i~design 3

extending active living through more effective inclusive design

INTRODUCTION

Against the background of rapid population ageing, the study and practice of inclusive design in the UK has grown considerably over the past decade. This rise in activity and profile has been catalysed in part by the ten year i~design programme of research (2000-2010) funded by the EPSRC and led by Cambridge University's Engineering Design Centre (EDC) in partnership with the Helen Hamlyn Centre for Design at the Royal College of Art.

The first phase of the i~design programme (2000-2004) concentrated on building an academic knowledge base in inclusive design. Undertaken in collaboration with Design for Ability at Central St Martins College of Art and Design and the Design Council, this phase resulted in an number of influential outputs that laid out the ground, including a major book, *Inclusive design: design for the whole population*, edited by John Clarkson, Roger Coleman, Simeon Keates and Cherie Lebbon (Springer 2003).

The second phase of i~design (2004-2007) set out to understand commercial needs and engage the business community in inclusive design. This phase was undertaken in collaboration with the Centre for Usable Home Technology at the University of York and Applied Computing at the University of Dundee. It produced a new British Standard BS7000-6 2005 - a guide to managing inclusive design, followed by a series of workshops with UK companies and a substantial body of case studies of inclusive design in action in business. A web resource for industry in the form of an inclusive design toolkit went live in summer 2007, supported by BT.

The third phase of the i~design programme (2007-2010) sought to build on previous work by focusing on designers and their interactions with people. Cambridge University's Well-being Institute and the Loughborough Design School at Loughborough University joined the research consortium. The aim was to make the practice of inclusive design more effective by giving designers more accurate, relevant and up-to-date data on capability in the population, combined with a robust model of human-product interaction with reference to environmental and social contexts of use. A key part of this third phase was to conduct a 400-person pilot to test the requirements, materials and measurement techniques for a new survey of national capability.

By providing designers with improved data in a form that would be most useful, and by creating advanced tools for calculating levels of inclusion, the i~design team wanted to support the practical development of new products and services that would give older people greater independence and bring disabled people into mainstream life and employment. Building on earlier phases of i~design which defined inclusive design and made the business case for its practice, this final phase – oriented towards the work of designers – was regarded by the research team as critical to the whole i~design programme.

Research Partners

UNIVERSITY OF CAMBRIDGE · Engineering Design Centre · The Well-being Institute · Royal College of Art · helen hamlyn centre for design · Loughborough University

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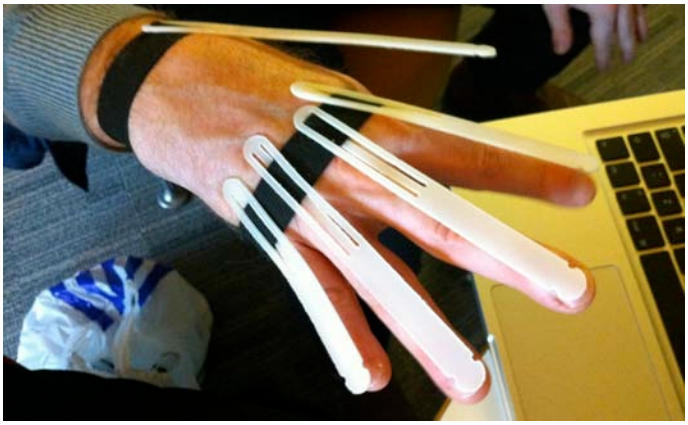
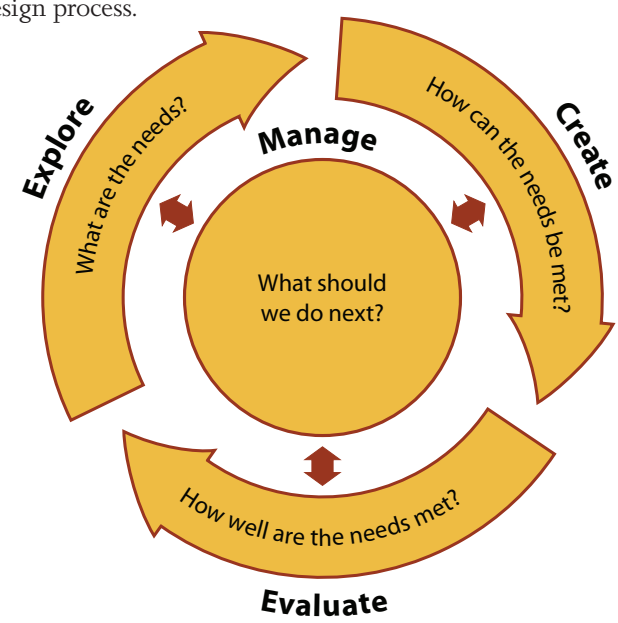


KEY OUTPUTS

EDC Cambridge University: design tools

Cambridge Engineering Design Centre produced a range of tools to help designers put inclusive design into practice, hosted on the website www.inclusivedesign.toolkit.com. These include a **framework**, which highlights four key design questions, as shown in the diagram below. These can help designers to incorporate inclusive aspects within a general design process.



Cambridge EDC also produced specific tools to support individual parts of this process. These include a **Demand Assessment Grid**, which assesses the vision, hearing, thinking, mobility and dexterity demands associated with each of the steps required when interacting with a product; **Impairment Simulation Tools** such as gloves and glasses that enable designers to experience the effects of visual and physical impairment for themselves; and an **Exclusion Calculator** that quantifies the proportion of the UK population that would be unable to use a product.

A particular focus of i~design 3 was on evaluating products and services through **Exclusion Audits**. These were developed through a series of experiments and examine the demands a product places on users' capabilities – for example, a mobile telephone may have small buttons requiring a certain level of dexterity to operate. The **Exclusion Calculator** guides designers through the process of conducting an Exclusion Audit and estimates the percentage of the UK population who would be unable to use the product due to its demands.

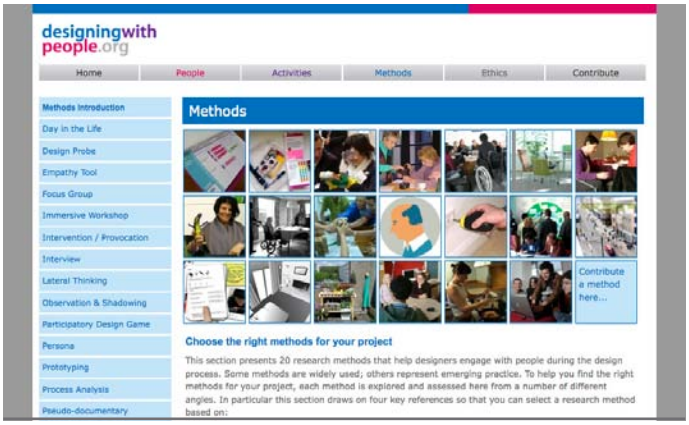
Work on the Exclusion Calculator involved developing and testing algorithms for the underlying calculations, and reanalysing the population data so that it is more suitable for design purposes. The Exclusion Calculator is, however, limited by the data that is currently available, so the i~design team developed a pilot survey to produce a more suitable database.

Cambridge Well-being Institute: pilot survey

Product designers require practical input on individual capabilities in order to make informed decisions. However, to make use of such information, databases that cover multiple functions and individual characteristics of product users must be accessible. **Two major studies** were therefore directed at producing the most useful measurement for understanding capabilities across a range of products.

First, a detailed investigation with 100 participants aged 50-80 was undertaken to examine how they managed typical household products. Variables included self-report and performance measures across vision, hearing, dexterity and cognitive function. Then, 30 interviewers attended 990 addresses across England and Wales to recruit participants aged 16 and older. 362 participants took part in a second study within people's homes.

The collective purpose of these studies was to inform a national survey of design-relevant capabilities, which will lead to the creation of a national capability database. This will be converted into a tool for designers to understand the implications of their design decisions, so they can directly calculate inclusivity in their work.



Loughborough Design School: context of use

A team from Loughborough Design School at Loughborough University investigated the extent to which everyday contexts of use impact on the way people use products. Context of use refers to the circumstances in which a product interaction takes place and can include factors such as lighting levels, temperature, weather conditions, vibration, noise, assistance from other people, a person's mood, and so on.

Early in the project, focus groups and observations with older people helped to identify situations where context has the biggest impact upon product use. The team explored people's feelings and motivations, the nature of their everyday tasks and both the physical and social environments in which they interacted with products. These terms formed the basis of a **Context Framework**, which illustrates the multi-faceted impact of context upon user capabilities and product demands.

Two experiments were conducted with older people aged 65 and over to determine what effect the physical environment has on two key product interaction capabilities – vision and dexterity. For **vision**, four everyday lighting levels were investigated (daylight, overcast, in-house lighting and street lighting) with older users reading different letter size and contrast combinations. Findings from this experiment demonstrated the importance of considering ambient illumination when designing everyday products.

For **dexterity,** neutral (19°C-24°C) and everyday cold temperatures (5°C) were investigated. Findings from the dexterity study indicated that grip strength (power and pinch grip) is not affected by 5°C cold temperatures. However, fine finger dexterity is significantly reduced when a person is exposed to this average winter temperature.

Both sets of results demonstrated the importance of considering environmental contexts of use to improve access to products and technologies – not just for older people, but for everyone. The experimental data was developed into a design tool called **the Context Calculator** and iteratively tested with designers to ensure its usefulness and usability. This tool provides data on older adults' capabilities in a range of environmental conditions related to everyday lighting conditions and cold winter temperatures.

Royal College of Art: resources for designers

The RCA research team in the Helen Hamlyn Centre for Design worked closely with colleagues at Cambridge and Loughborough to turn their scientific findings into practical resources for designers. A key objective was to bring hard capability data alive for the design profession in an empathic and meaningful way. This research was consolidated in an open-access web-based resource that explores the current shift from designing *for* people to designing *with* people, **www.designingwithpeople.org**, aims to offer a wealth of practical information on inclusive design practice.

The website has four main sections. A **People** section presents 10 individuals drawn from the Helen Hamlyn Centre for Design's user network – their vision, hearing, dexterity, mobility and cognition capabilities correspond to different scales on Cambridge University's population capability data and their life experiences can act as an inspiration for designers.

An **Activities** section uses the centre's extensive track record of inclusive design projects to present precedents and case studies related to the activities of daily living. Insights on user behaviour are grouped under four themes - Personal Care, Household, Work & Money and Communication – and communicated via images, video and first-person testimonial. Loughborough's Context Framework is presented here.

A **Methods** section maps and evaluates common design methods in practice and classifies them within a special framework. Designers can browse exemplar projects related to each method and identify the most appropriate method for their current project. Finally, an **Ethics** section offers designers guidance on good practice in working with people. Designers can work through the stages of contact, consent, confidentiality and conduct step-by-step in order to understand the principles of user involvement.

Alongside the development of the web resource, which invites contributions from designers and seeks to build an online community of practice, the RCA research team also developed and tested an educational workshop for design students, **The Methods Lab**, which works in tandem with the web tool.

Cold Work
Case Study

How the i~design tools work in design practice

To test the relevance and usefulness of its design tools, the research team wrote a hypothetical inclusive design brief and commissioned a London-based product design firm, Vitamins, to pilot the toolkit in exploring a solution.

The brief was code-named Cold Work and asked this question – how do you find a novel and inclusive way to remove ice from a car windscreen on a cold winter's morning without resorting to the standard, environmentally-unfriendly can of aerosol? A three-strong design team from Vitamins spent two days at the Royal College of Art in July 2010 working on the brief. It was the height of summer with temperatures above 30°C. So how did they get on?

The two days were set up to simulate the initial explore-and-create phases of a typical design project, in which the designers would scope out the work, conduct some preliminary exercises in user interaction, sketch and model some early concepts, and plan more in-depth user research. The i~design 3 research team was on hand to explain the tools as the designers worked on the project and the exercise was filmed.

Demand assessment

Right at the outset the design team got to grips with Cambridge's Demand Assessment Tool – this enabled them to use simple cards to map out the user experience of de-icing a car stage by stage. Each stage was broken down in terms of the demands on vision, dexterity, cognition and so on, alerting the designers to what might cause people problems.

Having assessed the nature of the task, the designers then tried out a range of existing solutions – scrapers, aerosol cans and so on – donning Cambridge's special impairment simulation gloves and glasses to experience various impairments for themselves and learn at first hand their impact on performance.

By trying to open car doors, read instructions or drag a scraper across a car windscreen while impaired, the designers began to understand the challenges that many people face in using products everyday. 'The tools feel very familiar to the way we normally work,' confirmed designer Duncan Fitzsimons of Vitamins. 'There is a good fit with our creative process but the tools make sure that we look at every stage of the task thoroughly and methodically. That fuzzy front end of design is made more formal and less ad hoc.'

An early breakthrough for the design team came with the insight that scraping ice off a windscreen required two different types of force – chipping to break the ice and scraping to wipe it away. Neither existing scrapers nor aerosols allowed for such dual action.

Context of use

The designers now turned their attention to the context of use – light is likely to be poor on a cold winter's morning and icy conditions might make handling and operating a device even harder. Loughborough Design School's Context Calculator came into its own at this point as the design team investigated what size of text and colour of background would include the most people in reading instructions in poor light, and what cold hands might do to the level of dexterity.

'It's reassuring to have the numbers right at hand, to have empirically tested data that lets you make the right design decisions,' explained Fitzsimons. 'We're condensing hours of trial-and-error work into a few simple calculations with this tool. I'd use the Context Calculator not only at the early stages of design but also during the testing of prototypes.'

Having explored the context of using a de-icer at dawn in winter, despite working on a hot summer's day, the design team now sought inspiration and ideas from a different source. They explored the RCA open-access web resource, www.designingwithpeople.org, looking first at a section called Activities for a match to de-icing a car. Here, they found a wealth of material on Home Maintenance and watched a video of an older driver standing upright and washing his car with an extended

power washer. This chimed with an idea the team had to create a longer and more ergonomic handle for the scraper itself to give access to the car window without leaning over.

In the People section, the designers read profiles of real people with different capabilities. Susan, a 76 year old car driver with mild osteoarthritis, appealed directly to the team from the website: 'Involve the envisioned user at the beginning and throughout the design process,' she implored in a Message to Designers, 'so that things that don't work or could work better are discovered long before the design reaches the production stage.' Chris, who is 63 and registered blind, called for simpler, easier interfaces.

As the project challenge took shape, the designers turned their attention to devising some in-depth user research to be undertaken once the two-day pilot with the i~design 3 toolkit was over. By now they had sketched out a range of design concepts, including a heated de-icing tool, a vibrating scraper and a sheet of removable cellophane that you simply peel off the windscreen. The front runner turned out to be an idea called Scraper-Plus: this uses a levered ball action to create two types of force – chipping and scraping. This was modelled in card to see how it feels in the hand.

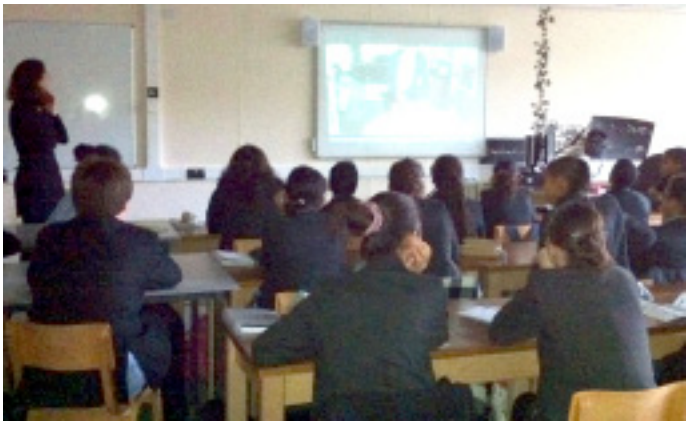
Ethical considerations

The design team returned to the RCA website to review different design methods that engage users in the creative process. They followed a simple framework to assess which methods are right for the next stage of their project. They also looked at the Ethics section for practical advice on how to contact older user groups, how to gain their consent and how to treat them with respect. A standard consent form was downloaded that Vitamins could adapt for their own use.

The design team was ready to take the project to the next stage – an in-depth study of user behaviour. The two days were over. The i~design3 toolkit had given them hard data on the demands of the task and on the context of use; it had given them a simulated insight into the human experience of impairment as well as rich practical information and support on designing with people – precedents, cases, methods and ethics. Critically, the tools had supported the generation of early-stage design concepts.

At a later stage in the project, once a new de-icing product has been designed, the team would be able to use the Exclusion Calculator to carry out an Exclusion Audit to evaluate its effectiveness prior to market introduction.

'The whole point of the i~design tools is that they work together – they respond to the fluid and iterative way in which designers gather and synthesise information,' explained Duncan Fitzsimons of Vitamins Design. 'This pilot has been a useful exercise which has opened our eyes to how much it takes to make a truly inclusive product.'



FUTURE DIRECTIONS

Over a ten-year period, the i~design research programme has developed the knowledge and business case for inclusive design, and created a comprehensive toolkit for designers. The legacy from the project has been instrumental in reshaping the landscape of inclusive design in the UK through a number of channels.

The third phase of i~design has in particular generated a prodigious volume of academic publications. Work by the Cambridge EDC and other partners has found its way into national and international publications in the contexts of inclusive and universal design, assistive technology and product design. Academic publications include journals and book chapters as well as key conference and workshop papers. A number of resources for designers have been generated, among them the Inclusive Design Toolkit, the Context Calculator and the Designing With People website.

Platforms for dissemination

Two alternating conferences on inclusive design, the Cambridge Workshop on Universal Access and Assistive Technology (CWUAAT) and Include at the Royal College of Art, are now fixtures on the event calendar for researchers and designers as a result of the i~design programme. They represent a considerable dissemination arena that will carry the messages and pointers towards better inclusive design to: business and industry; user groups and populations; designers of products, services and interfaces; and academic and government departments.

National capability survey

The central research goal of designing and piloting a national inclusive design survey has been achieved. Once this is translated into a national data set, the benefits to both older and disabled populations will be incalculable, so it is important that a national survey of capability goes ahead based on the lessons of the pilot.

In the meantime future research will focus on the application of i~design tools and techniques to real-world design contexts. This will focus on longer term projects aimed at addressing significant research and application areas within the fields of healthcare and inclusive interaction design for use in mobile and other communication technology. Considerable industrial and EU funded work is already propagating i~design into many and varied knowledge transfer and assistive technology applications.

Extending the research

KT-Equal, for example, is extending the reach of the research. The i~design project team is one of the three research consortia funded by the EPSRC under this scheme. Its remit is to extend quality of life for older and disabled people by translating high-quality research into real benefits that have an impact on people's lives. It aims to show how ageing and disability research can make a difference to people's lives by a series of practical activities.

The i~design research is also being extended into secondary schools through the DOT (Design Our Tomorrow) project. This started in July 2010 and is an 18-month project funded by the EPSRC to engage secondary school teachers in the principles and tools of inclusive design to enable their students to think creatively. This public engagement project addresses ways in which approaches to teach creative thinking in schools can be embedded with inclusive design principles in order to inspire young people to create a more inclusive world.

Selected Publications

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- Cardoso, C., Clarkson, P.J. (2010) 'Simulation in user-centred design: helping designers to empathise with atypical users' in Journal of Engineering Design, DOI 10.1080/09544821003742650
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- Elton, E, and Nicolle, C (2011) Translating inclusive capability data for designers. Proceedings of Include 2011 conference, Helen Hamlyn Centre for Design, London
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- Elton, E, and Nicolle, C. (2010) The Importance of context in Inclusive Design. Ergonomics Society Annual Conference 2010 - Keele University. Contemporary Ergonomics 2010
- Elton, E, and Nicolle, C (2009) Now you see it, Now you don't. Proceedings of Include 2009 conference, Helen Hamlyn Centre, London
- Elton, E, Nicolle, C, and Mitchell, V (2008) Identifying contextual factors in inclusive design. Proceedings of the 4th Cambridge Workshop on Universal Access and Assistive Technology (CWUAAT 2008)

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- Myerson, J. & Lee, Y. (2010) 'Inclusive Design Research Initiatives at the Royal College of Art' Chapter in Universal Design Handbook (2nd Edition), McGraw-Hill Professional, USA
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- Lee, Y., Myerson, J., Bichard, J. & Harrison, M. (2009) 'www.designingwithpeople.org: A new web-based resource for implementing design for social inclusion' Paper published in International Association of Societies of Design Research (IASDR) Seoul 18-22 Oct
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- Lee, Y. (2010) 'Development of the social implications of inclusive design and some thoughts on the next steps' Paper published in the 5th Cambridge Workshop on Universal Access & Assistant Technology (CWUAAT), Fitzwilliam College, University of Cambridge 22-25 March

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