A computer for the mature: what might it look like, and can we get there from here?

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The prevailing personal computer paradigm emerged from the hobbyist market, and is arguably still oriented towards that segment, coercing us all to become like hobbyists, and failing to serve many of the population, especially people who are more mature than most technology designers. Based on a variety of research including two years working with older people on technology design, we present some general requirements of people in the second half of their life, critique the prevailing PC design, suggest some characteristics of genuinely usable and useful computer technology for all of us as we grow older, and consider how if at all such technology may appear.

Keywords: Aging Ageing HCI technology TAM accessibility usability.

1. INTRODUCTION

As we progress through the second half of our lives, our abilities, interests, preferences, enthusiasms and motivations change significantly. Unfortunately most ICT is designed by, and largely for, computer enthusiasts in the first half of their lives, many of whom find it difficult to imagine the lives of others or indeed their own future life. This disparity means that for many (not just older) people, the home or work PC as currently conceived is completely inappropriate for their needs, and frequently a source of considerable annoyance and frustration, eventually leading to technology abandonment for many people.

Based on a wide range of research with older people and technology, this paper:

- discusses technical, practical and commercial problems with the current PC paradigm;
- explores the changes which often accompany aging, especially as they affect technology use;
- discusses the attitudinal factors which influence adoption, effective usage and rejection of technology by older people;
- attempts a completely fresh look at user requirements for the older population;
- dreams a little of what a genuinely useful computer might be like; and
- considers whether and how such technology may appear.

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2. TODAY'S COMPUTERS – THE PROBLEM

It would be easy, but self-indulgent and unoriginal, to begin with a polemic about the inadequacies, failings, annoyances and frustrations of today's PCs. It has already been done, in books by noted researchers, including Don Norman's (1999) "The Invisible Computer" and Alan Cooper's (2004) "The inmates are running the asylum". The subheadings of these respectively are "Why good products can fail, the Personal Computer is so complex, and Information Appliances are the solution" and "Why High-Tech Products Drive Us Crazy and How to Restore the Sanity".

This section instead provides a brief summary of parts of these two insightful books, observing that many of the problems apply particularly to older users, and notes that in the intervening years PCs seem to have got worse, not better.

General purpose personal computers for domestic or workplace use have evolved over the last 35 years, in an industry founded and still dominated by hobbyists and technology enthusiasts. Many fundamental design decisions in areas such as interface complexity are made by computer experts instead of by user champions. The latter might

recognise that many people would benefit from (and perhaps purchase) devices which set out to be life-enhancing or task-enabling, undemanding and unintrusive, and have interfaces which speak the user's language rather than expect "computer literacy". The industry needs to shift its focus from the technology to the task.

According to Norman (1999, Chapter 4) computers are jargon ridden, too general purpose and hence over-complex and sub-optimal for any particular task, overbearing and dominating, and above all attempt to become the focus of attention instead of a medium to improve focus on a task. The industry is addicted to adding extra features instead of extra usability (ibid), or as Cooper (2004, p198) puts it:

"These gadget-obsessed programmers love to fill products with gizmos and features, but that tendency is contrary to the fundamental design insight about good design. Less is more."

People who struggle with PCs tend to be dismissed as lacking in "computer literacy" instead of the industry recognising its poor user and task literacy

Older people and indeed many others would benefit if the PC industry and culture moved from the hobbyist paradigm to a domestic appliance paradigm. Norman (1999) compares PCs to the Swiss army knife – capable of many functions but optimal for none, and overly complex. As a remedy he describes "Information Appliances"; devices which perform a single task very effectively.

A few devices have since appeared which are nearer to this description and have met with market success; e.g. the iPod music player; the Kindle book reading device, tablet computers. Such devices are designed for a single purpose, optimised for that purpose, and the interface is uncluttered by extra functions.

In the years since Norman and Cooper, general purpose computers have got considerably worse than either author could have imagined. Modern computers are designed to be regularly connected to the Internet, and many software components require regular automatic updates. This creates a feeling of loss of control, and possible loss of software quality as suppliers become more complacent. The virus problem is not yet solved and has become more virulent. Older people tend to have a heightened fear of viruses, malware and hacking. Operating systems and versions proliferate, each with different usability characteristics creating an impression of inconsistency. Software is becoming bloated with features and complexity; for instance a leading Word processing package has over 1600 controls. Despite ever increasing processing power and memory capacity, PCs are slower to start up than 20- years ago, and (from the perspective of older users) slower than the TVs of the 1950s. Sometimes the close down process takes extra time as updates have to be applied. The computer is rapidly becoming the master rather than the servant. Software programs exchange personal information in a secretive and impertinent way, leading to targeted advertising and loss of privacy – a concern particularly common in older users.

Norman (1999) presents a maturity model for developing technologies, in which technology and extra features dominate while the product is immature or consumers are thought to want more features, and later, at maturity, the functionality is deemed to be sufficient and companies focus on improving user experience. The capabilities of computers are so fast progressing that arguably they have not entered the mature phase.

A temporary cohort effect?

Sometimes it is suggested that the difficulties older people can experience with computers are a temporary problem affecting just the current generation of older people who grew up without access to personal computing technology. This neglects two important factors: firstly that older users often abandon a technology which they have previously used and found beneficial; and secondly that technology moves on, and familiarity with computers of 2012 will not guarantee ability with the technology of the future.

3. RESEARCH BASIS AND METHOD

Good research always begins with a literature review, which prompts a research question, then a study design, study, analysis of results, drawing conclusions and reflecting on them; at least that's what we feel obliged to claim in our dissemination activities. Our findings are based on all of those components but they have been conducted in a far less neat and systematic manner than we would normally admit.

Our main sources can be summarised thus:

- Listening to and trying to understand the struggles of older people with technology for the last two years;
- Immersion in the academic literature of HCI for the last four years;
- Personal reflection on 30 years work in an emerging computer culture.

The authors have been working with older users of technology as part of the University of Nottingham's contribution to the MyUI project (www.myui.eu ; funded by the European Union MyUI project under

grant FP7-ICT-248606), involving over 40 field study visits conducted in 2011-12, over 130 hours contact time with between 1 and 5 researchers and >240 engagements – formal and informal – with over 110 older people, picking up a wealth of systematic and anecdotal information while conducting a wide variety of studies using multiple methods (Edlin-White et al, 2012). The author has also observed a series of computer support drop-in sessions in the computer suite at one of Europe's largest retirement villages.
The author also spent 30 years working in IT departments of large blue-chip companies, followed by 4 years working in (and immersed in the literature of) academic HCI. This paper is also partly based on reflection on the commonalities and contrasts, as well as on his own personal journey from being an enthusiastic early adopter of leading edge technology in 1975 to his very pragmatic and selective approach in 2012 at the age of 55.

Finally, so that this is not a merely anecdotal and opinionated polemic, the ideas which emerged from this process and are presented here were discussed with two focus groups of older people in a retirement village in Nottingham, and modified in the light of their input. The method adopted was to start with open questioning, and gradually move towards checking specific pre-existing notions.

4. AGE-RELATED CAPABILITY CHANGES AFFECTING TECHNOLOGY USE

Much excellent material has been written and guidelines produced concerning technology design for older people and those with disabilities, (e.g. Pernice & Nelson, 2002, Carmichael, 1999, Fisk et al, 2009). The ISO document "*Ergonomics Data and Guidelines for the application of ISO/IEC Guide 71 to products and services to address the needs of older persons and persons with disabilities*" (ISO/TR 22411, 2008) is an excellent source in this area. These sources tend to provide strong guidance on physio-motor and sensory impairments, some guidance on cognitive impairments, but, as we will see in section 5, don't address many of the more fundamental motivational issues which affect technology acceptance or rejection. This section briefly discusses the value and importance of such guidance.

However, more important and more fundamental than these are the attitudinal factors which affect whether an older person will adopt or reject a technology, or even abandon one already in use. This is discussed section 5.

4.1 Physio-motor and sensory changes in healthy aging

(Smith, Norris & Peebles, 2000; Fisk et al, 2009)
People age very differently. What follows are population trends.
Physical & motor: Decrease in height, weight, strength, joint mobility, including grip strength and digital dexterity, decrease in fine and gross motor control (e.g. tremor, clumsiness). Mobility impairments.
Visual impairments: accommodation, acuity, contrast detection, visual field, glare effects & dark adaptation, interpretation of movement and speed.
Hearing: loss especially at high frequencies (consonants, alarms, female voices); poorer temporal resolution, frequency discrimination & localisation.
Other sensory: Proprioceptive & vestibular faculties – some decline ("unsteady on feet"). Tactile sensitivity of hand often retained. Taste and smell can decline.

4.2 Cognitive changes in healthy aging

(e.g. Salthouse, 2010; Fisk et al, 2009)
All highly correlated with sensory and socialisation decline.
Memory: declines in episodic memory (especially for names),
Working memory (or effective use of WM; especially when in conjunction with other cognitive demands) and prospective memory.
Attention: decline in selective attention (focus on task; ignore distraction; also noticing change in "blocked out" areas); divided attention; attending effectively to multiple simultaneous tasks; visual search
Language: comprehension well retained but articulation (& unprompted recall of vocabulary) can slow or become impaired
Slower processing speeds across many tasks; including reaction times

Many cognitive abilities are well retained in older age, or even improve; e.g. semantic memory, procedural memory, focussed attention, crystallised intelligence, emotional maturity, expertise, soundness of judgement, creativity etc.

Design implications

Some key trends with respect to technology interfaces: (see also Fisk et al, 2009)

- Preference for familiar metaphors, consistent and stable interfaces which maximise use of crystallised intelligence and less reliance on visual search or "spotting" what's changed.
- Directing attention selectively and ignoring distractions (e.g. on cluttered displays) is often more difficult for older users.

- Low confidence with technology; less likely to learn by trying; fear of "breaking it".
- No specific love of new technology for its own sake; leads to extreme pragmatism; need to explain lifestyle benefits.
- Tendency to ignore much functionality or abandon altogether, especially if it makes them feel stupid, angry or frustrated.
- Learning: more effortful (but mastery is possible). Motivators for learning: valued functionality ("sell it to me"), aesthetic appeal, familiar standard stable metaphors.
- Learning styles – different; human input & support much preferred; also manuals and handbooks. Less learning by unsupervised experimentation; lower use of online resources.
- Low willingness to buy into a designer's mental model, or a technology driven model. The interface should be based on the user's understanding of the task.
- Wizard style interaction may be better for unfamiliar / rarely attempted tasks.

5. AGE-RELATED ATTITUNIDNAL CHANGES AFFECTING TECHNOLOGY USE

As we have discussed, capability factors are important to take into account when designing technology for older adults, to improve accessibility, performance and enjoyment. However, a more fundamental and important area is the attitudinal, motivational and psychological factors which can lead older people to adopt or reject technology, learn how to use it effectively, continue to use it in life-enhancing ways, or perhaps to abandon a technology, disenchanted and frustrated.

The HCI and Human Factors Design disciplines have in recent years increasingly recognised the importance of affective factors. E.g. Jordan (1998), Green & Jordan (2002), Aboulafia & Bannon (2004), Hancock et al (2005), Peter et al (2008).

5.1 Factors influencing technology acceptance

Davis' (1989) Technology Acceptance Model (TAM) identifies the main clusters of motivation to be in the categories of Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). Later he and others (Venkatesh et al, 2003) reviewed and tested 8 models of technology acceptance and created a Unified Theory of the Acceptance and Use of Technology (UTAUT) which included factors such as performance expectancy, effort expectancy, Attitudes towards technology, social influence, facilitating conditions, self efficacy, anxiety and intention.

Based on literature review, Chen and Chan (2011) recommend extending TAM to make it more relevant to older users by adding factors relating to bio-physical and psychosocial characteristics, whereas Chung et al (2010) found TAM adequate to predict use of online communities by older adults. Nayak et al (2010) found attitude, good health, (perceived) usefulness and gender were the main factors predicting Internet usage in older adults. Wang et al (2011) based on factor analysis of survey data, labelled the four main factors as needs satisfaction, public acceptance, perceived usability and support availability.

Based on this literature and our own studies, some important factors seem to be (1) that the technology appears to be genuinely life-enhancing and could contribute to one's quality of life; (2) it should be easy to assimilate into one's lifestyle; issues such as purchase cost, delivery, unpacking, installation and any setup activities; (3) it should be easy to learn, preferably with a manual or face to face instruction; (4) it should be durable, reliable, stable and trustworthy; (5) it should be easy to use for the individual (with their particular combination of abilities and limitations); (6) it should speak the user's (task-oriented) language, not draw them into its own jargon; (7) it should maximise simplicity and avoid unnecessary functionality.

5.2 Factors influencing technology rejection

Reasons for technology rejection or abandonment do not seem to have been studied in the same way. Researchers such as Neil Selwyn (2003, 2006) provide insight into the categorisation of older non-users of technology, but not into the motivational factors influencing rejection or abandonment.

From our own studies and work with older people, it is very clear that reasons for rejection or abandonment are not merely the opposite of reasons for adoption. Rejection tends to be for reasons of loss of self confidence and self-efficacy, a breakdown of trust in the system, feeling patronised, feeling the system is untrustworthy or unstable, or that it isn't for "people like me"; i.e. it doesn't meet the user's needs.

6. WHAT DO OLDER PEOPLE WANT OF TECHNOLOGY?

Based on systematic and anecdotal findings from our body of research with older people in 2011-12, and in particular the Focus Groups on this topic, some clear themes emerge. To be attractive to these older people, technological products should be:

- Life-enhancing
- Learnable
- Accessible
- Easy to use & "speaks my language"

- Enjoyable
- Durable
- Stable
- Reliable
- Affordable
- Simple – and drop most of the functionality
- Support for learning and use – in person
- Guaranteed (Sale of Goods Act)
- Single purpose (not phone with camera & music)
- Task oriented, not technology
- Ambient / ubiquitous
- Modest, going into the background, not demanding attention

Personal computers, by contrast, are often:

- Fragile, with important software on the vulnerable medium of a writable hard disc, vulnerable to bugs and pollution from viruses or accidents of various sorts.

- Lazy, expecting the users to "get it working" – e.g. by installing or upgrading software or components such as "drivers" or anti-virus software.

- Irresponsible, fitted with semi-tested software provided by complacent companies who think they can always issue online updates.

- Too self aggrandising – wanting to be in focus rather than to fade into the background and unobtrusively help the user with their task.

- Intrusive – not respecting the users privacy, but sharing information behind their back.

- Overbearing, not service-oriented.

7. WHAT MIGHT A GENUINELY USEFUL COMPUTER LOOK LIKE?

Reflecting creatively on the themes above, and technological hardware and software possibilities, one imagines something very different.

There is little or no need for a hard disc. The users want stable, reliable and trustworthy, but current computers are inherently changeable and in constant flux, due to the software being stored on a writeable medium, making it vulnerable to viruses, bugs, accidental damage on the part of the user, and uncontrolled online updates form the vendor. This allows software vendors to evade responsibility for quality, since the software isn't under their control. Supportable software could be provided on a non-rewritable medium such as a ROM, or – performance permitting – loaded automatically from the vendor's server.

Operating systems should be invisible. The only visible controls should be task oriented; the operating system should serve the task.

Personal data stored securely on cloud or on portable device (memory stick or similar). This would include software portfolio preferences and registrations, and accessibility preferences, giving consistent experience in multiple locations and hardware platforms.

Peripherals should be interchangeable and genuinely "plug and play", to improve accessibility by the use of personally chosen devices. Adaptive interfaces which detect a user's accessibility needs and automatically adapt to them (e.g. see www.myui.eu) may be beneficial, if problems of perceived instability can be addressed.

Systems should of course be designed so that there can be no viruses or other malware.

Systems should be turnkey solutions, with no boot up or slow power down procedures. Switching on or off should take no more than about a second, and use a proper switch like a light switch. Turning a device off should have the obvious meaning; i.e. that it stops consuming electricity. Too many types of "offness" cause confusion..

Simplicity. There should be no unnecessary or unwanted programs or toolbars or other cognitive clutter. Everything should be pared down to the essentials. Similarly all software user interfaces should start up in basic mode, and any extra features should be in an expert user mode.

All jargon and advertising should be avoided and meaningful names used. If programs have to be named, the name should indicate the function only. E.g. "Document reader" not "Adobe acrobat" (which means mud and gymnast); "Web" not "Mozilla Firefox" (which is meaningless); "email" not "Microsoft Outlook Express" (which is the name of a company and then two words which are not linked to letter writing).

Provide life enhancing functionality; e.g. social communication, exercise, puzzle and games, medical and health information, reminders, travel information / booking etc.

All software should be task oriented in its user interface, not technology oriented. Task oriented controls do not require the user to learn a new mental model.

All interfaces, including icons, should speak the user's language, not new coinages or technical jargon.

8. CONCLUSION – A WAY FORWARD?

The problems Norman (1999) and Cooper (2004) identified with general purpose PCs have got considerably worse in the intervening years. These problems impact particularly on older people and indeed all of us as we grow older.

It is very difficult to envisage any likely route by which personal computers might evolve from their current state to the sort of computer described above. Commercial interests seem likely to create inertia and retention of the current model, which serves part of the population well and part badly.

We have noted that devices similar to Norman's (1999) "Information Appliances" have appeared. Such single purpose devices so seem to appeal to many who find PCs unappealing. There is evidence that older people prefer mobile phones which only do calls and texts, and tend to ignore photography or music facilities. The next generation of web-enabled interactive TV may provide some key services using a device which is well accepted in many older people's lifestyles and homes. From our research it is very clear that the Kindle is exceptionally popular with many older people.

It may be that the personal computer industry will remain with its current model, serving mainly technology enthusiasts, but that more Information Appliances, optimised for specific tasks, and designed by the domestic appliances industry rather than the computer industry will become available and provide beneficial accessible services for those segments of the market who are not attracted to personal computers; solutions (to user problems) rather than applications (of technology).

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