development and real world adoption of assistive technology. There have been many high profile projects in health informatics, which have failed to include relevant stakeholders, often resulting in systems, which have not been adopted by users. In this paper we documented the SMART2 methodology for knowledge transfer from condition specific domain experts to computer programmers and engineers and most significantly end users. Of course, there

is much common knowledge to be shared across conditions as we attempt to provide generic solutions. Nevertheless, we have also found that meeting the needs of people with each LTCs demanded further requirements, increasing development time beyond that originally anticipated. The technology: both hardware and software is at a high state of evolution, but is not yet mature e.g., a solution developed for the home hub (Flash), cannot be directly ported to the mobile device (C#), again adding to development complexity and time. Capturing domain knowledge has also proved to be challenging. Clinical guidelines and other content has been identified but providing personalised, ‘context aware’ information provides a challenge that can only be addressed in the later stages of the project. Thus we have encountered issues, both technical and managerial, that pose a risk to this type of development. Our approach, based on involving users (health care professionals and end users) from the beginning provides us with encouragement that the PSMS will be relevant and will be attractive to industry and health care commissioners.

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Methodological considerations in the evaluation of technologies, drawing upon the experiences of the SMART projects

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Introduction

This paper draws upon our recent experiences of evaluating prototype systems for Telerehabilitation (SMART1) and for self management (SMART2) (www.thesmartconsortium.org) and considerations regarding how to take forward prototype devices into mainstream practice. Funding available for the SMART projects has enabled both formative and summative prototype evaluation. However it has not extended to examination of population based effectiveness, which is the evidence most often sought by health commissioners. Our experiences mirror those of other researchers involved in developing and testing systems for Telerehabilitation and Telehealth and are exemplified by the plethora of small scale studies that are reported compared to a relatively modest number of large studies. This paper suggests a process for the evaluation of prototypes which can provide the necessary underpinning for future robust evaluation and also might facilitate future data aggregation.

The current evidence base for Telehealth Enthusiasm for the embedding of various forms of Telehealth systems within services continues to gather pace. Furthermore, interest in technology for remote rehabilitation (Telerehabilitation) is accelerating, with the future use of these devices within services being anticipated. However the extent of technological development that has taken place over recent years has not been matched by investment in evaluation. The evidence base, where it exists is dominated by small scale pilot and qualitative studies and there is a paucity of generalisable evidence. This is confirmed by Whetton [1] who examined the results of several reviews of Telehealth

evaluations and identified eight shortfalls in reported research including ‘insufficient or inadequate data to substantiate claims’, ‘a focus on pilots and/ or short term perspectives with limited analysis of long-term or routine use’ and ‘a focus on descriptive rather than analytic evaluation criteria.’

The evaluation ‘challenge’

There are a number of challenges in ensuring thorough evaluation of Telehealth. The first involves producing reliable technology which has been devised out of consultation with users. If this is not achieved, issues such as malfunction or poorly designed features will override other considerations and adversely impact upon the experience of all users. Once stable prototypes have been constructed and subjected to small scale evaluation, the second challenge is to reproduce the prototype for larger scale evaluation. This is unlikely to be achieved through R&D funding and consequently demands industrial involvement. Not surprisingly, manufacturers are reluctant to engage if adoption in practice is not guaranteed. The recognised methodology to determine population benefit is an associated challenge. This places the trial methodology at the top of the pyramid with qualitative studies of individual views and experiences being placed much lower. UK decision makers continue to base their judgements upon systematic reviews such as those produced through the National Institute for Clinical Excellence, with trial evidence being considered to be the most reliable evidence. Confidence in trial methodology is also exemplified by the UK government investment in the Whole Systems Demonstrator Programmes of research into Telecare which are using trial methodology concurrently in three sites the UK, aiming to involve 5,000

subjects (www.wsdanactionnetwork.org.uk).

However it is well recognised that this methodology has limitations.

The paradox of the clinical trial is that it is the best way to assess whether an intervention works, but arguably the worst way to assess who will benefit from it. Mant et al, [2].

These observations are magnified for complex interventions like Telehealth/

Telerehabilitation where the issues that determine success extend far beyond the technology to the individualised service systems within which the technology is to be used, including the knowledge and experience of the staff and whether or not the device is accepted and then used by patients.

Nevertheless it is also true that reliance upon qualitative studies does not provide confidence in the ability to generalise benefit to a wider population. The longitudinal retrospective study is another method of examining population benefit. This demands very large scale implementation and robust data collection methods instigated from the outset and continued throughout.

The technology evaluation process

The first challenge posed above demands extensive research investment and expertise. The process we used for the SMART1 project which involved technology for upper limb stroke rehabilitation and are currently using for the SMART2 project (personalised technology for self management) involves the following:-

(1) Formative evaluation

For both projects an extended period of formative evaluation was deemed essential whereby user views and design expertise fully inform prototype design. This has required user centred design researchers, clinical researchers and technologists to work together on every iteration of the prototype. The process has been shaped by the involvement of the intended end users of the device (patients, their carers and professionals) from the outset. For the SMART2 project we have structured this process as follows;

- a) Paper prototyping of device features by designers based upon user views and perspectives

- b) Incorporation of paper prototyping into the build of a first prototype
- c) Use of cognitive walkthrough techniques by clinical researchers as a first stage evaluation of the prototype (not specifically with end users). This involves asking the subject to observe and use the device with identified problems being immediately conveyed to the technologists to correct in a subsequent prototype.
- d) Cooperative evaluation of the corrected prototypes with end users which involves asking them to use the device and voice their progress with the task, thus identifying design issues [3].

The process is continued until the optimal design and functionality of the device is reached including reliability in practice.

(2) Summative evaluation

For both the SMART1 and SMART2 projects, resources were also allocated to summative evaluation of the final iteration of the prototype. The case study, case report, single case experimental design and pluralistic realistic evaluation are all accepted methods of undertaking this form of evaluation. Each of these methods uses a mix of quantitative and qualitative methods to collect multiple observations of the attributes of the device and its use as well as the social and environment factors that may have an impact upon usage. For the SMART1 project, this evaluation comprised of a series of single case studies. Within each case acceptability of the device by the individual users and carers was explored through qualitative interview and by collection of quantitative data on parameters which would provide an early indication of its clinical effectiveness [4]. However it should also be noted that the original timeline for evaluation of the SMART1 device was curtailed by the time taken to construct a reasonably stable prototype.

Summative evaluation of the SMART2 is due to commence in 2011. The evaluation lead (2nd author) has identified that a realistic evaluation framework, proposed by Pawson and Tilley [5] is the most appropriate methodology to use even though it is intended for programmes of research rather than small evaluations. Implementation of the framework

is shown in Figure 1.

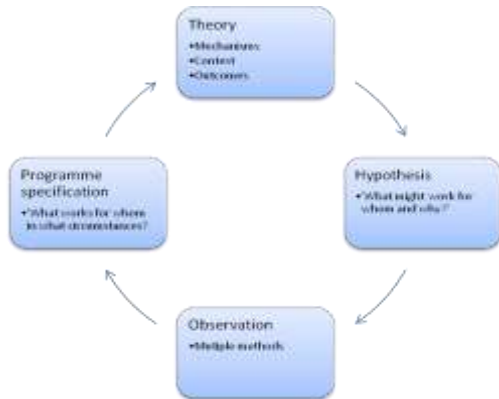


Fig 1: Realistic Evaluation Framework, Pawson and Tilley 1997

The principles suggested by Pawson and Tilley allows the investigation of the mechanisms involved (for SMART2 this are dimensions of self management) and how these relate to the eventual outcome.

The initial stage involves exploring the theory and evidence for the underpinning mechanism, also enabling the researcher to set out a study design and the research questions regarding what might work for whom and why. This is then followed by multi-method fieldwork involving multiple stakeholders in a number of settings. The final aspect of the research cycle involves the analysis of the data; *‘what works for whom, in what circumstances and why.’*

(3) Population based evidence

In acknowledgement of the many variables which have to be taken into account in the evaluation of complex interventions, The UK Medical Research Council (MRC) have produced an updated framework for evaluation of complex interventions (through randomised controlled trials) which places greater emphasis upon the development, feasibility and evaluation phases [6]. The four elements within the framework are shown in Figure 2.

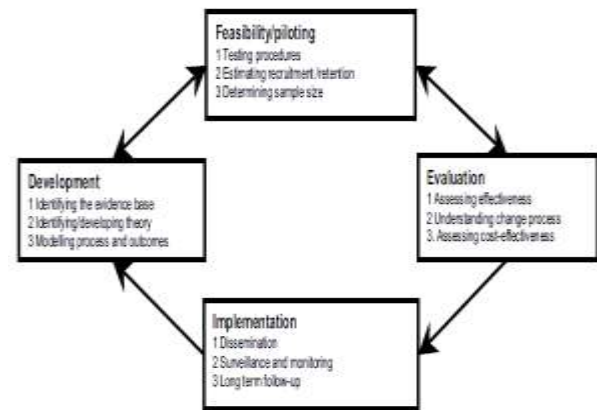


Fig 2: Key elements of the development and evaluation process (MRC 2008)

The new framework recognises the need for early testing and the importance of contextual factors;

“external clinical evidence can inform, but can never replace, individual clinical expertise, and it is this expertise that decides whether the external (formal) evidence applies to the individual patient at all and, if so, how it should be integrated into a clinical decisions.” [6].

The MRC propose that work on development and feasibility/ piloting should be undertaken prior to population based evaluation. These two phases are convergent with the methods previously described for the formative and summative evaluation of prototypes, thereby providing the underpinning for robust evaluation within this framework. The next step should therefore entail industrial partnership and the acquisition of further project funding to enable the replication of prototypes.

Discussion

A considerable body of technology development remains in the laboratory rather being tested in practice and it is speculated that many good ideas have not been taken forward. We consider that the work on formative and summative evaluation used for the SMART projects is fit for purpose in ensuring that technology is usable and accessible, and in providing evidence of association to support or refute a-priori theoretical assumptions. However the final challenge of how to move towards demonstrating population based benefit

remains. As Whetton and others have already identified, a common evaluative framework for Telehealth technologies would assist in the aggregation of data and enable wider conclusions to be drawn and we propose that the MRC framework provides this opportunity. A final caution however lies in the ability of established health systems to accept devices in practice. Our work to examine the clinical and cost effectiveness of one established Telehealth system confirms the need for significant investment to ensure that technology is understood, accepted and adopted before any further evaluation can take place[7].

Conclusion

The push to incorporate technology into health and social care continues unabated. However, if new technologies are to be successfully adopted by practice, and in particular those technologies classified as ‘medical devices’, evidence of population based clinical and cost effectiveness is essential.

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Partnering with AT companies and Including Users in a User Centred Design Ethos

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Abstract

It has long been recognised that the most usable technology will involve a range of stakeholders in the design and development including end users, their associates and any professionals in the field. For researchers working in the field of assistive technology this presents additional challenges. This paper describes some methods of working with adults with complex communication needs in the design of technology.

As much of the cutting edge research in the field of augmentative and alternative communication is taking place in the academic environment it is vital that researchers and assistive technology companies find ways to communicate and work together. Work done at the University of Dundee's School of Computing has shown that it is possible to work with all of these stakeholders and this paper provides guidance for others wanting to do similar work.

Introduction

Augmentative and Alternative Communication has the potential to greatly improve the lives of people with Complex Communication Needs (CCN) by allowing them access to shared communication.

Assistive technology, in particular Augmentative and Alternative Communication (AAC) technology is a varied multidisciplinary field. The field is comprised of medical professionals, speech and language therapists, teachers, carers, software engineers, technical engineers and the end users themselves and their families.

The benefits that assistive technology has the potential to bring to users are clear but the rates of users giving up assistive technology are high. The figures reported for the lack of success vary widely from 33% [1] to 53.3%

[2]. There are many reasons reported in the literature for why technology is successful or unsuccessful [3].

It has been suggested that a lack of user centred design may contribute to the poor adoption of technology [4].

The Challenge of working with different Stakeholders

Good design can only be achieved by all of the stakeholder groups working together. The varied nature of the stakeholders in the field of AAC can present difficulties to academic researchers who wish to develop AAC devices.

Academics and researchers wishing to work with assistive technology companies may also face challenges such as deciding what point to work with the companies and how to balance a company's wish to keep all of their developments private and a researcher's need to produce papers describing their recent work.

Papers on the topic of involving end users with complex disabilities, in particular those with CCN, in user centred design have discussed the problems that can occur when attempting this. These can include difficulties in getting users to communicate their thoughts, balancing conflicting requirements between users, traditional methods in software development may not be suitable for these users, there may be problems in gaining informed consent from users with CCN and there may be difficulties in finding representative users to be involved in the process [4].

Work done at the School of Computing, University of Dundee has investigated how these issues can be addressed to allow better devices to be designed.

Working with Adults with CCN

The CHAMPION project has investigated methods for involving adults with Complex

Communication Needs in active participation on the design of technology. For the purposes of the project participants were asked to assist in the design of a piece of information sharing software for use in hospitals. 4 adults with CCN and a member of their support staff took part in the user centred design process.

The first challenge when working with adults with CCN is the recruitment of participants and ensuring that informed consent to participate in the project is taken correctly.

The usual method of recruitment of participants for design or research would be to: put an advert in a local newspaper; put an advert in the university wide email or contact organisations for contact details of members and contact them directly.

However, these methods are not best suited to working with adults with CCN. The research did not want to distress participants by inviting them to take part, then discover that they were unable to consent and have to tell them that they could not actually join in. It was also felt important to ensure participants did not feel unduly pressured into agreeing to take part.

It was decided to make contact with a local centre for adults with complex disabilities and provide them with details on the study. The management then provided a member of staff to be the liaison on the project. The researcher met with the staff member and gave further study details and asked them to consider potential participants. The staff member discussed the project briefly with participants and with their consent arranged a meeting between the participants and the researchers.

In this meeting the researchers went through the Participant Information sheet with the participants, discussed the activities they would be invited to take part in and what their rights in the study were.

The participants were encouraged to ask questions and were then taken through the modified consent process. This process asks participants a series of yes and no questions based on their rights in the study to ensure that they correctly understand what they are agreeing to.

Throughout the CHAMPION project

participants took part in a variety of activities in design of the software. One of these activities was the paper prototyping of the software.

Paper prototypes are usually sketches by the designer or participants, using these sketches a user can 'press' a paper button and then be shown what would happen as a result of that. The problem in carrying this out with participants with CCN is that the participants are not able to easily draw or reposition paper items from a sketch. The participants needed something more tactile and colourful to engage them and help with any sensory impairments.

The other requirements for the paper prototyping was that the objects in the process were large enough to be moved around on the prototype screen. To facilitate this large pieces of foam were cut to shapes representing objects on the screen and magnets attached to the back of these. This allowed the researcher to place objects on a screen sized magnetic white board and present this screen to participants at an angle in front of their wheelchair. Participants were then asked questions such as "How do you think you would let the computer know you wanted to save a picture for your information? Right can you show me how you would do that?".

Participants then commented on what they liked and didn't like about the screen and were encouraged to move the objects to positions that made more sense, ask for the text on the object to be reworded or to ask for the size of the object to be changed.

Participants reacted positively to the session which showed early design problems. Although users might wish to use a touch screen, they weren't all able to use a finger to point and used the side of their hand; this meant buttons, lists and text boxes all had to be bigger. It also showed that the text on buttons was too technical in language and that two of the participants would need text read out to them. Participants were able to offer negative and positive feedback and suggest features that should be changed and features that should be added.

Other methods throughout the software development process were also adapted.

Throughout the process participants demonstrated their ability to be active participants in the design of software. One key factor in being able to work closely with the participants was ensuring a good relationship with their support staff. Support staff were key in helping to organise design sessions and being willing to take time from their own work to support the participants in the sessions.

The CHAMPION project has demonstrated that it is possible to include adults with CCN and their support workers in the design of assistive technology and that this involvement has positive effects on the design of the software and on the self esteem of participants taking part.

Working Children with CCN

A number of projects at the School of Computing that were concerned with AAC for children with CCN have included expert users such as therapists and school staff as well as the end users right from the start of any system development. Staff at special schools were involved in the planning and execution of research tasks. Participating children were chosen in collaboration with staff with the aim of providing a valuable alternative to any time missed at school so participants would benefit from the research tasks.

Ethnographic studies in the environment of the users, early feedback and input into interface design using mock-up prototypes and semi-structured interviews with additional support such as Talking Mats™ can assure that most of the needs of the users are met by the new system.

The additional challenge when working with children is to make all research time constructive and valuable for the participant. Any time spent away from educational or training activities for research needs to provide an equally educating and training alternative.

Working with AT Companies

A main aim of any research that looks into the efficacy of technology should be to facilitate the transfer of results into products for the end consumer. This is particularly true for niche markets such as AT and specifically AAC. The

establishment of dedicated institutions such as ATCare who specialise on this transfer shows that there is a need to support the process from the beginning.

Involving AT companies as early as possible

In order to shorten the realisation process AT companies should be involved as early as the proposal stage or even preceding pilot studies. Collaboration with industrial partners provides a number of advantages to the researcher:

- Provision of Equipment
- Feedback
- Contacts to potential participants and institutions

Choice of collaborator

Industrial collaborator need to protect their intellectual property (IP) and hence working with more than one industrial collaborator might not be possible. Putting a non-disclosure agreement on company/university level into place is standard procedure, protecting both partners. This makes it important to find the right partner from the start who is likely to support the researchers' ideas. A later change of collaborator is likely to impose problems concerning the exchange of knowledge gained during the preceding research.

Reciprocating benefits for research and industry Improved efficacy has a direct effect on the market value of products. Information from both sides – consumer feedback through industry and participants' feedback from research – can, if taken on, have a direct impact on the usability and in fact usage of the technology.

Conflict with research funders

Special care needs to be taken to comply with the research funder's policy. In general research funding is not available if it is likely to mainly contribute to a single companies R&D budget.

Discussion

Interest in the field of AAC is increasing and a growing variety of researchers from different disciplines are now undertaking research into the development of devices. In order for the best possible devices to be created all of these

different disciplines need to work together.

One problem when different disciplines work together is finding common language through which to communicate. Different disciplines attach different meanings to words such as “evaluation”, which to a Human-Computer-Interaction developer means “a continuing process looking at how well a design is developing”, while to a medical professional means a standardised and measured of a completed project.

It is important that time is devoted to developing a working relationship between the different disciplines to avoid misunderstandings and help good communication to exist between the disciplines.

For work with participants with CCN in design to be a success, careful planning must take place to ensure that the environment in which the sessions is taking are suited to the tasks and that participants will be able to understand what they are doing.

There is now a growing awareness of the value in including participants with disabilities in research around technology which both may have an effect on interventions for people with that disability and also in research involving the general population.

Participants with CCN may have a range of other disabilities that have the potential to impact on their ability to participate in design, however with proper planning and consideration the impact of these disabilities can be reduced.

The decision to work with assistive technology companies is a significant one and careful thought must be given to how the company will be involved. A research team should give careful consideration to which company they wish to work with.

When planning a project, a team wishing to work with AT companies should include additional time into the project plan to allow for this.

It is also helpful for the research team to consult with their research funders and their university’s legal research services to discuss

the implications of working closely with a corporate company.

Conclusion

There are many challenges for those wishing to work with all the stakeholders in an AT project. When working with end users the resources and time needed will be greater than a project that does only includes ‘traditional’ participants. However, the benefits of including the end users in development are clear and if this inclusion results in a reduction in the high rate of abandonment of AT then this will be time and money well spent.

Time spent carefully working with assistive technology companies can potentially help a research product get to market sooner, but this too has to be carefully managed and planned for.

The advice provided here comes directly from the experiences of researchers at the University of Dundee’s School of Computing and should be used alongside researcher’s own experiences. The process of working with all stakeholders in design is not yet complete but this work gives suggestions for starting points.

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Devices for Dignity in Practice

Collaborative working to achieve technology transfer

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Introduction

Devices for Dignity is one of two pilot Healthcare Technology Cooperatives (HTCs) set up in January 2008 as a result of the UK Health Industries Task Force report [1]. The principle for HTCs was to bring together NHS professionals, industry, academia and end users to create 'technology pull' into the NHS. D4D has the mission:

"To deliver innovative medical devices to support patients with long term conditions, which preserve their dignity and independence."

D4D has three main themes, Renal Technology, Urinary Continence and Assistive Technology. This paper will focus on examples from the Assistive Technology theme however the same principles are applied across the three themes within the D4D HTC.

D4D has projects on its portfolio which are at different levels of development, ranging from unmet needs with no current solutions through to building an evidence base to aid adoption and dissemination of a device. Figure 1 illustrates the cycle of development considered by D4D.

The early stage of this cycle considers articulating and identifying needs for development. With the aim of achieving 'technology pull' rather than 'technology push' understanding the need for a device is essential. In addition key to D4D's philosophy is user involvement and we look to identifying needs or collecting evidence of needs in conjunction with users.

Having identified unmet or unsatisfied needs there is a requirement to prioritise these in order to work towards a solution. Again utilising the evidence from user involvement can enable prioritisation of needs.

The next step is to take the identified specification and develop a prototype, or

number of prototypes. Within this stage D4D's methodology is to adopt an iterative process of evaluation, development and re-evaluation.

The stage of evaluation within the development cycle (figure 1) refers to the evaluation and testing of a final prototype or a commercial product. We would also consider there being evaluation when identifying needs, prioritisation, prototyping, acceptance and post market surveillance.

D4D's philosophy is not only to develop new devices, for identified unmet needs, but to ensure that these devices do become available to users when developed to an appropriate level. The stage of acceptance and uptake is to consider carefully how a device will get to its target audience to ensure that successful research equipment moves from the laboratory and reaches its intended market.

D4D are aware that technology is continually changing and therefore post market surveillance or knowing which devices are currently available to solve a need, is essential. This surveillance is needed both within D4D's three themes, and outside of them to ensure we recognise technology which is being developed for a different purpose but which could impact on healthcare.

Within the Assistive Technology Theme we have identified 'clusters' of projects. These 'clusters' are not isolated and our approach encompasses projects influencing each other and knowledge being shared across projects and themes. These 'clusters' however enable the key areas within the Assistive Technology Theme to be clearly identified and also enables the theme to consider the distribution of projects across the stages of the process described to ensure a balanced portfolio of projects.

This paper presents, using four case examples, to demonstrate how the D4D approaches projects and facilitates the innovation process.

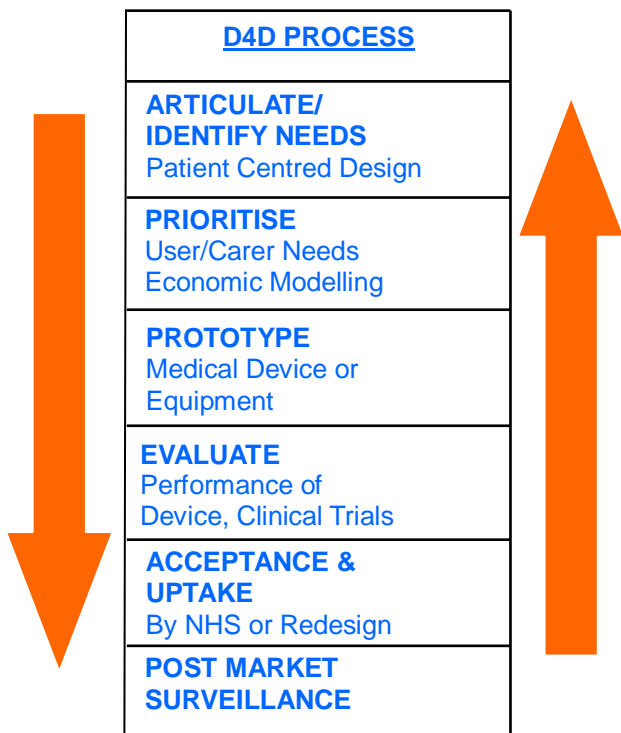


Figure 1 : Devices for Dignity Generic Device Development Approach

Case 1 (Articulate/Identify Needs Stage) – Augmentative and Alternative Communication – Identifying current user perceptions of AAC

The Assistive Technology Theme of D4D has identified that in the field of Augmentative and Alternative Communication (AAC) there is a need for more user involvement in the design and development of communication aids. There is limited evidence identifying that this lack of user involvement could contribute to high levels of abandonment [2], and also evidence highlighting the complexity of devices [3]. D4D also identified that there had been little research into users’ perceptions of current communication aids or identification of key user requirements for future devices [4]. A research project was undertaken to look at users’ opinions and requirements with the aim of this initial work directing future research and device development within D4D.

The primary research objectives were to perform an exploratory study to:

- (i) identify what users of Voice Output Communication Aids (VOCAs) want from their devices, and
- (ii) establish which factors contribute to the perceived success and dignity of use of these

devices.

This project took a mixed methods approach with questionnaires being distributed across the UK and qualitative face to face interviews being conducted within South Yorkshire. 64 professionals and 43 communication aid users completed the questionnaire and 18 interviews were undertaken. The following priorities for future work were identified:

- The need for decision making tool to enable communication aid users to be more involved in the choice of communication aid for them – a prototype of this has been developed during project and further validation of this is planned
- The need to ensure that the communication aid industry are using evidence from user generated information in future device design.
- The need to explore emerging technology within and outside of the communication aid field to further developments in design of devices.
- The need to further develop research methods to enable end users with speech disorders to influence and be more involved with the design and evaluation process of technology.

Work is now underway to start tackling the priorities identified within this project. D4D feel that having taken this approach to the identified unmet need important evidence for future work required in this area has been produced.

A key success within this project also highlights some of the challenges of carrying out research with this group of participants, and more generally when building evidence for future research required, namely engaging hard-to-reach cohorts of participants. AAC users are potentially difficult to engage with research both in terms of identifying participants and in terms of the research methodology adopted. Face to face interviews with speaking participants tend to be rich in data, however for participants using a communication aid, communication can be slow and can often result in short, or yes/no, answers being given. This project explored methodology for aiding the participants during

the interviews, and further validation of these methodologies will be performed.

In terms of device development, this project has generated a large amount of potential future work with evidence to support the rationale behind it, demonstrating the importance of scoping research when investigating unmet need.

Case 2 (Prioritise and Prototype Stage) – Development of a new Paediatric Transport Chair

In 2009 the NHS National Innovation Centre (NIC) ran a series of ‘Wouldn’t it be great if...’ events to identify unmet needs within the NHS in a range of areas. One such area identified was the need for a new type of paediatric transport chair or wheelchair for children with high medical needs i.e. children who may use a ventilator, suction, feeding pump etc. and for whom current solutions involve strapping the equipment on to a wheelchair as safely and securely as possible. The group who identified this need developed a ‘wish list’ of requirements and the NIC developed a call for organisations to produce a solution to this identified problem.

Devices for Dignity and Frazer-Nash Consultancy (a Systems and Engineering Technology Consultancy), applied to the call and were teamed up by the NIC to bring their different areas of expertise and ideas together to tackle and solve the problem.

This collaboration approached the project by initially moving from the ‘wish list’ to a design specification. This involved undertaking a large scale internet survey to establish user and carer needs and requirements. Frazer-Nash subsequently generated a series of design schemes based on this specification and these were presented to a user and carer focus group, and the project steering group, to establish the features to be taken forward to develop into the final early-stage design. This final early-stage design was presented to the NIC and key stakeholders. Feedback from these groups indicated that the project had been highly successful in achieving its initial aim, a concept design with feasibility calculations. Following on from these initial design stages, a considerable quantity of work and resource will be required to translate this to a product

which is available for use.

This project focused on taking an identified unmet healthcare need and developing a solution, taking a collaborative working approach. Each of the collaborators contributed to the design in different ways. Frazer-Nash brought a new perspective on the design of a wheelchair and what is achievable due to their experience in many different areas of industry, particularly the automotive industry. This was complemented by Devices for Dignity’s strong focus on user involvement at all project stages and their network of collaborative links, both with NHS professionals and other bodies, including Whizz Kidz, a charity that provides wheelchairs to disabled children aiming to make them as independent as they can be.

D4D and Frazer Nash have benefitted from having access to the original stakeholders via the NIC which has strengthened the project.

This project highlights the key principle of D4D of bringing together key team members to produce an effective outcome.

Case 3 (Evaluate Stage) – Maavis

Maavis is an example of D4D taking an existing product and looking at developing it for a different group of users.

Maavis was initially developed within a research project with the aim of presenting a simple computer interface for people within care homes [5,6]. This initial project was successful, and a number of additional applications were proposed during the initial evaluation of Maavis. Within D4D we have considered use of Maavis to enable children within special needs schools to have more independent control over the activities they undertake on the computer. The project has therefore included adding switch functionality to Maavis and evaluating this within special needs schools.

This is an example of taking a piece of assistive technology software which has been developed for one user group and adapting and evaluating it with a different user group. It is essential that in terms of technology transfer we not only look within assistive technology but also at technology in general when considering needs. Technology can be

applicable to many different applications and we need to be open to exploring other industries or research areas when looking for solutions.

Case 4 (Acceptance and Uptake Stage) – Dignity Commode

The Dignity Commode is a device which has moved through a number of the development stages of D4D and is now at the stage of acceptance and uptake. It came to D4D as an early prototype, developed by a loan inventor who identified an unmet need when his friend suffered a stroke. Through D4D, this early prototype has been developed to the commercial product. As identified previously D4D are aware that it is not sufficient to create a new product for healthcare, however large the unmet need, without considering how it will eventually get to the target users and that having got to this stage work is required to facilitate acceptance and uptake.

It was identified that a piece of work designed to evaluate the Dignity Commode in use would aid acceptance and uptake and D4D have been granted a Regional Innovation Fund award for this piece of work.

This project will fund the introduction of the Dignity Commode in one of its target healthcare settings to generate evidence about its use under real circumstances.

The latest Dignity Commode prototype is shown below.



Figure 3 : Latest Dignity Commode Prototype

Conclusions

D4D utilises collaboration between industry, academia, healthcare professionals and end

users to facilitate development and adoption of devices which address an identified unmet need. In our process of reviewing projects we ensure that either the evidence of the unmet need is already in place, or that researching the need is a key initial milestone in any work undertaken. Having identified the project plan we facilitate appropriate teams to bring the required expertise to the project. The emphasis on user involvement, multi-disciplinary collaboration and an awareness of the full process of device development, including how the device will be adopted leads to successful projects and devices.

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Introduction to Sus-IT, a New Dynamics of Ageing project

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Motivation

The influence of technology upon all aspects of everyday life is unprecedented in history. As the speed of change increases, it becomes difficult for many older people to keep up-to-date. According to the Digital Britain report 2009 [1], the on-lining of information and services is now beginning to confer real disadvantage upon those who are not keeping pace with technological change. Additionally, many items that were once simple are now complex, requiring more steps or knowledge to operate.

Information and Communication Technologies (ICTs) are, for the older adult, becoming crucial not only for the mechanics of day-to-day living, but also for maintaining social inclusion as well as maintaining people's overall ability to live independently.

The Sus-IT Project

Sus-IT is a research project funded by the UK government's New Dynamics of Ageing (NDA) programme – the largest research programme on ageing ever mounted in the UK [2].

Sus-IT is an important and prestigious 3-year project which is undertaking research into ways of helping older people to use IT to sustain their independence. It has a budget of approximately £1.5 million and is led from Loughborough University. Cross-disciplinary collaboration is paramount to Sus-IT and the project involves academic partners from seven UK Universities and many other stakeholders including local government, commercial organisations, charities and groups of older people.

This 3-year project is researching the ways that digital technologies such as the computer, internet, mobile phones and so on can help older people (50+) to sustain their independence and autonomy. This research will impact on policy decisions and scientific, technology and design choices that will make

sure that older people will enjoy better quality lives.

The Sus-IT research project aims to:

- understand the challenges faced by older people using computers and other IT products;
- identify ways to help older people to be confident and competent users of these products;
- explore how older people can be helped to continue to use these products despite changes in their capabilities and circumstances.

The Sus-IT project is working in a number of areas to satisfy the declared objectives. Groups are working on various social and technical aspects and the remainder of this paper explores the work of the team charged with identifying and developing technical solutions to improving access to ICTs by older people.

Improving Access to ICTs

The goal of supporting older people and, indeed, any with specific accessibility needs, requires more than advocating and supporting the creation of accessible ICT. There is an additional task of matching people with an accessibility solution that best accommodates their particular needs. For many people, and older people in particular, these needs may fluctuate over time in severity, number and combination. Lack of user awareness of their own accessibility needs and assistive technologies that may exist to accommodate them may significantly reduce the quality of ICT usage experience or even lead to abandonment.

Substantial progress has been made in advocating inclusive design of ICTs. Perhaps the exemplar for this is the improvement of Web content and applications, led by initiatives such as the W3C Web Accessibility Initiative (WAI) and accessibility is supported

with increasing interest from IT suppliers in the commercial and open source fields. Research by the accessibility research community is tackling the problem through investigating improved browsing technology, enhanced support for accessible content creation and support for tasks such as navigation and search [3].

There is also an active, if still relatively niche-market, industry in assistive technology, producing a range of hardware and software solutions to support people specific, usually more extreme, accessibility needs. This has extended to development of specialist, simplified software targeted at older, novice ICT users, and even ‘simplified computers’ [4]. Yet, many challenges remain in providing equitable access to ICTs for older and disabled people. Surveys continue to find accessibility barriers present in web sites and other ICTs, while accessibility features of ICT may be hard to find or difficult to implement. Additionally, the challenge of accommodating dynamic disability and identifying and dealing with changing accessibility needs has still been largely unmet.

Mainstreaming assistive technology, by integrating it into consumer products, can ease its "findability" and reduce the stigma on people who require to use it – popular examples include predictive text for mobile telephones and display of captions on television. Indeed, Microsoft and Forrester showed that accessibility features of an ICT can benefit more than those who fall into conventional definitions of ‘disabled’ [5]. Despite this, there are significant socio-technical challenges to be addressed in supporting the transformation of an independent ‘normal’ user to one who requires assistive technology for independent ICT use.

Adaptive Interfaces and Mainstream Accessibility

People with more extreme disabilities, who are most likely to be at least aware of their accessibility needs, and for whom a dedicated assistive technology is likely to be available, are reasonably well supported. In contrast, supporting those with less severe but still significant impairments will require three

actions:

1. making a person aware that they have accessibility needs;
2. making them aware that a solution exists to accommodate those needs;
3. providing them with that solution.

As a way of reacting to and accommodating accessibility needs, the concept of adaptive interfaces fits well with basic principles of universal or inclusive design [6], particularly if adaptivity already exists and does not have to be acquired from a separate source. Attempts have been made to support accessibility adaptations at the interface level, from Web browser extensions to more expansive solutions [7].

Closely related to adaptivity for accessibility has been work on user profiling for accessibility purposes. This has included the work of the IMS AccessForAll metadata initiative, which has led to the creation of a three-part standard, ISO 24751; a range of systems for storing and maintaining users’ preferences have been proposed, for example [8]. In each case, the initial population of a profile and subsequent maintenance of accuracy over time remains a challenge.

Many of the conditions that afflict people as they age fluctuate in their severity. Fluctuations can occur across a day, across a week or be just part of a gradual decline in capabilities. This gradual decline can lead to a lack of awareness of accessibility needs and of the appropriate solution for them [7]. A valuable extension to existing accessibility support can be provided by a system that can help close this gap by matching a person with appropriate accessibility accommodations at a given time. Employing inclusive design practices is important, but as perceptions of an interface and the situations in which applications are used are variable, no single interface can satisfy the needs of all users at all times.

The likely outcome of adopting the kinds of standards to which we have already alluded is that a given adaptation will be able to deliver content to the user in an accessible form. The reason for this is that standard methods for adaptation may be used (such as the DOM

[9]). However, adopting such baseline standards may be only the beginning. Whilst adhering to standards can create a common platform upon which adaptations can build, the dynamic diversity of users, devices and environments may prevent the final deliverable of ensuring accessibility.

For example, it is almost certainly impossible to anticipate the context in which information or applications may be utilised. Often, users' capabilities and preferences would mean that they could benefit from slight changes (adaptations) to the way in which information is rendered. Moving to another device or experiencing changes in the environment, would need to trigger a reactive adaptation to be executed. Such changes could be sudden, for example light or noise levels, or could be such things as familiarity with the equipment or software. In the former case, the reactive adaptation might be a change in display contrast or audio volume or redirection of output to other modalities.

Adaptations would need to be focussed on solving one particular accessibility problem and be aware of specific users' needs and characteristics in order to minimise unintended side-effects. Further, they would need to be applicable in a very localised manner. For example a user with vision fatigue should be able to configure an adaptation that can read aloud to concentrate purely upon the content of long documents and to ignore the containing application or browser's menus or toolbar. This does not reflect the way in which most traditional ATs function, rendering them unsuitable in their current form; adaptations developed through research, seem more suited to this kind of operation. Infrastructure to allow adaptations to be targeted at specific parts of applications (akin to Gajos' and others' abstract UI systems) would be required to support this. The likely outcome that combinations of adaptations could produce "interference" must be recognised by the reasoning system and further, that the effects of this may vary for each user [10].

Adaptive Accessibility based upon Capability

We need to reason about users, devices and

adaptations, and so reliable methods and metrics are required to match users to devices. We need to relate device input and output functionality to the human capability requirements for providing or perceiving that input or output. If a PDA is being in an outdoor environment and a substantial change in light level is detected, for example, the response should be to optimise the contrast or to switch to audio output. These metrics are also required to possess temporal flexibility in order to accommodate users' changing needs over time. Formidable challenges are presented by problems of reliable discovery and monitoring of user capabilities, as well as the interactions of potentially conflicting accessibility adaptations. Fortunately, there is an emerging body of work that provides a basis for such reasoning.

The internationally-recognised standard for classifying human capabilities, WHO's ICF [11], has been used by Billi to assist with modelling human-computer interaction scenarios [12]. The first step of the approach is to extend the existing classification by means of an appendix to include more fine-grained details such as the user's performance in clicking, dragging and moving the mouse. The second involves adding a device functionality appendix, in a similar vein to the extra human capabilities, which categorises device functions such as screen resolution, colour depth and whether or not certain input modalities are supported. Whilst this approach could help improve modelling of interaction with – and therefore hopefully the accessibility of – current devices, it is argued that it may not be the correct approach for the medium- and long-term as it is very much device-dependent. A more sustainable approach would be to express both the additional classifications in terms of human functionality, as (a) human capability classifications change incredibly slowly over time and (b) expressing the capability requirements of device functions in terms of human capabilities allows the same classification to support new devices as they are developed. An example of this is that the mouse scroll wheel may eventually be phased-out in favour of multi-touch control surfaces. When this happens, the information "user can

use the mouse scroll wheel" becomes irrelevant and so it would be better to express that the user has a certain level of sustainable, repeatable bending in their finger(s). This information can be used for reasoning independently of device class. Expressing as much data as possible in terms of human capability requirements has another benefit: it allows any "interference" relationship between adaptations to be exposed within the reasoning process. For example, the use of larger text may have a positive effect on visual acuity, but - through enlarging the volume of information when rendered visually - it may impose a requirement for scrolling, which may burden the user's motor capabilities. Each adaptation could be thought of as an overlay, or delta, to the user's overall capabilities data structure (which would be similar to that prescribed by the ICF, though not necessarily fully-populated). Further, when two or more users are collaborating, the reasoning technique can consider the combination of each user's requirements in the same way, effectively simply tightening the constraints on the process.

The promise of capability-based reasoning is to unify the process by which: (a) users can be matched to devices; (b) the rendering of information can be tailored for each user-device pair and (c) the application of accessibility adaptations can be orchestrated. However there are significant challenges to overcome. Using human capabilities as the basis for this reasoning requires a means to:

1. accurately assess and subsequently monitor user capabilities, as well as
2. the effects of the environment on a user and
3. the interference caused by the application of multiple adaptations.

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Gathering users views for the design of rehabilitation technology devices.

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Background

Within the current health and economic climate providing adequate rehabilitation services is becoming increasingly challenging (RCP, 2004). Arguably as a result of this, there has been a growing recognition that technology could play a significant role in the rehabilitation programmes of the future. However, historically the adoption of rehabilitation technologies into main stream clinical practice has been slow with many devices lying redundant in the cupboards of therapy departments or in patients' homes. With this in mind involving service users in the design of rehabilitation technology devices is paramount.

One intervention that is showing significant promise for the restoration of function is Functional Electrical Stimulation (FES). FES is "the use of Neuromuscular Electrical Stimulation to activate paralysed muscles in a precise sequence and magnitude so as to directly accomplish functional tasks" (Sheffler and Chae, 2007).

Evidence for User Involvement

Recent trends in healthcare in the United Kingdom have highlighted the importance of placing users of health care services at the heart of design, delivery and evaluation (DH, 2001; Healthcare Industries Task Force, 2004; Smith et al., 2005). The establishment of organisations such as INVOLVE (<http://www.invo.org.uk>) shows a commitment to users having a stronger voice in health and social care research. Users bring a unique and inside view to the research process and their contribution should not be underestimated. Research has shown that academics and professionals sometimes find it difficult to see

the value of including users in the process, often perceiving that they lack the necessary knowledge to inform the research process (Hanley et al., 2003; Beresford, 2003).

Within this paper two National Institute for Health Research (NIHR) funded studies involving the development of FES devices will be drawn upon to illustrate the role of two kinds of 'users,' namely therapists and members of the public, when informing the design process.

The first study aims to develop a new device that combines a multi-channel, electrode array FES system with an orthotic garment to assist with foot drop following stroke. The new device addresses some of the problems limiting the uptake of FES for foot drop, namely the problems with 'donning' and 'doffing' the systems and the difficulties with electrode positioning.

The second study aims to develop an FES system (FES Rehab Tool) for upper limb therapy following stroke that can treat a wide range of patients, is easy to set up and is triggered by EMG or movement sensors, allowing voluntary initiation of movement by the patient that is task orientated as advocated by motor relearning theory.

In order to ensure that the design of the devices being developed were compatible with therapy approaches and met the expectation and needs of the public, it was imperative that their views were sought early on in the design process (Wilson et al, 1997).

Although there has been a growing realisation of the need to involve service users in the design of rehabilitation technologies the level

of involvement is often superficial and there have been few studies that have involved therapists in this process (Islam, 2006).

Gaining User Views

In study one a range of user advisors were recruited who had experienced stroke personally and who currently or previously had used FES as well as some who had never used FES. Following substantive preparation and support around their preferred working and learning styles, they were oriented to the study, facilitated to meet the design team and went on to meet 8 times during the 30 month study. Half day workshop meetings brought users and design teams members together for facilitated discussions based on what the designers needed to know to inform development of the FES device itself and also to help plan the clinical trial.

In study two views from potential therapy users of the FES Rehab Tool were gained by means of a therapist advisory group. Invitations were sent to a number of clinicians from both community and acute stroke settings across Greater Manchester.

In total 11 senior clinicians formed the group, comprising 6 physiotherapists and 5 occupational therapists. A total of 4 user groups were held during the first stage of the design.. A combination of semi-structured group discussions, patient case studies and mock-up presentations of the graphical user interface (GUI) were used to focus the discussions. Two researchers who took field notes and the academic facilitating the meetings each separately analysed the data using thematic analysis to identify key themes. The data was then further scrutinised by a separate researcher from the design team with a view to mapping the data in accordance with the design issues.

Impact on Design

In the first study, users highlighted challenges to their walking known as 'tripables' that the design team could consider in developing an FES prototype. The user feedback also informed plans for a 10 metre lab to test the device. Examples from this feedback included:

- Very small rises or drops for
 - example ¼ or ½ inch
- Side to side tilt
- Ramps: '*like walking on scree*'
- Pebbles
- Lawns
- Textured/knobbly paving stones (for example at crossings)
- Cracked paving stones
- People coming towards you

Users were less concerned with walking speed and preferred that the design team concentrated on balance and stability. Other suggestions centred on where to attach control boxes to clothing and the functions of this box e.g. knobs and audio alarms.

The data from the second study fell into 3 broad categories 1) Factors that had a bearing on the design requirements but that did not relate to hard and fast specific technology issues. 2) Specific design requirements 3) External factors likely to affect adoption of the device. The design requirements considered to be most important from a therapist's perspective for the FES Rehab Tool were:

- A suitably advanced and flexible system that could treat a broader range of patients.
- A device that compliments therapists approaches to treatment rather than attempting to replace them.
- A portable system that could be used across a range of rehabilitation settings.
- A device that is easy to set up (less than 30 minutes), operate and maintain, with the ability to store previous treatment settings.
- Provision of tailor made feedback to patients that would help to maintain motivation levels.
- Provision of objective performance analysis data for therapists.
- Software that intuitively follows the therapists approach to treatment.

Conclusions

Therapists are often the 'gate keepers' of rehabilitation interventions and without their involvement in the development of new devices there is little chance of these

promising technologies being adopted into main stream clinical practice. Similarly, involvement of the public in all stages of the design process has significant potential to ensure that devices are developed which are truly 'fit for purpose'. However, involvement of users must start early and be supported by skilled facilitation in order to be effective at extracting users views.

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REALISE : on-line open innovation

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Background

REALISE is funded through the JISC Business and Community Engagement (BCE) programme and focuses on the application of open innovation principles to develop ground breaking and life changing accessibility and ease of use, technology solutions. Equal access through reasonable adjustments for those with disabilities and age related difficulties, is a legal requirement for employment and public services including health and education, especially since the ratification of the UN Convention on disability rights. Many commercial opportunities exist for personalised support for individuals through specialist products and services, or the expansion of existing markets. Simple innovative ideas may not appear particularly valuable until applied to a specific product or use case when it can greatly increase utility and value. REALISE will identify routes to sustainable innovative solutions through engaging key researchers, businesses, developers and users in exploring open innovation through an on-line community marketplace and will combine experience of accessibility and open development in the key education, employment and health sectors.

Southampton's Electronics and Computer Science (ECS) accessibility group, members of Sheffield's School of Health and Related Research (ScHARR), OSSWatch, Devices for Dignity (D4D) and Full Measure are combining their experience of accessibility and open development in the key education, employment and health sectors alongside leading companies and other collaborators.

There is a need for technology innovators to share their ideas with researchers and those who manufacture and sell products. Users of technical products also need to have an input

into their design.

REALISE will build on Sheffield's experience with the ATIB online Innovation Broker prototype developed by ScHARR and D4D to act as an intermediary between health professionals seeking innovations and those who innovate.

REALISE Approach to Open Development

As identified by OSSWatch⁶ increasingly the corporate sector is looking at open development as inspiration for their R&D and innovation policies and finding networking within appropriate communities can be a more important source of competitive advantage than jealously guarding trade secrets. Encouraging the creation of publicly available innovations can bring higher benefits than just committing resources to achieve returns on investments or publicly subsidisation with non-rivalry and non-exclusivity agreements. REALISE will build on this growing awareness of and interest in the open development of AT and the partners' experience in applying open development to explore and evaluate how the benefits realised by being a part of a community can maximise for example:

- the possibilities of collaboration by making developments visible to all
- user participation and support
- innovative, robust, agile and low cost solutions for users
- easy flow of academic ideas into AT solutions
- value to all parties
- easier upgrade paths
- shared development expertise

⁶ <http://osswatch.jiscinvolve.org/2010/03/26/open-innovation-vs-trade-secrets/>

Some of the issues REALISE aims to address are:

- developing an on line community with trust in an open development culture
- identifying relevant projects and people
- engaging users to help define the problem
- connecting parties interested in collaboration
- building the solutions
- identifying potential revenue streams
- managing the collaboration and any Intellectual Property
- engaging external parties in education and research

Overall Approach

Project REALISE aims to identify routes to sustainable innovative solutions through engaging key researchers, businesses, developers and users in exploring open innovation. These groups frequently express the unmet need for collaboration in accessibility. The need to foster public-private partnerships to create affordable innovative technology solutions for an aging society and those with disabilities has also been highlighted by UN Agencies in the past.⁷

REALISE aims to address this through an on-line community and will combine experience of accessibility and open development in the key education, employment and health sectors.

Project Outputs

The deliverables of the project, with the advice and guidance of the Support and Synthesis team, will include:

- Project website with a blog⁸ holding minutes of meetings and news – excluding confidential information that could result

⁷

http://www.wipo.int/pressroom/en/articles/2009/article_0055.html

<http://www.un-gaid.org/Networks/FlagshipPartnershipInitiatives/G3ict/tabid/879/language/es-ES/Default.aspx>

⁸ <http://access.ecs.soton.ac.uk/blog/realise/>

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in adverse consequences to progress of the project, future sustainability of the community or to individuals.

- Set-up an Advisory Group with expertise in open innovation, software development, disability, accessibility, community building.
- Develop a REALISE online open technology transfer marketplace with essential and desired requirements for health, education and employment sectors that will include design ideas developed as a result of work with D4D and from a selected cross sectional group of stakeholders. This work will also include an evaluation of other platforms such as myExperiment, Cloudworks, A-Tutor and Drupal for ease of use and accessibility.
- Community building and face to face AT technology transfer through workshops and presentations such as the AAATE 2010 Workshop hosted by the Rehabilitation and Assistive Technology team at the University of Sheffield and KT-EQUAL and RAATE 2010, the only UK conference focused on the latest innovations and developments in assistive technology
- Dissemination through further workshops both in local regions and across sectors with online information provided through the REALISE marketplace with community links via global social networks.

Project Outcomes

This project will aim to:

- Develop links across sectors of business, education, employment and health working in the field of open innovation and assistive technology with for example members of the British Health Technology Association, the British Assistive Technology Association and other Educational sector organisations (such as JISC Techdis and JISC), plus 3rd Sector Organisations that will bring patient, student, carer, parent and public perspectives.
- Enable growth in community

collaboration across the boundaries of open source assistive technology development with the introduction of a market place / brokering system to encourage ideas and project development with guidance and social networking.

- Encourage wider interest in the provision of open source assistive and accessible technologies with case studies of ongoing projects.
- Guidance for future work in this area, as to how the methodologies used influenced the project outcomes.

Illustrative Scenario of REALISE in Practice

Susan is a blind university maths student who has been having particular problems working with the mathematics documents produced by her tutors. Susan uses commercially available AT software funded by the Disabled Students Allowance and recommended by Chris, her AT professional assessor from her regional assessment centre but Susan finds this AT software is difficult and time consuming to use and would like to find a better solution. Susan and Chris work with Hamid, an ECS computer science master's degree student and Lisa his supervisor to develop a better application as part of Hamid's final MSc project. Through REALISE Susan, Hamid, Chris and Lisa link up with OpenAT's business expertise to enhance the design and ensure it reaches the market place. Observing this process through REALISE encourages other external parties to engage in education and research through collaborating on future MSc projects with staff and students.

Online Marketplace Development and Evaluation

The REALISE online marketplace (including access and identity management, moderation service, access to knowledge and research etc.) co-development, testing and evaluation will be agile and iterative to ensure responsiveness to changes with four phases/iterations and a final version at the end of the project. Analysis and design and development will involve usability studies including iterative evaluation with

users to finalise software design for deployment. The marketplace will be evaluated using quantitative and qualitative evaluations and observations based on deployment by users including activity logs. Evaluation will include evaluating business models to exploit accessibility innovations to add significant value to UK business and community engagement and innovation including IPR issues relating to open innovation and open development and sustainability issues.

Conclusion

REALISE aims to allow for the flow of ideas to occur both in and out of the online market place in such a way that it allows the situation suggested by Laursen and Salter [1] where "firm boundaries are permeable, resulting in an interactive and distributed innovation process..." These interactions aim to be inclusive and it has been shown that when users of assistive technologies and their carers become involved in online communities their contribution may not just be related to the functional issues that arise in product development but also linked to issues around "symbolic and aesthetic value as well as sense-making qualities" [2] .

It is also felt that REfining And Learning from on-line tools for Internet Shared Enterprise (REALISE) is in itself a way of discovering the mechanisms by which one can encourage open innovation, governance and community as espoused by open source **supporters**.

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Licences, copyright, patents and business: Making the most of exploitable assets through open innovation

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Abstract

While users require innovative and appropriate solutions at reasonable cost with good support, creators of software such as universities and businesses usually want to make the most of their exploitable assets.

Being based on copyright and protected by licences allows open source to be exploited in ways that may not be obvious to those familiar with closed source exploitation. These ways foster open innovation in software yet allow exploitation. This session explores the fundamentals of IP and some of the common business models that are successfully used with open source software.

Copyright

When you write software, you are creating a kind of property. By default, this property will be owned by somebody. If you are an employee, it is likely that your employer will own the software you create in the course of your employment. If you are working for yourself, or working in your free time on matters unrelated to your work, then it is likely that you will own it. If you are self-employed and developing software as a service under a contract agreement, then the contract ought to define who owns the intellectual property that results. If the contract does not define who will own the property, it is more likely than not that the contractor who wrote it will own it. If you are working as part of a group, where there are multiple employers, contractors and/or individuals, or some parties are based outside the UK, then the ownership of the resulting property can be complex. It may be that all contributors jointly own all of the property, or that the property is divided into sections

that are owned by different people or organisations. Ideally, an agreement detailing who will own what should be made before the work is begun.

Computer software is protected by copyright law. Copyright law gives the owner of a work certain rights over it, and makes it illegal for others to use the work as though they were its owner. Copyright originally came into being to ensure that literary authors were properly remunerated for their work. Its concepts originate in the protection of written works, and it can be helpful to remember that computer software and its associated materials are treated by the law as species of literary work.

Owning the copyright in a piece of work, whether literary or programmatic, means that you decide who can copy it, adapt it and distribute it. By default, only the owner can do these things. Anyone who copies, changes or distributes someone else's work without permission can have legal action taken against them.

Patents

Inventors can apply to their government for the right to own the ideas in their inventions. This right is known as a patent. Without a patent, anyone else can imitate their invention. With a patent, the inventor enjoys a period during which they own the idea behind their invention, and can prevent others from imitating it. They can also allow others to use their ideas for a fee.

To get a patent, an inventor must describe their invention and in doing so demonstrate that

- it is new
- involves an inventive step - meaning that it is not merely a progression that would be obvious to anyone who had good knowledge of the field, and
- it can be used as part of an industrial process - meaning any practical application outside the spheres of purely intellectual or artistic endeavour.

If the invention meets all these criteria, then the inventor can receive a patent in exchange for a yearly fee. As a result of the patent being granted, the description of the invention is made public. The patent right will lapse after a certain period set by the government, and can be allowed to lapse before that if the inventor wishes to stop paying the fees. Once a patent has lapsed, anyone can employ the ideas that are embodied by the invention. The body of lapsed patents provides a valuable resource for all who wish to work on technological and industrial solutions to problems.

Open Innovation

Many people confuse innovation with invention. However, innovation is not invention. Invention focuses on the creation of something new without necessarily realising economic benefit. Innovation, on the other hand, is the application of inventions to generate economic benefit. You can't have innovation without invention.

Open innovation is a specific form of innovation. Simply put, open innovation is a practice involving:

- seeking useful inventions and innovative technologies outside your organisation
- making your own internally developed inventions and innovative technologies as widely available to others as possible
- working collaboratively with external

partners wherever it is advantageous

Underlying the promotion of the sharing of inventions across organisational boundaries is the conviction that - in an increasingly complex technological world - no individual organisation can command a monopoly of top talent. Given this, previous 'vertical' models of technological development (in which a single organisation invents and develops every aspect of its products) are no longer optimal, or in some cases even possible. Proponents of open innovation argue that organisations must avoid what has become known as the 'not invented here' phenomenon, in which external technologies are treated as inferior simply because they come from outside.

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Designing Usable and Acceptable Reminders for the Home

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Abstract

Electronic reminders can play a key role in enabling people to manage their care and remain independent in their own homes for longer. The MultiMemoHome project aims to develop reminder designs that are accessible and usable for users with a range of abilities and preferences. In an initial exploration of key design parameters, we surveyed 378 adults from all age groups online (N=206) and by post (N= 172). The wide spread of preferences that we found illustrates the importance of adapting reminder solutions to individuals. We present two reusable personas that emerged from the research and discuss how questionnaires can be used for technology transfer.

Introduction

In the MultiMemoHome project (MMH, [1]), we work on reminder solutions that help older people remain independent and in their own homes for longer. In a highly personal space like the home, it is particularly important to adapt technological solutions to end users' individual needs and preferences.

Therefore, we performed a comprehensive mixed-methods user requirements study. Here, we report on one aspect of this work, a questionnaire survey. This method allowed us to reach an audience that was larger and more diverse than our focus group and home study participants. The questionnaire was designed to cover key factors that had been derived from a literature review and our own previous user requirements work. In order to maximize coverage, it was disseminated both online and by post.

Questionnaire Design

The questionnaire was designed to be completed in 15 minutes. It consisted of 23 questions, many of which had already been used in the MATCH project [2]. Seven questions

focused on basic demographic data (age, gender, living arrangements), and the use of computers and related technology. This allowed us to spot frequently used technologies that might serve as the basis for a reminder system. Two questions provided space for comments about relevant health issues such as hypertension or diabetes.

Since we aim to adapt reminder delivery to the user as much as possible, we included questions about preferred reminder delivery modalities and delivery devices. Devices ranged from mobile phones to specialized screens; modalities included vision, hearing, touch, and smell. We also asked respondents about sensory impairments that might impact on the modalities they can access. Several questions focused on remembering, i.e., whether respondents felt they were experiencing problems with their memory, what tasks and events they needed reminding of, and what reminder strategies they currently used around the home. Finally, we asked whether respondents were caring for a person with memory problems.

We provided as much space for comments and suggestions as possible, both in multiple-choice questions and through open questions where respondents were asked to elaborate on earlier choices. Although many respondents did not take advantage of the open questions, those that did provided important insights into user groups that we had not anticipated.

Online versus Mailshot Sample

The online questionnaire was created using SurveyMonkey [3] and published in November 2009. It was disseminated through email, social networking, and web sites. It was also sent to the email mailing list of the Centre for the Promotion of the Older Person's Agenda (COPA), Queen Margaret University, Falkirk

Sensory Centre, and West of Scotland Senior's forum. The questionnaire is prominently linked on the "Get involved" section of the MMH website [1].

The online questionnaire was revised and reformatted for postal distribution using a 16pt font to ensure readability. A total of 900 copies of the postal version of the questionnaire were sent out to the MMH user panel, colleagues, charities, Community Health Partnerships, and the postal mailing list of COPA. The questionnaire was distributed in mid May 2010; responses were still coming back in mid July 2010. Postal responses were entered in anonymised form into a database using SurveyMonkey, which ensures uniform storage and allows people at several sites to share data entry. The present paper is based on a snapshot of the online and postal results taken on July 16, 2010.

Demographics

	18-30	31-60	61+	Total
Online	46 (22%)	128 (62%)	32 (16%)	206
Mailshot	2 (1%)	46 (27%)	124 (72%)	172
Total	48 (13%)	174 (46%)	156 (41%)	378

Table 1: Distribution of Age Groups

The return rate for the postal questionnaire was 19%. The best single response rate was achieved through our project volunteer user panel (75%), the response rate for the large COPA panel was 22%.

The postal questionnaire was indispensable for obtaining a good sample of responses from older people, as Table 1 shows. A third of respondents to the postal version were aged between 61 and 70, a third were aged between 70 and 85, and 8% were 85 or older. 44% of respondents to the postal version lived alone, as opposed to 23% of respondents to the online version.

80% of postal and 99% of online respondents owned a computer, and 69% of the postal and

90% of the online sample used their computer daily. While 73% of the online sample used mobile phones daily, this was only the case for 40% of our postal sample. A similar proportion of people regularly watched cable or satellite television (37% online, 41% postal).

Although our postal sample allowed us to access a segment of the population that is less computer-literate, the proportion of people using technology is still comparatively high. For example, 62% of our postal respondents aged 71 or above used the internet, but in a recent survey of internet use in the UK, only 40% of people aged 65-74 and 20% of people aged 75 and over were online [4].

46% of the postal sample had long-term care conditions, as opposed to 17% in the online sample. Postal respondents also reported more sensory problems (40% vs. 25%) and more problems with their memory (40% vs. 15%).

Does One Size Fit All?

Half our younger and middle-aged participants and 44% of our older respondents stated that they sometimes forgot to do things around the home. While only 17% of younger participants said that they frequently forgot chores, tasks, or events, 31% of middle aged and 41% of older respondents noticed that they often forgot to do something.

Table 2 lists the types of tasks and events of which respondents would like to be reminded, sorted by age group. 44% listed special occasions and birthdays, followed by appointments (32%) and weekly tasks (28%). Although older people overall describe themselves as more forgetful, they are less likely to want reminders for almost all of the items listed. In particular, older people remembered daily routines and important, urgent tasks such as bill payments well.

21% of respondents did not specify a preferred modality for reminder systems, while 17% of did not specify a preferred device. The reasons for not answering these questions are diverse. While some respondents may not have understood the items or forgotten to answer them, others, especially older people and people aged between 45 and 60, made it clear that

they did not need or want reminder systems, because their existing strategies worked well for them or their memory was still good. Therefore, they felt that the questions did not apply to them. This is a common problem: Healthy active older users who take part in user requirements studies often do not identify themselves as the group who would benefit from the solutions offered.

	18-30	31-60	61+	All
Medication	11 (23%)	23 (13%)	33 (21%)	67
Daily Tasks	11 (23%)	24 (14%)	6 (4%)	41
Weekly Tasks	19 (40%)	54 (31%)	33 (21%)	106
Bills	20 (42%)	57 (33%)	15 (10%)	82
Appointments	17 (35%)	65 (37%)	40 (26%)	122
Birthdays etc.	29 (60%)	91 (52%)	58 (37%)	168

Table 2: What is Forgotten? (% of Age Group).

66% of those who specified a preferred modality voted for visual reminders, 37% for speech, 30% for non-speech sounds, 23% for touch and only 3% for smell. Older people were more likely to favour speech (46% positive, $p < 0.01$, χ^2 test) and less likely to vote for vision (53% positive, $p < 0.005$, χ^2 test).

58% of those respondents who specified a modality voted for only one modality (174 of 299). No strong default choices emerge. Only 54% of these 174 people chose vision, while the other 46% prefer non-visual reminders. Of the 38% who chose audio reminders, 22% chose speech, while 16% strongly preferred non-speech sounds. This result underscores the importance of offering users a range of modalities to choose from, as well as the importance

of offering choice within modalities.

A similar wide range of preferences can be observed for devices. 55% of those who specified at least one device would like to receive reminders on their mobiles, 43% on their computers, 29% on a watch-like device, 25% on the TV, and 21% on a landline phone. 30% of respondents liked the idea of a screen in the kitchen, but only 15% favoured a screen in the hallway.

Again, the preferences of older people differed significantly from those of younger or middle-aged respondents. Older people were more likely to prefer landline phones (40%, $p < 0.00$) and less likely to want reminders on their mobiles (33%, $p < 0.00$).

36% (N=114) of those respondents who indicated preferred devices only specified one device. Those preferences are even more evenly spread out than the modality preferences. The most popular single device, the mobile phone, receives just below one in three votes in this particular group (31%), watch-style devices are favoured by 21%, landlines and computers are chosen by 14% each, 11% favour the TV, 7% like the idea of screens in the kitchen, and 3% want them in the hallway.

In conclusion, reminder systems should not just support a range of modalities, they should also be adaptable to a range of devices. The preferred device will also depend on what is available and acceptable at the time. A more representative sample of the population might not yield the relative ranks we observed here. In particular, we would expect computers to be less popular as reminder devices. The sheer diversity of strong preferences, however, will probably remain.

Personas

Assigning appropriate individual packages to users is crucial for increasing the likely uptake and fostering continued use of telecare solutions. However, it can be difficult to codify knowledge required to tailor packages to clients. Technology designers, developers, and care professionals can use personas to make an initial informed choice among the devices and care packages available.

Personas are intended to serve as a starting-point for discussion. If the client is a good fit to the persona, the initial care package associated with that persona should already be relatively close to the client's needs and preferences, and therefore only require minor adjustments. Personas can be revised and augmented to reflect the experience of health and social care professionals in the field. Here, we describe two personas that pose particular challenges for reminder system deployment, Rita and Derek.

Rita prides herself on being fit and healthy. She is very well organised, and does not need any automatic system to help her, so she does not have any opinion on devices and modalities. The medication reminder system that came as part of her standard telecare package, such a system is for old people, not for her.

Derek knows that he needs reminders, because he forgets a lot. But he simply cannot motivate himself to stick to any single system, especially when he has another bout of depression. Reminder systems will only work for Derek if they are coupled with appropriate support from the Community Mental Health Team.

Lessons for Technology Transfer

Questionnaires such as ours have great potential for informing technology development and care provision if the results are interpreted judiciously. We found that postal distribution is essential for reaching older users, even if they have and use a computer. To ensure acceptable return rates, it is also important to liaise with groups that have access to active user panels. Our own user panel consists of around 50 people who have been recruited through projects including UTOPIA [5] and MATCH [2].

Although our sample is not representative of the older population, the results vividly illustrate the range of devices and modalities that need to be accommodated in a truly flexible design. Small design decisions such as where to place the screen of a visual reminder systems matter greatly.

We were also able to identify useful and reusable personas by looking for salient patterns in respondents' answers that can be linked to

known properties of the target population. We found that giving respondents plenty of space to share stories, ideas, and remarks is crucial for identifying personas and making sense of patterns of responses, even though many respondents will not take advantage of this opportunity. For example, the persona of Rita was based on answers to open-ended questions by some of the people who did not state any modality or device preferences.

We recommend using questionnaires for exploring high-level parameters of personalisation. Patterns and themes should be taken seriously even if they are based on only a few questionnaires, because these responses might be representative of groups that are less likely to participate in research or that are under-represented due to the sampling strategy. For example, the persona of Derek was based on two questionnaires that gave a voice to older people with depression, who account for around 10% of the older population [6].

Our questionnaire items could also be re-used when configuring deployed systems. For example, the items designed to elicit device and modality preferences could be extended with pictures or small vignettes to elicit users' views on the configuration of their own system. If users are not willing to engage with those questions, this might indicate that they are not ready to use automated systems, and reasons for this resistance as well as alternative solutions need to be explored.

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