Interaction patterns: the key to unlocking digital exclusion assessment?

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Abstract. A user's prior experience with digital technologies predicts their success with a novel digital interface. Consequently, low technology prior experience can cause a potential user to be excluded from successfully navigating a user journey with a digital interface. The Engineering Design Centre's exclusion calculator can predict the percentage of a population who will be unable to complete a task step in a user journey, but it does not explicitly take into account user exclusion due to insufficient technology prior experience. This paper develops the rationale for a proposed method for assessing the digital inclusivity of a digital interface user journey through evaluation of explicitness and digital interaction pattern familiarity.

Keywords: Inclusive design • exclusion audit • older user • usability • technology prior experience

1 Digital interaction, interaction patterns and exclusion

Inclusive design, ageing and the use of digital technology interfaces

Inclusive design is an approach to designing where products and services address the needs of the widest possible audience, regardless of age or level of capability [1]. Implicitly it advocates that ageing, capability impairment and disability should be designed for wherever possible. It has been shown that using 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].

There is evidence (e.g. [3–7]) that older people have lower digital technology prior experience than younger people, and that even for simple tasks this represents a dramatic loss of ability to carry out simple digital interaction goals [8]. As a result, difficulty and potential exclusion from digital technology interfaces are often encountered by those with low technology prior experience, such as many older people.

Interaction design and patterns

Interaction design (IxD) is the practice of designing interactive digital products, environments, systems and services [9]. It is closely related to the rapidly emerging disciplines of user experience (UX) design, which attempts to take a broader view of the content, form and behaviour of interaction, and the more technical information architecture (IA), which focuses on the navigational structural aspects of websites.

Within these domains, the individual elements that users interact with are referred to as 'patterns' (e.g. [10]) from Christopher Alexander's architectural concept [11] and this has been a focus of interest for the research for this paper in the context of older novice users. For example, Zajicek [12] generated a pattern language for a speech output system for older people, and advocates the approach for communicating solutions to developers and designers.

The use of interaction patterns has been adopted in interaction design for reasons of programming efficiency as well as the more user-centred goals of interface consistency and best practice [13]. The major operating system manufacturers, Microsoft, Google and Apple [14–17], 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 and user interface elements. In addition there are sources of interaction patterns for touchscreens from Van Welie [13], and basic gestural interaction patterns from Saffer [18].

Despite the available guidance and interaction patterns from the Apple iPad Human Interface Guidelines [15], Budiu & Nielsen [19] found that, for externally authored applications, the implementation of the simplest touchscreen action, a 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 image, flipping the image to reveal further images, enlarging the image, popping up a set of navigation choices to no response whatsoever. From a novice user's 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 sufficiently constrained user journey to follow.

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

Difficulties, errors and when 'trial and error' is too much of a trial

There are many people with 'normal' levels of capability which are more than sufficient to enable them to successfully interact in the analogue world. However, many of these people can struggle to use digital technology interfaces, such as those found on computers, tablets and mobile devices. For example, in a national study carried out to assess UK population abilities, only 72% of people under 65 successfully completed a simple 'highlight and confirm' task requiring three button presses on a paper prompt representing a push-button mobile phone interface [20]. However, older participants had substantially lower success rates, with only 28% of over 65s achieving the simple task [20].

In a Microsoft survey from 2003, 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 say that they do not want to engage with it [21]. It is suggested that for those with low digital interface 'prior experience', this perception is at least partially true: they do not have the experience with the necessary interaction patterns to engage with interfaces without error.

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 [22]. Error making tends to reinforce negative feelings of confusion and stress, and frequently puts the device into a state from which the user is unable to recover [22]. Therefore error-free interaction for these users is critical to ensure they can achieve their goals, have a positive experience, and continue to use the product or service.

Digital interfaces and exclusion

Interfaces for digital technological devices can be difficult or impossible to learn and use, particularly for older people [22]. 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 currently prevalent style: touchscreen interfaces. Interfaces for digital devices are continuing to become more prevalent even for devices that previously were simple and analogue, e.g. domestic heating thermostats, fixed telephones, automobile heating and air conditioning controls, household appliances, and even light switches. Consequently, those that struggle to successfully operate digital interfaces are likely to increasingly face them in their daily activities.

However, extrapolating the difficulties individuals face using digital interactions to estimates of population exclusion is currently problematic, as the currently available tools are insufficiently developed and population data sets inadequate to do so, although some work has attempted to fill this gap [23].

The University of Cambridge's Engineering Design Centre (EDC) has developed a method of estimating the percentage of the UK population [24] who are unable to do a specific task (and are therefore 'excluded' from doing that task) by reference to the 1996/7 Disability Follow-Up Survey which assessed the abilities of over 7,000 surveyed people [25]. 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 [26]. For example, until the widespread adoption of capacitive touchscreens on mobile devices, the idea of 'swiping' a screen to initiate an event was very unfamiliar.

The fragility of acquired heuristic and procedural knowledge is also not captured 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 also likely to exhibit perceptual, sensory and motor skill variability [25, 5] which will affect their interactions with technology devices, especially technology devices which are new to them and/or exhibit unfamiliar interaction styles.

Exclusion Calculation

The proportion of the UK adult population who are unable to achieve certain interactions due to degradation of perceptual and motor skill performance can be estimated using the Inclusive Design Toolkit's exclusion calculator [24]. This is done by comparing task demand to capability data collected in the 1996/7 Disability Follow-Up Survey [25]. For example, the exclusion calculator can estimate the percentage of UK adults who would not be able to read a small textual font by considering whether the task would be achievable by someone who can read a newspaper headline, a large print book, or ordinary newsprint. By using similar comparisons, the calculator helps to estimate the proportion of the UK adult population who would be excluded through the visual, hearing, thinking, dexterity, reaching and mobility demands of the actions required to achieve a goal. This process has been used successfully to estimate exclusion in categories as diverse as fast-moving consumer goods packaging, vehicle control and maintenance tasks, kitchenware and domestic appliances. However, the criteria used to create the thinking dataset had been developed to assess the consequences of cognitive impairment on daily living, prior to the proliferation of digital devices and services, and consequently have little validity for assessing interaction with digital interfaces. For example, relating the extent to which someone "who cannot concentrate enough to run a bath without getting distracted" affects their ability to operate a digital light switch is problematic.

Other methods for assessing interaction issues

Usability Inspection Methods (UIMs) are seen as low cost and quick to deploy, as a precursor to more detailed, richer, but more time and cost consuming, user testing. They are normally used formatively to assist in the product development process, and consequently need to be usable within the constraints of the timeframes and budgets of a project.

There are a large number of UIMs available in the literature, in addition to many more proprietary variations used in industry to enable an early assessment of an interface design. They include cognitive modelling methods (e.g. GOMS [28]), heuristic evaluation or usability inspection [29], error identification (e.g. TAFEI [30]), and understandability (e.g. cognitive walkthrough [31]). 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 [31], as it builds on a task analysis for a particular user goal, and requires an assessment at each of those task steps.

2 Interaction Pattern Assessment Method

2.1 Rationale for interaction pattern assessment method

People develop mental models of the way the world around them works from early childhood [32]. To successfully carry out a task with a system, a user must have a sufficiently accurate mental model of how the system will respond to their inputs [32]. These mental models allow prediction of outcomes for actions that are made, for example that pressing a light switch on a wall will turn the light on [33]. In a population residing in the physical world, the mental models developed for interaction with everyday artefacts will be similar, if they experience artefacts with similar behaviours. For example, in the UK the dominant expectation within the population for a vertically oriented rocker light switch, would be that pressing the lower part of the control, or pushing down would cause the respective light to turn on. In the US, a similar control would be expected to operate such that the same action would turn the light off, due to the prevalence of light switches operating in a different manner in that territory. These controls can be described in terms of interaction patterns, albeit different ones in the two territories. When a user has a correct mental model for an interaction pattern, they should experience a low level of errors in operation, and if they have the wrong mental model or no appropriate mental model then their actions are likely to be highly error prone. Whilst a 'trial and error' approach is likely to build or modify mental models, previous work has shown that, for some people using complex technologies, this process can lead to task failure and thus exclusion [34–36].

If mental models for physical or analogue interaction patterns within a territory are sufficiently consistent throughout that population, then designers could reasonably assume that a user will have them and can design their interfaces to take advantage of a positive transfer of procedural knowledge.

Fig 1. "Slide to unlock" interaction pattern from iOS 3

However, when it comes to interaction patterns that only exist in the digital world, it is reasonable to assume that someone who is a digital novice will not have experience of digital interfaces, and therefore will not have the corresponding digital interaction pattern mental models. Thus, an assessment of the digital exclusivity of an interaction can only assume that the user will have mental models derived from interaction patterns from the physical or analogue world. A task step that requires a mental model from the digital world is likely to cause errors and attendant exclusion. However, a digital interaction pattern may not directly give rise to digital exclusion, if it is sufficiently explicit or employs a metaphor to a familiar interaction, such that it is clear what action is required to achieve the next step. An example of this might be the 'swipe to unlock' interaction pattern that Apple's early iOS devices displayed (see Figure 1) and one study supports that this interaction pattern can be interpreted correctly by digital novices [34].

The left set in Figure 2 shows examples of controls that exist in the physical or analogue world that almost all adult members of the current UK population are highly likely to have experienced and have appropriate mental models for. The intersection between the analogue and digital contains a control which only exists in the digital domain, but its design carries a sufficiently strong mimic to a control in the physical world (in this case a slider rheostat) that it would not intrinsically preclude someone with no digital experience from successful use. The right set contains controls which only exist in the digital domain, and do not sufficiently map to a control (or interaction pattern) in the analogue world. It is likely that someone without digital experience would be unable to successfully use them.

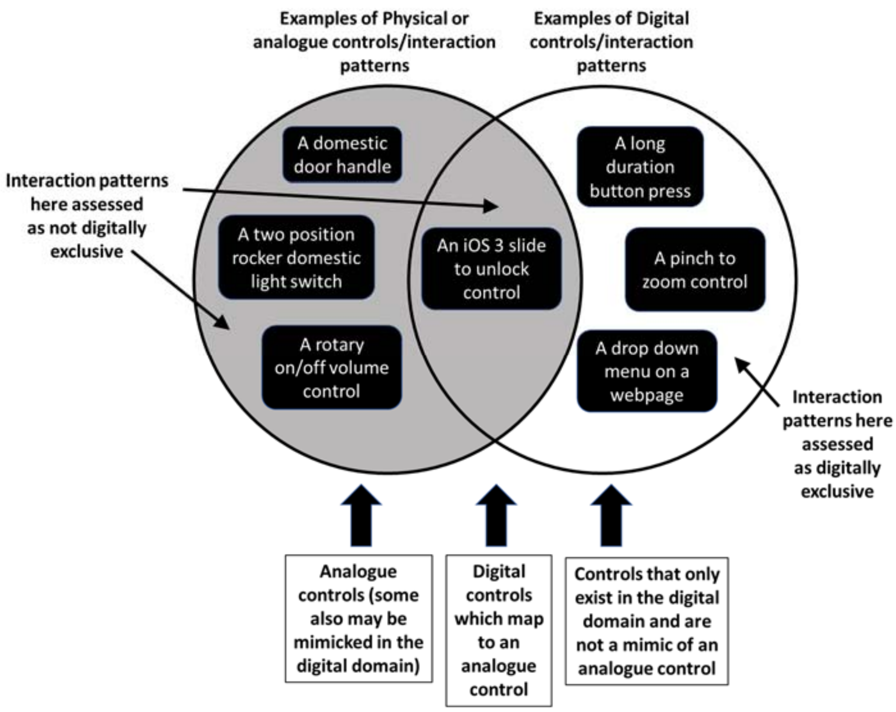

Fig 2. Examples of analogue and digital controls and associated interaction patterns showing the relationship between the two sets, and the associated digital exclusion assessments

2.2 Criteria for the digital exclusion assessment method

In developing a method to assess digital exclusion, it was recognised that for it to be useful to practitioners designing interfaces in the context of project and organisational constraints, it should be usable by non-academic designers, human factors practitioners and others involved in product development in industry since an unusable method becomes an unused method.

The output of the method should be formative and sufficiently diagnostic to enable it to be useful for informing the design process, and sufficiently quick and cost effective so that it can be used within the constraints of a time and cost-bounded product development project.

2.3 Exclusion assessment process for digital interfaces

Where the assessment needs to differ from a conventional exclusion audit is the point at which the task requires a digital interface or digital interaction pattern to be used [23]. 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 or does not map directly to an interaction pattern in the analogue world (i.e. clear that this function is available, is likely to do the required function and that the operation to invoke the function is clear), then the assessor would record this as 'exclusionary' for someone with no digital interface prior experience. Such a user would need to engage in a conscious trial and error strategy to have a chance of operating the interface successfully. As this process is highly susceptible to errors [34] and there is no guarantee of successful goal completion, it is classified as a task step that causes digital exclusion.

2.4 Limitations of this approach

The method requires the assessor to be sufficiently aware of the difference between an interaction pattern that only exists in the digital world, and one that exists in the physical world. This may prove problematic for digital natives [37], who may not be able to easily separate their own digital experiences from their physical ones, and hence struggle to make appropriate assessments at that point.

Assessing an interaction pattern that is digital, but which has 'sufficient explicitness' may also require a degree of training or experience, particularly for an assessor who has not experienced observing a person with limited digital prior experience using a digital device for the first time.

This method will not predict higher order cognitive issues such as conceptual ones relating to the function of a system, the required inputs and the expected outputs. So the assessment will require augmenting with another method which can take this into consideration.

3 Conclusions and further work

This approach appears to offer a mechanism to assess the digital exclusivity of an interface user journey, in a manner that would be achievable by someone without an academic background. Clearly however, this method will require testing with appropriate assessors to ensure that it is learnable, sufficiently quick and hence cost effective to be of use to practitioners. The outputs from those method experiments will also need to be validated against the performance of people with very low digital prior experience actually using the interface under test conditions to understand the predictive power of the technique. This will need to be compared to extant methods which can be brought to bear on the problem.

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5 References

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