MATCH

Home Care Technologies

Summary of Research Findings of the MATCH Project
Mobilising Advanced Technologies for Care at Home

Fitting in with people's needs

www.match-project.org.uk

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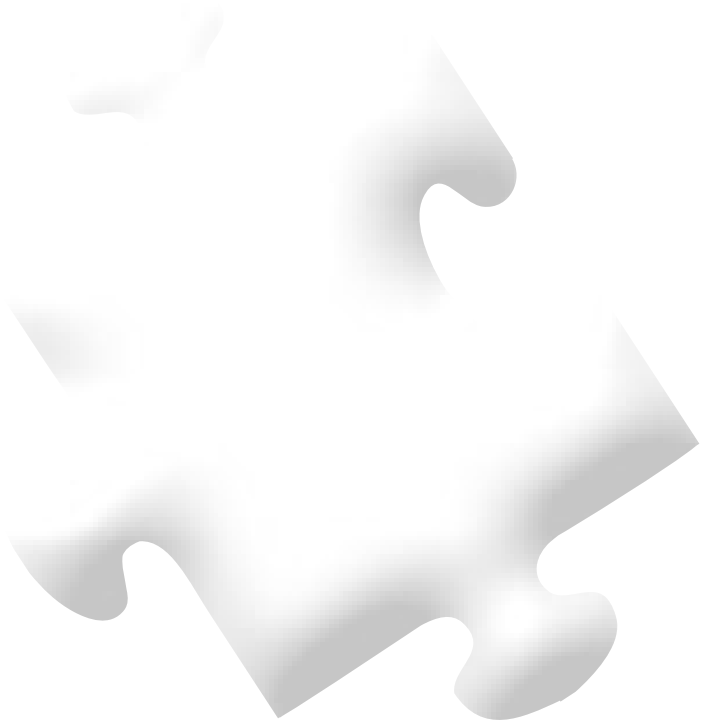

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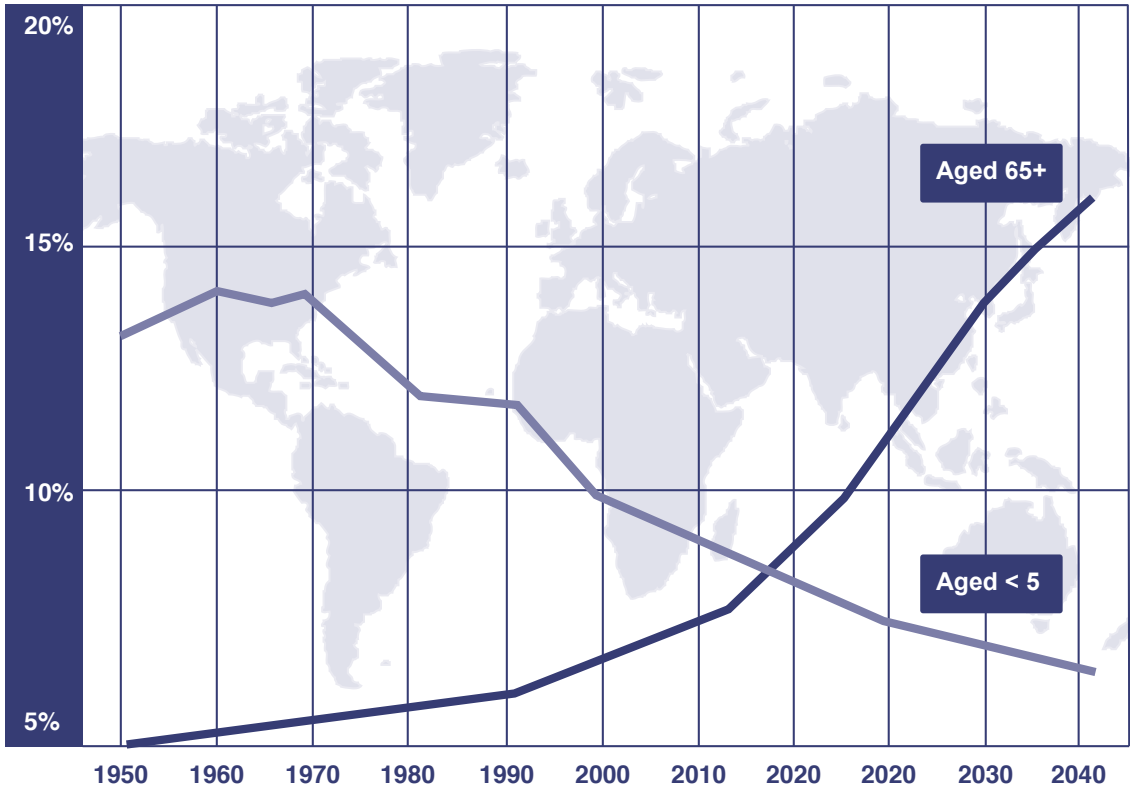
Introduction To MATCH

Context

The world population is ageing, with the percentage of older people (over 65) gradually rising. In the UK, for example, the figure was 24.4% in 2000 and is expected to become 39.2% by 2050. A similar situation applies in other developed countries, with much higher percentages forecast for some countries (e.g. 71.3% by 2050 in Japan). At present, older people receive care from family and friends or professional care providers. In future, it will become increasingly common to augment this care with services delivered by technology, allowing people to live independently in their own homes for longer. To offset this trend, older people are increasingly active and healthy. A larger proportion of older people will therefore not have the level of dependency that might be expected. However, age-related conditions are becoming more common. The growing percentage of older people, coupled with pressure on social and health care budgets, means that care providers will be increasingly challenged to cope.

Young children and Older people as a percentage of the global population

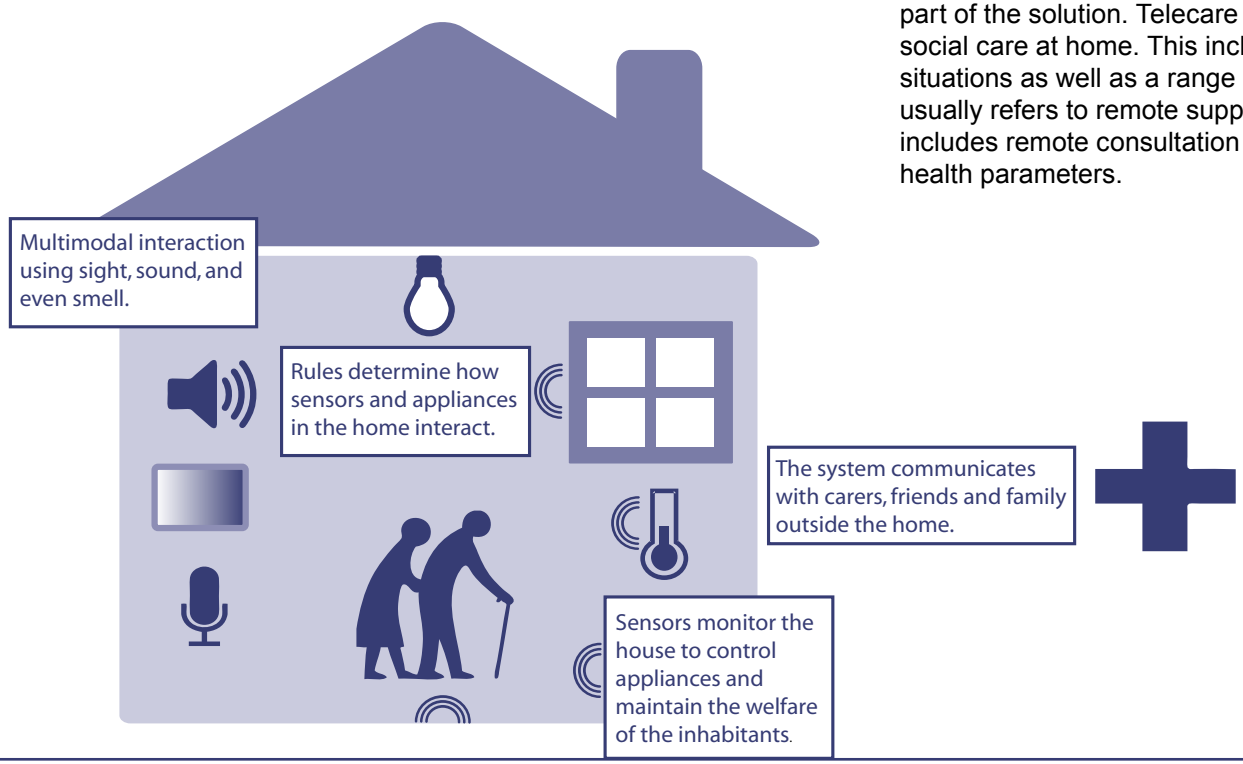


Source:
United Nations Department of Economic and social affairs, Population Division. World Population Prospects. The 2004 revision. New York. United Nations 2005

Technology To Support Independent Living

Home care technologies offer significant benefits. Particularly in rural settings, the ability to support care at a distance can save substantial travel. The user can be remotely given advice and support. Many health authorities are promoting self-care at home rather than relying exclusively on centrally provided care. Trends, anomalies and alert conditions can be identified and reported to a central location (e.g. a health centre or a call centre).

Family members can be reassured that the user is being monitored for undesirable situations. Professional carers can also be relieved of low-level monitoring tasks. Of course care will continue to require a significant element of human involvement, but routine aspects can be supported through technology.



Older people can be assisted to stay longer in their own homes, where they are in familiar surroundings and near to the people and the area they know. As a result, there should be less need to provide care homes (which are much more expensive than looking after someone in their own home).

Home care technologies are computer controlled, with different solutions for different purposes. To allow home care technology to really support independent living and to offer a choice for those receiving care, these systems need to communicate with each other and with the users in the house. Users need to be able to customise the system without technical know-how. Care providers have to be able to configure the system to support the user's needs.

Technology for home care has been enthusiastically embraced as part of the solution. Telecare usually refers to remote support of social care at home. This includes monitoring for undesirable situations as well as a range of services for the less able. Telehealth usually refers to remote support of health care at home. This includes remote consultation and diagnosis as well as monitoring health parameters.

The MATCH Project

The MATCH project (Mobilising Advanced Technologies for Care at Home, www.match-project.org.uk) conducted research into a variety of technologies for helping people to live more independently at home. This brochure gives a high-level overview of the project work and summarises the key findings.

The overall aim of MATCH was to develop a research base for advanced technologies in support of social and health care at home. This included care at home of those with long-term illness, physical or mental impairment. The project established a research infrastructure in the specific areas of home care networks, lifestyle monitoring, multimodal interfaces and speech communication.

The client users for MATCH included older people and people of all ages with disabilities. MATCH aimed to create a research network with sufficient breadth of expertise to explore issues for a range of needs. As examples, MATCH aimed to benefit older and/or disabled people living in their own homes, or in sheltered/warden-assisted housing.

In support of the overall aim, the high-level objectives of MATCH included the following:

- to create a centre of excellence in the field of technologies for home care
- to create a network of permanent staff from academic, industrial and care partners
- to elaborate existing techniques from the academic partners into a viable and integrated research base
- to integrate existing industrial products into the research base
- to integrate current care practices into the research base
- to prepare management and technical guides for use of home care technologies
- to establish care models for appropriate and ethical use of the technologies

The project set out to answer key questions about how home care might be supported through technology:

- what requirements do users have for a home care system?
- what is a good design for a home care system that allows for flexibility, customisation and adaptation to evolving user needs?
- how can a home care system observe how users behave in the home, and draw useful conclusions from this about trends and potential problems?
- how might users communicate with a home care system, both to use it and to configure it?

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The Caring Home

We envisage a home of the future supporting care using a collection of technologies from different providers. Some will be bought by the occupants from companies, and some will be installed by local authorities or health services. The individual solutions will not all be from the same company, and the capabilities will not have been designed to integrate closely (or at all). This will leave homes full of technology that needs to communicate with the occupants of the house who use it, as well as the care providers who install and monitor it. Each individual solution will also need to communicate with other solutions in the same house to work in an integrated fashion.

For the caring home to be effective, all of the following must be supported:

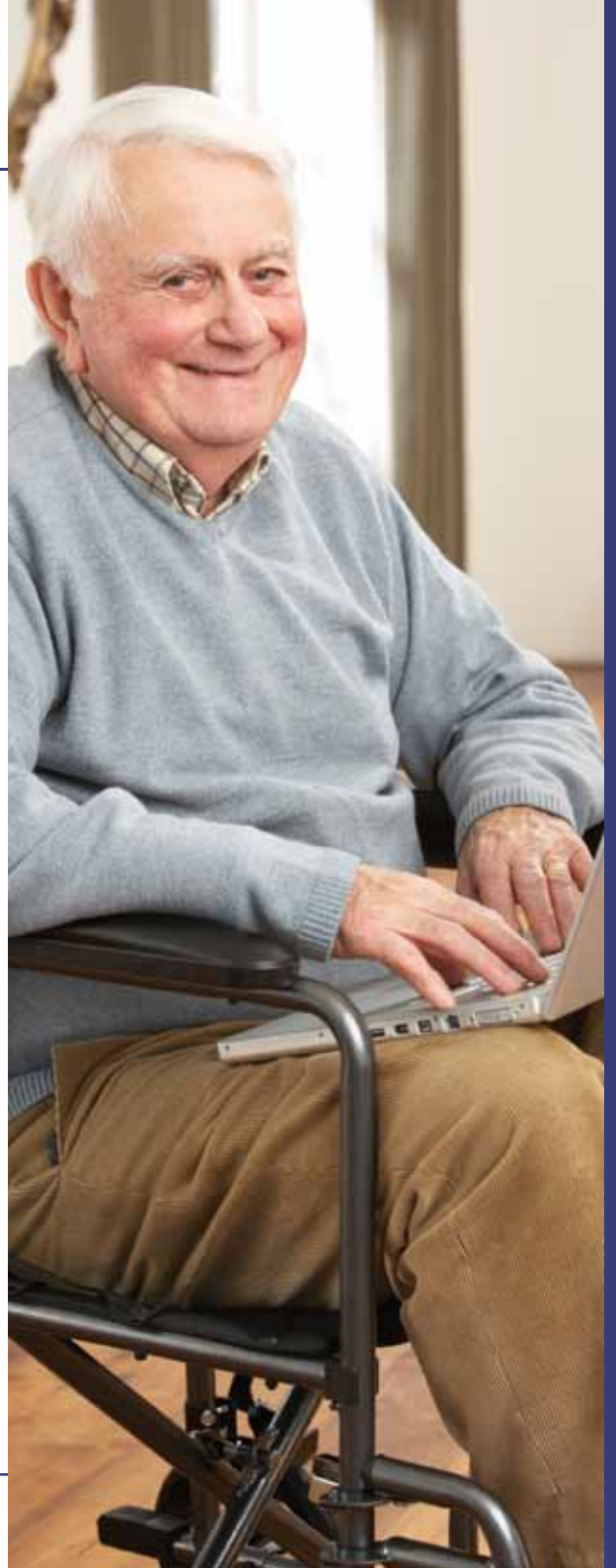
- the occupants of the home
- a collection of solutions using different technologies to achieve different goals
- appliances in the home such as lights, entertainment systems and white goods
- communications systems that link friends, family and care services
- events and activity in the home that need to be detected or monitored

At the moment, most appliances and devices in a home are independent of each other. If you wish to control the television, you find the remote control for that device. If your burglar alarm needs to know if a window is open, there is a sensor specifically for that. If you wish your heating system to know whether or not the window is open, it cannot ask the burglar alarm. If the TV in the lounge should automatically turn off if a sensor detects that you have gone to bed, this cannot be done because there is no way for the two to communicate.

Many current home care systems have limitations:

- they do not share components such as sensors or alarms – these are likely to be from different suppliers
- they are difficult to personalise or alter – one size does not fit all
- they offer little choice about how users interact with them – if an alarm is designed to make a sound, it will not work with a vibrating wrist band for users with a hearing impairment

MATCH has researched the needs of people who need help to live independently in their own homes. MATCH has developed approaches that make this happen.



User Requirements

MATCH was guided at every step by the needs and requirements of end users. To ensure that user needs were adequately represented, we carried out extensive studies to discover who the users would be, what their different needs were, and what obstacles existed to the adoption of technology. This was done by involving experts in social care and health care, a panel of older users, and informal carers.

We used questionnaires, focus groups and home visits to better understand our users and their needs. Firstly, the different user groups were identified. The occupants of a home (those receiving care and other residents) are the obvious users. However, other users include carers (both professional and family or friends), technology providers, and those who have a responsibility for the people in the home.

Focus groups involved social care professionals, policy makers, telecare technicians, informal carers and older end users. The main themes that emerged from these groups concerned the following:

Acceptance: Professional care providers claimed that older users had a higher degree of technophobia than the users themselves reported. Barriers to acceptance included negative views towards being monitored and the stigma attached to such systems.

Ethics and Privacy: Many users had concerns that monitoring systems would be an invasion of privacy. There was also concern from several of the user groups over legal responsibility for ensuring a home care system is working correctly and safely.

Personalisation: Different users have different needs, and these needs change over time. It may also be the case that two people share a system in the same home, each with individual needs. It is important that a home care system should be easy to personalise without the need for expert technicians. Users should also be able to choose how they interact with the system. MATCH studied several different modes of interaction as described later.

Awareness and Training: There was a general feeling across the focus groups that carers, users and professionals lacked an up-to-date understanding of the support that current home care technology can provide. Training will not only make it easier for people to adopt such technology, but it will also go a long way to removing misconceptions or fears about its use.

Live Forum Theatre

MATCH researchers were seeking high impact activities that would encourage dialogue within design communities, and between designers and users, as a way of changing the mind-sets of designers. They were also seeking powerful communication tools aimed at designers with little or no experience of inclusive design. It was postulated that professional theatre could be very effective in transmitting important messages about user characteristics to this group.

Format

The format consists of a 'story' which is scripted in close collaboration with the researcher(s). Professional actors are carefully briefed to create 'real', believable characters both for the scripted performance and for the subsequent extemporary dialogue with the audience. A facilitator provides the interface between the 'story' and the audience, and encourages the audience to debate the issues raised and related issues. The format allows the audience to interact with the actors, who stay in role. Where appropriate, the audience itself can change the story, or propose changes which are then enacted. At crucial points in the story, the facilitator enables the audience to discuss, debate and further the ideas and concepts. The characters in the drama are generally seen in the story trying to use technology, often with mixed success. The story is not focused on the technology, however, but rather on the characters themselves, their relationship with the technology and the effect that it has on their lives. This helps the audience to engage with the characters and their situation, to project their own concerns onto the characters, and to express these concerns in the discussion sessions. Stakeholders in the audience can express views and comments in the context of the characters and the story, with less risk of offending other groups or individuals. The drama also gives a clear focus and reference for discussion, enabling the facilitator to return the audience's attention, when necessary, to the main thrust of the story. Theatre offers a way of engaging multiple stakeholders and different user groups in the requirements gathering process; contrasting priorities and agendas may be seen to emerge.

Picture right

"Shirley" (left) and "Fred" (right) discuss their home situation with "Mary" the Occupational Therapist (centre), who suggests options, including technological options, to help make their life at home easier. Scene from drama that MATCH used in live forum theatre for stakeholder engagement, using the Wolfson Theatre at the School of Computing at Dundee University.

System Platform

To allow different solutions from different providers to work together, we need to solve a number of problems. Firstly, we need to choose a standard system platform and adapt it for use in home care. Next, we need a method for defining everything in the home care environment so that each solution can understand the other solutions it has to interact with. We then need a way for different systems to be coordinated, configured and controlled.

We adopted an industry-standard architecture called the 'Open Systems Gateway initiative' for software-based components. MATCH then adapted this for use in home care systems. Any product, from a simple sensor to a full scale system, that conforms to this approach will be able to interact with other products that also conform. This allows providers to develop new products without the need to specifically integrate them with those that might be installed in the home. They can simply be added to the home in a 'plug and play' fashion. MATCH has pioneered the approach by creating support for many kinds of care technologies.

The MATCH system uses a home network that may be wired, wireless or a combination of these. The home network links devices such as sensors, computers, mobile phones, and various kinds of controllers. Even a simple system that turns on a light when somebody enters a room after dark requires two sensor nodes: is it dark, and has somebody just entered the room? A controller is also needed to activate the light under control of some software. Of course this particular capability could just have been specially designed, but with reduced flexibility and re-use. Once the light sensor is on the network, any other product, current or future, should be able to discover the service it provides (measuring light level) and make use of it.

Home Devices as Services

One aspect of the MATCH work is that home devices are considered to provide services. That is, the emphasis is on how devices support services to help the user. System components can find out what other services exist by using a process called service discovery.

For example if we add a security service, it should be able to discover window, door and movement sensors. This will allow the security service to automatically make use of these devices.

How does a component know what existing ones offer?

It is not enough to look up their name – 'movement sensor' might not mean anything to other devices. We need to introduce real meaning into the description of each service. MATCH has developed a hierarchical representation (a kind of dictionary) for the meaning of services provided by components in the home care system.

Adjusting The Home Care System

The MATCH approach integrates different solutions, allowing them to share services and communicate through a common architecture. We then need to find a way for the users to control and alter how the home should support them. This makes the system much more flexible, customisable and adaptable.

Current home care systems are relatively fixed, requiring expert re-programming where a change is needed. It is desirable to allow the user, or their family and carers, to modify how the home care system behaves. This requires a method of changing the software that controls the system, but without the need for programming knowledge or technical expertise. Goals and policies for home care are used to achieve this.

A goal is a high-level objective for how care should be supported. For example, a user might wish to be comfortable, to adhere to medical advice, or to save energy. Goals are triggered by things that happen around the house. This leads to a selection of various policies (i.e. rules) that decide how the house should behave. Goals have different levels of importance, and may even conflict with each other. The MATCH system is able to detect and deal with such conflicts.

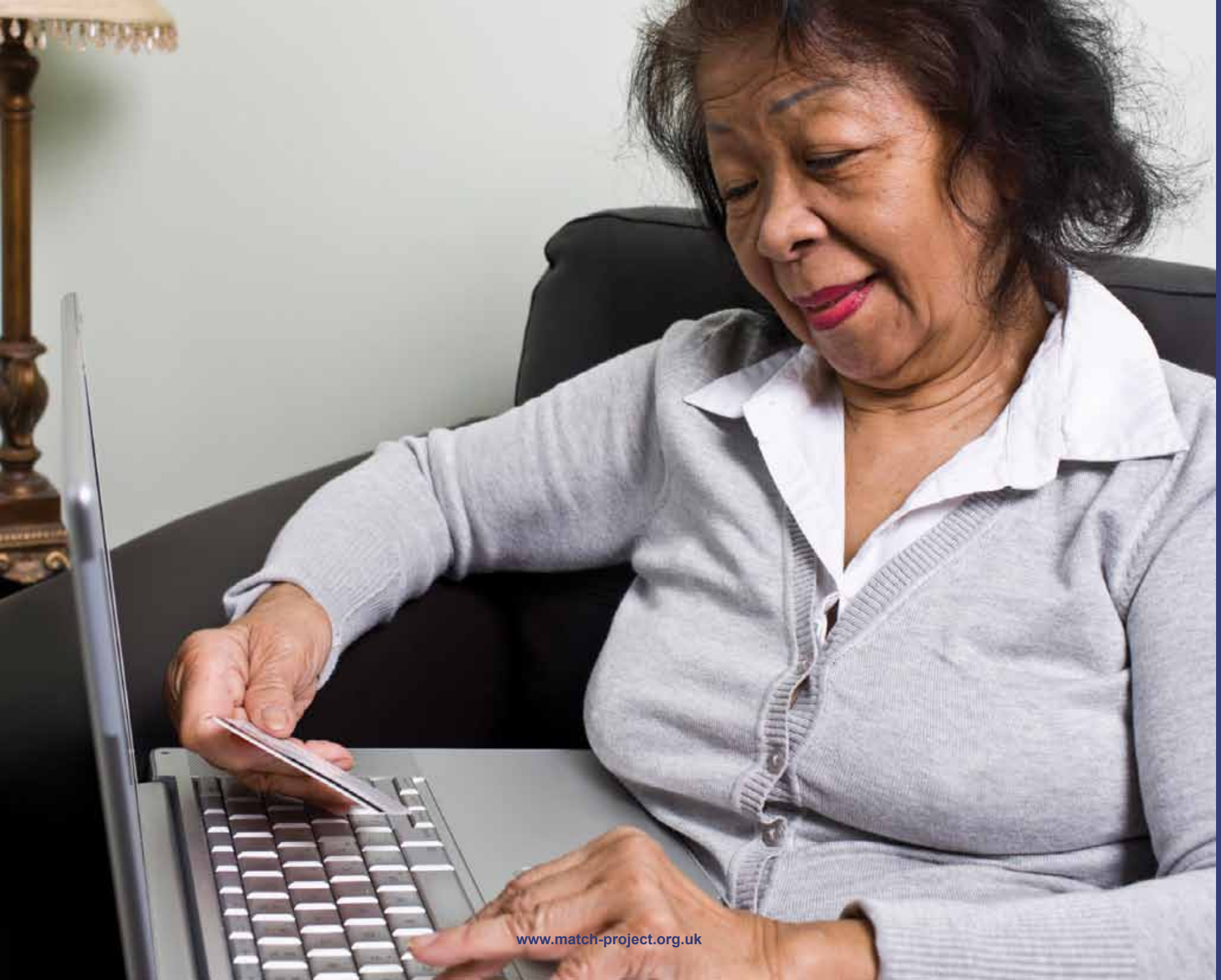
A policy specifies how the home should react in various circumstances. For example, the policy might contact a call centre if a flood sensor is triggered, or might alert a family member if the user forgets to take medicine. Policies associate events (e.g. medicine not taken) and conditions (e.g. it is a weekday) with actions (e.g. to send a text message to the daughter). Like goals, policies might contradict each other so the MATCH system handles this. Goals and policies give users the flexibility to change the way their home behaves without the need for technical knowledge. The approach also works with many kinds of appliances and devices.

Interacting with The Home Care System

You interact with your TV using a remote control, you set the burglar alarm using a wall panel, and you set the room temperature with the thermostat. Your alarm clock buzzes to wake you up, your mobile phone vibrates, and your smoke detector flashes if the battery is low.

For older users, some modes of interaction are better than others. Arthritis can make small buttons hard to press, while deterioration in vision can make screens less useful. Regardless of age, people have different preferences and different capabilities, all of which can change over time depending on their individual circumstances. Ideally, users would be able to choose a mode of communication that suits them best. Allowing this level of personalisation not only increases the likelihood that the system is more usable but also ensures that it is more enjoyable to use by the individual.

We have studied the different ways in which people – older people and those with sensory impairments in particular – may prefer to communicate with home care systems. This has included using several senses (sight, hearing, touch and smell) as well as ways to convey information to users. We have studied how age affects hearing and speech. This allows us to recognise speech from older people, and to produce spoken output that is easy for older ears to understand.



Multimodal Interaction

The User Interface

Much of the interaction between a user and a home care system or device has the form of a command (e.g. turn the heating up) that causes the system to take some action (warming the house). The system may also need to deliver messages to the user, for example an acknowledgement of a command or a reminder to do something such as take medication.

Short messages can be delivered via any modality – a sound or a spoken message, a light flashing, a message on a screen, a wristband vibrating, or a scent discharged from a controllable device. A system should allow users to choose how they wish to receive messages. Fixed messages are defined by a system and have a specific meaning. For example, when the oven timer reaches zero it makes a predefined 'ping'. Text messages, on the other hand, are variable and need to be notified in a different way.

Sound

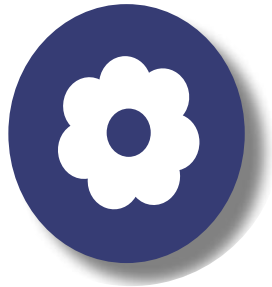
We have used sounds as methods of delivering fixed messages. An auditory icon is a sound that relates directly to the meaning of the message, e.g. the sound of a bin being emptied. An earcon is more abstract, usually a series of notes that have less (if any) relationship to the message they convey. Neither auditory icons nor earcons employ speech, which is a third option for delivering a short message. The choice might be a matter of preference, but each offers different levels of comprehension, privacy and intrusiveness. Speech requires no learning, auditory icons might need some learning and some creativity in picking the right sound, and earcons need the most learning. However, earcons can be the least intrusive and offer the most privacy as they do not advertise what is meant.

Touch

Your mobile phone can vibrate when you receive a phone call, but this kind of signal is very basic. We developed tactons, which are tactile messages. A tacton can be structured by varying the frequency, rhythm or location of the vibrations. Users are able to learn the meanings of a number of tacton messages. A simple and discreet way to deliver these messages is by using a small disc worn against the skin. This type of message could be used by people who have both hearing and visual impairment. When a message is private (e.g. to visit the toilet) it can be delivered directly to the user.

Smell

The use of smell for delivering messages has been largely overlooked by researchers. However, a smell can be very evocative of memory and emotion. We found that smell could be more suitable when other senses or memory are impaired. Someone with memory impairment, for example, could be notified by an appetising smell that they should have lunch.



Speech Interfaces For Older People

Interaction with technology via speech is becoming more mainstream. Apple's Siri on the iPhone, for example, recognises human speech and delivers messages back to the user with synthesised speech. The interaction is controlled using a dialogue management system.

Speech recognition becomes more difficult as users grow older, however, because age-related changes of the lungs, throat and mouth change what speech sounds like. Hearing also becomes less acute with age, which means that people may find computer synthesised speech more difficult to understand.

MATCH researchers at Edinburgh investigated to what extent speech can be used in the interface between older users and a home care system. They found that speech recognition systems often need extra training to work well with voices that show signs of ageing. Training sessions need to be carefully designed to reflect the type of speech that systems will be expected to recognise when in use.

Although the team found that computer synthesised voices can be difficult to understand, especially when long and unfamiliar words are used, older people can understand messages with familiar words and simple structures easily. This suggests that complex information and longer messages should be delivered multimodally, with visual backup for audio.

The way in which users interact with voice interfaces varies. It seems that the natural quality of speech interaction encourages a more chatty dialogue style, particularly in older users. However, dialogue systems are more reliable when users keep to short, factual responses, because the amount of possible inputs is more tightly constrained. This needs to be kept in mind when designing interactive systems.

Lifestyle Monitoring

Our research has shown that some people are uneasy about being monitored in their own homes and that video cameras can make people uncomfortable. For older people to live safely in their own homes, it would be helpful if home care technology could watch over the household to look for immediate problems such as a fall or longer term changes such as the cooker not being used as much as it used to be.

Busyness

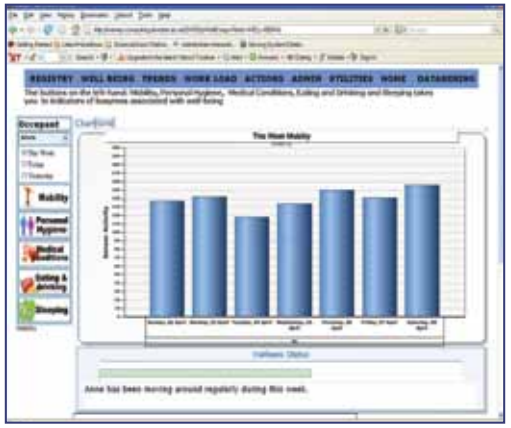
Within MATCH, investigation was conducted into “busyness” in the home. Investigation was based on the approach of measuring activity and seeking to find whether a busyness model of a person’s life could be built to describe the lifestyle of that person as an indicator of well-being.

“Busyness” in this context was a measure of overall movement and activity within a dwelling, and of interactions with objects. Busyness is an aggregation of movement and activity within the home to give an overall view or measure of people doing things, without detailed analysis or representation of the individual activities that people are undertaking. Busyness is seen as potentially describing or characterizing the lifestyle of an individual. The intention would be to build a busyness model of a person’s life which, in conjunction with contextual information, could give indications of well-being for that person. Following from this, changes in busyness patterns or levels might indicate changes in well-being which should be looked into by carers.

Domestic Well-being Indicator System

MATCH investigated how to identify those aspects of life that are regular and relate to well-being, and how to present information about how they evolve and change, with a particular emphasis on engaging key stakeholders such as domestic residents and their carers with this information. The concept of well-being was important and changes in well-being needed to be illustrated to these stakeholders so that they could understand them and react to them. The development of a system to display well-being in an understandable manner was therefore undertaken – a Domestic Well-being Indicator System (DWIS).

Example displays of prototype user interfaces for the DWIS are shown here.



Example display of the prototype user interface for older people / residents.

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