Assessing the Inclusivity of Digital Interfaces - A Proposed Method

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Abstract. In the assessment of the inclusivity of products with interfaces for digital devices, there are difficulty and validity issues relating the cognitive demand of using and learning an unfamiliar interface to the capabilities outlined in the population source data. This is due to the disparity between the types of cognitive tasks used to create the source data, and those needed to operate a digital interface.

Previous work to understand the factors affecting successful interactions with novel digital technology interfaces has shown that the user's technology generation, technology prior experience and their motivation are significant. This paper suggests a method which would permit digital interfaces to be assessed for inclusivity by similarity to known interaction patterns. For a digital device interface task that contained a non-transparent or novel interaction pattern, then the resulting cognitive workload could also be assessed.

Keywords: Inclusive design · Exclusion audit · Errors · Older user · Usability · Prior experience

1 Introduction

1.1 Inclusive Design

Inclusive design is a general approach to designing in which products and services address the needs of the widest possible audience, regardless of age or ability [1]. Implicitly it recognises that ageing, capability impairment and disability should be designed for wherever possible in the goods and services for use by the mainstream population. It has been shown that adoption of inclusive design approaches during the design and development of mainstream products and services can not only improve the uptake for those with capability impairment, but also improve the user experience for those who do not consider themselves impaired [2]. From the authors' experiences it seems that many people prefer tasks that require less of their capabilities (typically: visual acuity, dexterity, cognitive ability) to be achieved successfully.

M. Antona and C. Stephanidis (Eds.): UAHCI 2015, Part I, LNCS 9175, pp. 25–33, 2015.
DOI: 10.1007/978-3-319-20678-3_3

1.2 Digital Interfaces

It has been recognised for some time that interfaces for technological devices can be difficult to use, and particularly for older people. Docampo Rama [3] defined the technology generations that cohorts of people fell into based on the dominance of a style of technology interaction when those people were in their formative years. For example someone born in 1930 would be considered to be a member of the electro-mechanical generation, due to the dominance of this interface technology in their life experience until age 25. In this paper, we shall use the expression 'digital interfaces' to refer to any type of interface that incorporates electronic controls with an electronic display screen ('display style' and 'menu style' interfaces) including the most recent style: touchscreen interfaces. Interfaces for digital devices are continuing to become more prevalent including for devices that previously were analogue, e.g. domestic heating thermostats and timers, fixed line telephones, automobile climate controls, household appliances etc. This prevalence does not come without a cost: some people find digital interfaces difficult, and in some cases impossible, to learn and to use [4]. This is perhaps best summarised by Bjarne Stroustrup, author of the C++ programming language:

> *"I have always wished that my computer would be as easy to use as my telephone. My wish has come true. I no longer know how to use my telephone."*

However, extrapolating the difficulties individuals face using digital interactions to population exclusion is currently problematic, as the currently available tools are insufficiently developed and population data sets inadequate to do so, although recent work has attempted to fill this gap [5].

The University of Cambridge's Inclusive Design Group within the Engineering Design Centre (EDC) has developed a method of estimating UK population exclusion [6] by reference to a UK nationwide disability survey which assessed the abilities of over 7,000 randomly surveyed people [7]. However the current exclusion calculation does not take into account the prior technology experience of the users nor their expectations and familiarity with the ever increasing possible number of digital interaction types and styles [8]. For example, until the widespread adoption of capacitive touchscreens on mobile devices, the idea of 'swiping' a screen to effect an event was very unfamiliar.

The fragility of learning of newly acquired heuristic and procedural knowledge is also not currently addressed in the exclusion calculator. These effects have a very strong impact on the success or otherwise of the interactions that any user will have with digital interfaces. Older users in particular, are likely to exhibit perceptual, sensory and motor skill variability [5, 9] which will affect their interactions with technology devices, and in particular technology devices which are new to them, and/or exhibit unfamiliar interaction styles.

Exclusion Calculation. The proportion of the adult UK population who are unable to achieve certain interactions due to degradation of perceptual and motor skill performance can currently be estimated using the Inclusive Design Toolkit's exclusion calculator [6], by comparison of task difficulty to data collected in 1996/7, the Disability

Follow-Up Survey [7]. For example, the exclusion calculator is able to estimate the percentage of UK adults who would not be able to read a small sized font used on a display by comparison to whether the task would be capable by someone who can read a newspaper headline, a large print book, or ordinary newsprint. By use of similar comparisons, the calculator helps estimate a prediction of the proportion of the UK adult population excluded through the visual, hearing, thinking, dexterity, reaching and locomotion demands of the interaction required to achieve a goal. This process has been used successfully to estimate exclusion in categories as diverse as food packaging, vehicle maintenance tasks, kitchenware and domestic appliances. However, the thinking criteria used to create the dataset were developed to assess the consequences of cognitive impairment on daily living, and consequently have little face validity to apply to interaction with digital interfaces. For example, attempting to relate the extent to which someone 'who cannot watch a 30 min television programme and tell someone what it was about' affects their ability to operate a digital interface interaction element, is problematic.

1.3 Difficulties with Digital Technology Interaction

There are many people with sensory and cognitive capabilities which are more than sufficient to enable them to successfully interact in the non-digital world. However, many of these people will struggle to use some forms of digital technology, such as computers, tablets and mobile devices to varying degrees. For example, in a national study carried out to assess UK population abilities only 72 % of 35–44 year old adults were successful in carrying out a paper mock-up of a 'number navigation' task, and 85 % were successful with the more common 'select and confirm' interaction pattern. Older participants had substantially worse success rates, but the contribution of age related capability impairments to this cannot be isolated [10]. A Microsoft survey from 2003, found only 21 % of working age adults reported being able to operate ICT equipment without difficulty [2].

Some users complain that digital technology is not for them, and hence that they don't want to engage with digital technology [11]. It is suggested that for people who don't have much digital interface 'prior experience', this perception is at least partially true: they do not have the skill with the interaction patterns to engage with interfaces that seem almost always primarily designed for people with a reasonable level of digital technology experience.

In studies with older low technology literate people using digital technology, the usual user performance measures such as time to task completion are not as important as the ability for the user to be able to make error-free progress to their goal achievement [4]. Error making tends to reinforce the negative feelings of confusion and stress, and frequently puts the device into a state from which the user is unable to recover [13].

1.4 Interaction Design and Patterns

Interaction design (IxD) is the practice of designing interactive digital products, environments, systems and services [14]. It is closely related to the fast emerging disciplines of user experience (UX) design, which attempts to take a broader view of the content, form and behaviour of interaction, and information architecture (IA), which focuses on the navigational structural aspects of predominantly web design.

The individual interaction elements within interaction design are frequently referred to as 'patterns', and has been a strong focus of interest for this research in the context of older novice users. Zajicek [15] generated a pattern language for a speech system for older people, and advocates the principle for communicating solutions to developers and designers.

This approach has been adopted for use in interaction design for reasons of programming efficiency as well as user centred goals [16]. The major operating system manufacturers, Microsoft, Google and Apple [17, 20] have released through their software developer kits (SDKs) for external developers, their user interface guidelines which incorporate some of their versions of interaction patterns, elements, user interface elements. In addition, there are defined sources of interaction patterns for touchscreens from Saffer [21], and basic gestural interaction patterns from Van Welie [22].

Despite the available advice and patterns from the Apple iPad Human Interface Guidelines [18], Budiu and Nielsen [23] found that for applications written by developers external to Apple, the implementation of the simplest touchscreen action, the tap on an image, provided no less than five different responses on five different iPad applications. The responses included hyper-linking to a more detailed page about the item, flipping the image to reveal further images, enlarging the image, popping up a set of navigation choices to no response whatsoever. From a novice older user perspective, this does not sound encouraging; however it may be that as long as there is sufficient prior experience and/or 'exploratory desire' to initiate a tap action and that the response provides sufficient cues as to the available functions, this may provide a bounded route to follow.

In interaction design the design pattern approach has great benefit from the user's perspective, as the interface elements and patterns (combination of elements) should be used in a consistent way, which offers the opportunity for ease of recall once the user is familiar, and the much greater chance that the user will be faced with a well-developed interface. However, many interaction patterns exist – and as new technologies emerge to permit their evolution, more are added, and in the un-regulated mobile device app domain, human creativity seems to be the only limit to the novelty of new interactions. Of course, for these novel interactions, and in particular the less transparent (both perceptually salient, of obvious function, and operation) will require either trial and error to have a chance of learning (and hence an interaction which is liable to be exclusive) or prior experience of that learning to use successfully.

1.5 Other Methods of Predicting Interaction Issues

As most readers of this paper will probably be aware, there are a huge number of methods available in the literature, in addition to almost certainly many more proprietary variations used in industry, to enable an early view on the cognitive modelling methods (e.g. GOMS [24]), heuristic evaluation or usability inspection [25], error identification (e.g. TAFEI [26]), understandability (e.g. cognitive walkthrough [27]), etc. of an interface design. It is not the purpose of this paper to critique the strengths and weaknesses of each of these, other than to say that the exclusion audit process (and the proposed prior experience addition) is most similar to the cognitive walkthrough method [27], as it builds on a task analysis for a particular user goal, and requires an assessment at each of those task steps.

2 Method Proposal

2.1 User Task Flow for Unfamiliar Interaction

When users engage in activities with unfamiliar interactions, it is quite common for them to need to adopt trial and error strategies (for extreme examples see [13]), which do not necessarily end in a successful outcome. Figure 1 shows a users' task flow for a simple temperature control task and an assessment of which of the visual, hearing, dexterity and cognitive processes are required in each of the steps. For the cognitive assessment, Rasmussen's Skills, Rules and Knowledge (SRK) framework has been used to give an indication of how much conscious activity is needed to be used to carry out each step [28]. In this example, it suggests that the user will have to employ significant cognitive resources when there is an incompatibility between the expected control appearance and mode of operation, and the available controls and modes of operation. Where this requires decision making in the Knowledge level, it is deemed that this will lead to exclusion due to the errors that will be made. Future work in this area could look at assessment of the cognitive demand of coping with this incompatibility, and determining the exclusion based on population cognitive characteristics.

Figure 2 provides a structure for assessment of exclusion for a selected user journey, building on the current process for exclusion calculation. Where the assessment process needs to deviate from the conventional one, is when the task requires a digital interface or digital interaction pattern to be used. At this point, the assessor needs to determine the explicitness of the interaction for someone with no prior digital experience. If it is not completely explicit (i.e. clear that this function is available, is likely to do the required function and that the operation to invoke the function is obvious), then the assessor would need to identify where such an interaction pattern were to normally reside in the list of technology devices that are in the technology prior experience list [6]. If it is not explicit, and not found in any of the technology devices listed, then it would be deemed to incur 'mainstream exclusion', i.e. people without any impairments would need to engage in a conscious trial and error strategy to have a chance of operating successfully. Since this process is by definition very susceptible to errors, and there is no guarantee of successful goal completion it is classified as a step causing mainstream exclusion.

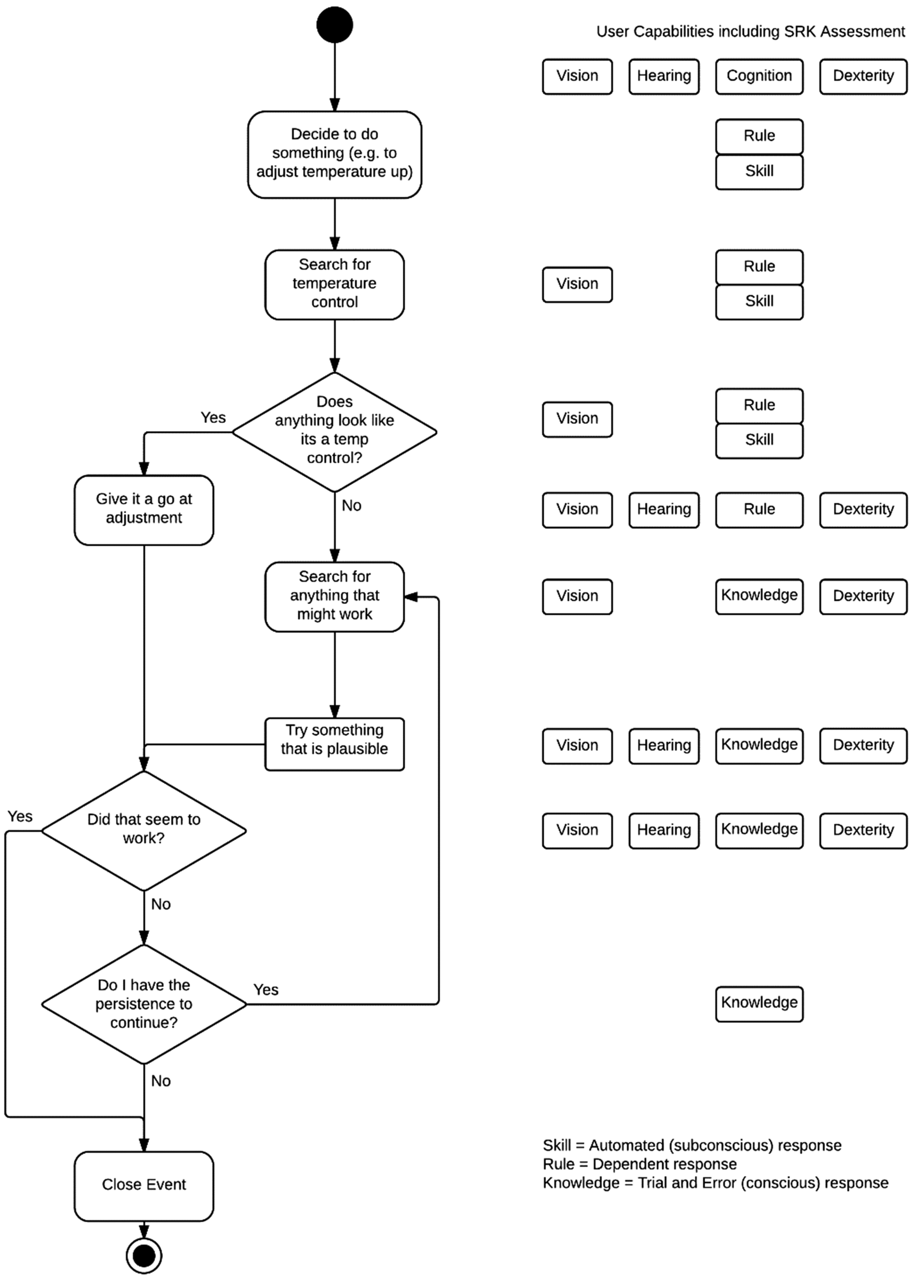

Fig. 1. User steps for carrying out an example digital interaction with the goal of increasing temperature including Skills, Rules, and Knowledge framework assessment. Exclusion assessment flow for digital interfaces.

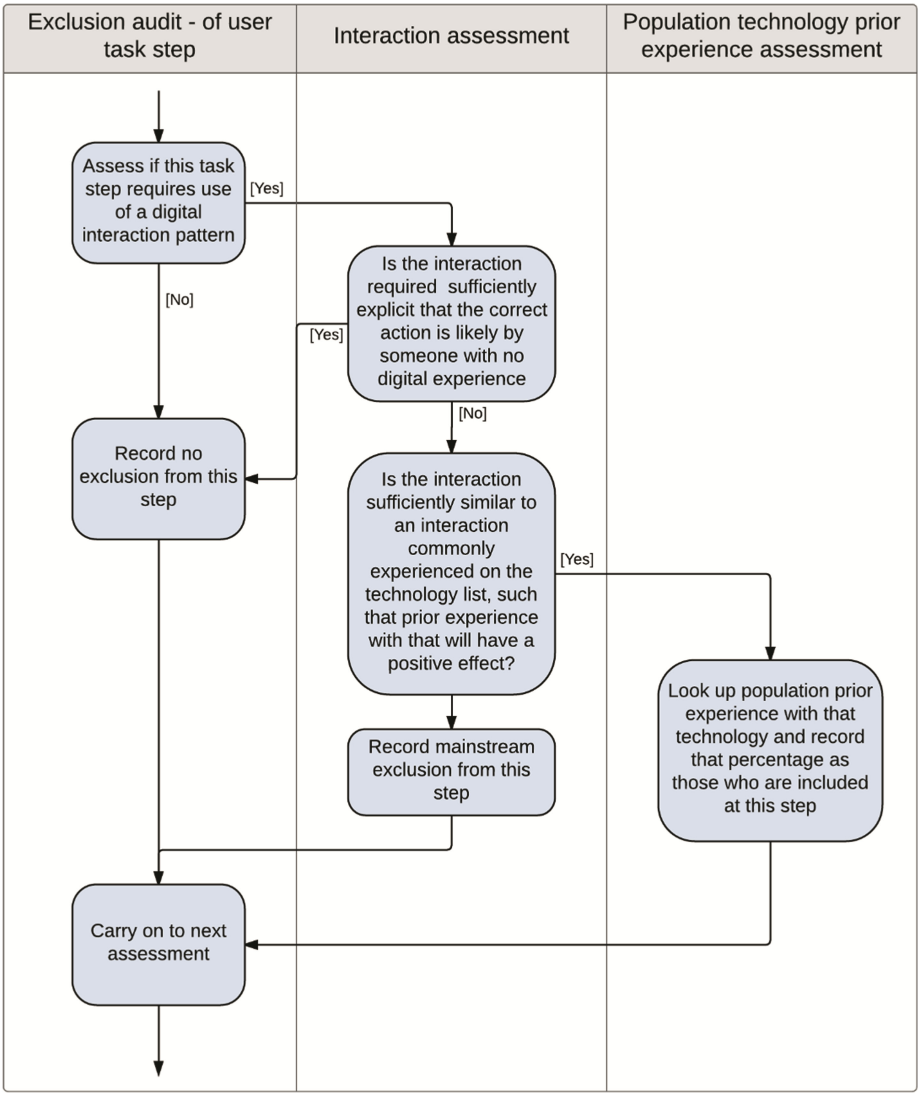

Fig. 2. Assessment steps for carrying out a digital interaction exclusion audit

3 Discussion and Conclusion

The exclusion audit technique has shown great potential to highlight not only the potential issues, but also the potential magnitude of the consequences of those issues expressed as a percentage of the UK population who are excluded from achieving that task step [29]. In the digital interface arena however, there are many factors both from a user's perspective and the characteristics of a digital interface (in addition to the context and scenario of use) that affect the potential for a successful task completion. The proposed method takes into account one of these additional factors: prior technology interface experience, and attempts to link it to the exclusion calculator to extend its functionality and applicability. The population data required to reference this does not yet exist, however a pilot data set [6] has been created for the UK, and will need testing to check to what extent the predicted exclusion is reflected in real user experiences. The potential to evaluate the learnability of unfamiliar interfaces also exists as a further refinement, but would require more detailed research to establish its viability.

Acknowledgements. This work was carried out in the University of Cambridge Inclusive Design Group in the Engineering Design Centre.

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