Combining utility, usability and accessibility methods for Universal Access

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ABSTRACT

It is known that many products are not accessible to large sections of the population. Designers instinctively focus on providing the necessary utility for someone with their physical and skill capabilities. They are either unaware of the needs of users with different capabilities, or do not know how to accommodate their needs into the design cycle. Usability engineering techniques exist that broadly extend the skill range of potential users, and accessibility techniques for physical capabilities. However, approaches for combining all three are rare. The aim of this position paper is to present a design approach for combining utility, usability and accessibility design activities into a single coherent approach. A tool for measuring the resultant success of the design is also described.

Keywords

usability, accessibility, universal access, universal design

INTRODUCTION

According to Nielsen [8] *system acceptability* is achieved by meeting the *social* and *practical acceptability* objectives for the system. He further identifies *usefulness*, constituting *usability* and *utility*, as a key objective to providing practical acceptability. Most designers focus on providing the necessary utility, or functionality of the system required for the task, and the social acceptability, such as the aesthetic characteristics, for users who match their own capabilities and taste. There are two reasons for this. The first reason is that these are indisputably very important objectives. The second is that it a minimally effective solution can be obtained in the minimum of time.

However, as numerous usability texts will attest [e.g. 8], such minimally effective solutions are increasingly unacceptable to the wider population. They argue that *usability*, that is the ability to use the utility, is also important and needs to be designed directly into the system. In principle, usability techniques should be applicable for the whole population. However, in practice, they still generally assume the same, able-bodied physical capabilities of the users.

Consequently, *accessibility* design approaches have had to be developed. These approaches are variably referred to as design for all, universal access and inclusive design. Accessibility practitioners believe that design for all practices need to be explicitly included in the design process to ensure that all user capabilities are considered.

Design for all approaches

There are several existing approaches for designing more inclusive interfaces. However, there are shortcomings of each of these approaches that prevent each of them from being used to provide the definitive design approach that designers can use in *all* circumstances. The principal weaknesses stem from the targeted nature of the approaches.

The existing design approaches are often targeted at specific population groups or impairment types. For example, Transgenerational Design [9] focuses on design for the elderly. Alternatively, they focus on specific impairment types, as for Rehabilitation Design [5]. They can also be targeted at specific cultures. For instance, Universal Design [3] dominates US/Japanese approaches to inclusive design, whereas Europe has generally tended to develop other methods, such as the User Pyramid Approach [2]. The prescribed methods of application of the existing methods are often vague. For example, Universal Design is more of an ethos than a rigorous, systematic design approach. There are very few structured descriptions of the implementation of Universal Design in more detail than broad design objectives [3]. Consequently, while combined the existing approaches may offer complete coverage of the population needs, individually they do not.

THE REQUIREMENTS FOR A NEW APPROACH

The aim of the new approach is to provide a practical, rigorous approach to inclusive interface design. Design typically involves the creation of solutions and then a review to ensure that the design criteria are met. At the lowest level the review process could involve a simple check to ensure that the resultant product offers the necessary functionality. At higher levels of sophistication, though, increasingly less quantifiable measures are required. The measures can range from whether the product is usable or accessible through to the outright qualitative, such as whether it is aesthetically pleasing and socially acceptable. Consequently, when developing a design approach for inclusivity it is necessary to consider the measure of success, i.e. the point at which the design is considered to have met the stipulated requirements. This shall be referred to as the *inclusive merit* of the product.

There are two important interpretations for defining the stipulated requirements of interaction for inclusive design. The first interpretation is that if the properties of a product/application, are defined, then this will directly affect the properties of the interface selected. For example, a word processing package on a PC has both software and hardware components that require addressing. The software interface will need menus, icons and toolbars with specific functionality. The hardware input/output devices selected need to support actions such as text entry and cursor manipulation. All of these properties determine the level of functional capability required for the user to be able to interact successfully with the application. The second interpretation of the interaction is that if the user's functional capabilities are known, then the range of hardware and software elements that the user can interact with will be defined as well and hence the range of tasks that can be achieved with the target application identified.

The traditional view of designers has been to follow the first interpretation, to specify the needs of the application and then through the interface place functional demands that the user must be able to meet. User-centered design practices put the emphasis on the user capabilities driving the process in the other direction, akin to the second interpretation. These interpretations have led to the two principal strategies for driving the development of an interface for different user capabilities. The first is to take the existing interface for able-bodied users and then tailor it retrospectively to different users. The second is to change the definition of the user at the very outset of the design process to include a wider range of capabilities. These approaches can be described as *adaptive* and *proactive* respectively [10].

The stipulated requirements of the application/product therefore have the potential to exclude certain sections of the population who cannot meet the functional capabilities necessary to meet those requirements. As another example, consider a kettle. If the kettle has to be able to boil a certain amount of water then there is going to be a minimum weight associated with the kettle when it has water in it. Therefore, users will be required to have the strength to move that minimum weight if they are to be able to use the kettle. Anyone not meeting that strength requirement will not be able to use the kettle, irrespective of other design decisions made or product requirements stipulated.

The recognition of fixed limits on the target user population set by the stipulated application requirements therefore leads to a possible measure of success for an inclusive design: *an inclusively designed product should only exclude the end users who the product requirements exclude.* The corollary of this is, of course, that the design fails to be inclusive if people are excluded from using it even though they possess the functional capabilities to meet the demands of the product. This implies that the designers have introduced new capability demands on the users that are not essential attributes of the product, but resultant from the designer's decisions.

The principle that only those who the product/application requirements exclude should be excluded by the product/application therefore provides a metric for measuring whether the design solution generated is successfully inclusive. However, this raises an issue that needs to be addressed at the strategic level of the design management, that of where the stipulated requirements should be set. Taking the example of the kettle, how much water should it hold? The smaller capacity decreases weight and increases inclusivity, but the marketability probably decreases. A managerial level decision is therefore required between marketability of the product and the level of population exclusion, and hence potential market size.

In summary, the *inclusive merit* of a product depends on two criteria: the merit of the requirements that define the product; and the merit of the product when judged against those requirements.

Many of these issues require the balancing of stipulated product requirements, demanded user capabilities and resultant population coverage. Influencing this will be the design approach taken. Consequently it would be helpful if a simple graphical representation of these properties was available that offered a visual summary of the level of inclusion achieved by the design. One such representation tool is the Inclusive Design Cube.

THE INCLUSIVE DESIGN CUBE

Building on the concept of the user pyramid [2] with its banding of users by impairment level, the authors have developed a model that relates capability level, population profile and suitable design approach in a simple graphical format. The resultant model, referred to as the inclusive design cube (IDC) [7], is shown in Figure 1. Each axis on the cube represents user capability and the enclosed volumes reflect population coverage.

It was recognized that the principles of Universal Design generate products widely accessible to the population and hence having good population coverage. Consequently this approach, denoted *user-aware design*, dominates the cube.

For severely impaired users, it may be necessary to adopt rehabilitation design approaches of custom products for specific users, *special purpose design* in Figure 1. In between the two approaches is an intermediary design approach with flexible boundaries. *Modular/customizable* design takes a base unit designed using the user aware design principles, but with a changeable interface that is either adaptable or can be swapped for one of a series of modular designs. The Inclusive Design Cube is a very potent visualisation tool and communicates the needs of different sections of the population. However, for practical implementation of inclusive design practices, it is necessary to supplement it with a systematic design approach.

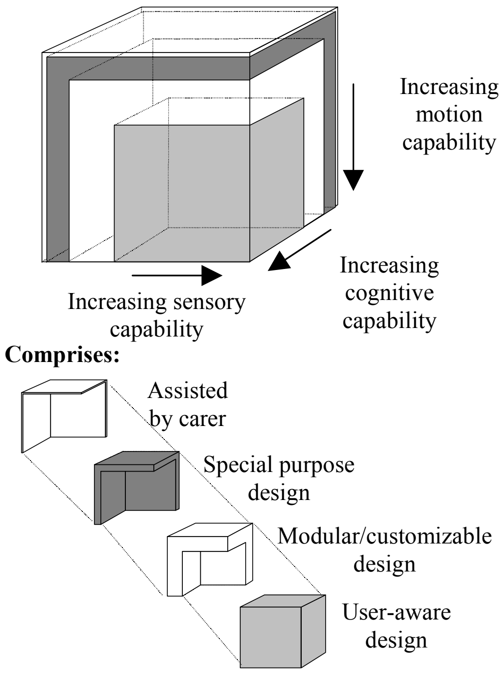

Figure 1. The Inclusive Design Cube.

THE 7-LEVEL APPROACH

To provide a complete design approach it is necessary to tackle the issues of practical and social acceptability in a structured manner that is straightforward to apply.

To meet the need for a new design approach, the 7-level approach, Figure 2, has been developed by the authors and is based on the known stages of interaction [4] and usability heuristic evaluations [8]. Developing an interface for universal access involves understanding the fundamental nature of the interaction. Typical interaction with an interface consists of the user perceiving an output from the system, deciding a course of action and the implementing the response. These steps can be explicitly identified as perception, cognition and motor actions [4] and relate directly to the user's sensory, cognitive and motor capabilities respectively.

To produce a new design approach, these interaction components have to be combined with the 3 basic stages of design: (1) define the problem; (2) develop a solution; and (3) evaluate the solution. Initially, a 5-level design approach was developed that divided Stage 2 of the design process into three constituent steps that address each of the interaction steps [3]. However, further resolution of the approach is possible by separating the problem definition into two steps: defining the user wants and defining the user needs, i.e. the required utility. To reflect these separate objectives, the evaluation procedure similarly needs to become two stage: verifying that the required functionality is provided and validating that the system satisfies the user wants. This generates the 7-level design approach.

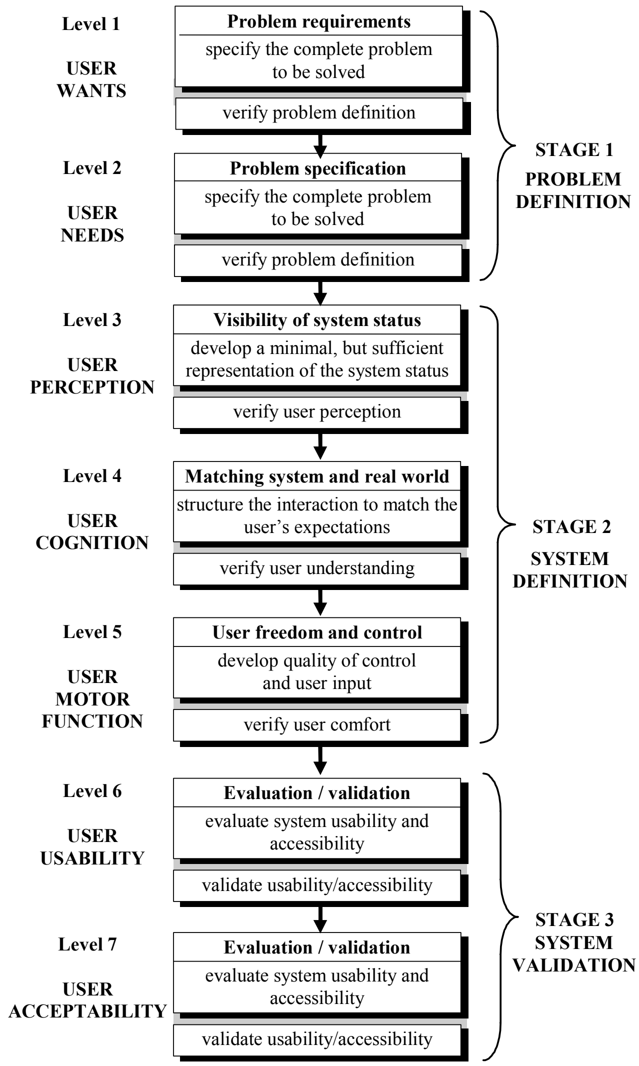

Figure 2. The 7-level design approach.

Applying the 7-level approach

The 7-level approach addresses each of the system acceptability goals identified by Nielsen [8]. The approach has been applied to a number of case studies including the design of a software interface for an interactive robot [6] and the review of an information point [7].

Level 1 defines the user needs, that is the social motivation for designing the product. This can be identified through softer, sociological assessment methods. Questionnaires and interviews are good methods for identifying the user needs.

Level 2 focuses on specifying the required utility of the product. Traditional engineering requirements capture techniques [1] can be used, as can task analysis [8, 4]. Alternatively, functional assessments of rival products or observation of existing methods can provide insight into the necessary functionality.

Levels 3 to 5 focus on the stages of interaction. Usability and accessibility techniques can be applied directly to these levels, as can anthropometric and ergonomic data and standards. Prototypes of varying fidelity play a key role in these levels. Level 3 addresses how the user perceives information from the system. This involves assessing the nature and adjustability of the media used, their appropriateness for the utility, and the physical layout. Anthropometric data are important to ensure that the output is in a position that the user can perceive it. Ergonomic and empirical data from trials are also necessary to ensure that the stimuli are intense enough to be perceived. Ideally, environmental conditions, such as lighting and noise, also need to be identified and modeled.

Level 4 assesses the matching of the system contents and behavior to the user mental model. Once the output channels are defined, the content/utility can be added to the system and evaluated because the functionality for monitoring the system is in place. Literally the user can see/hear/etc. the data. Common techniques to map the user system behavior to user expectations include cognitive walkthroughs.

Level 5 focuses on the user input to the system. As with level 3, this involves assessing the nature and adjustability of the media, their appropriateness for the utility, and the physical layout. Again anthropometric measures are important to ensure that the input media are within the operating range of the user. Ideally, empirical data from user trials needs to be gathered to evaluate the effectiveness of the input solutions. These can be supported by adopting user modeling techniques. Where user trials are impossible, suitably calibrated user models can be used to provide design data.

Level 6 involves the evaluation of the complete system to ensure satisfactory utility, usability and accessibility. Formal user trials and usability/accessibility assessments are essential at this point, before the design can progress to the final level, 7.

Level 7 assesses the resultant system against the user needs. This mirrors Nielsen's social acceptability requirement. Softer, more qualitative approaches are generally needed, such as surveys, interviews and questionnaires.

COMBINING THE 7-LEVEL APPROACH AND THE IDC

Both the 7-level approach and the Inclusive Design Cube share the same inherent emphasis on the interaction consisting of perceptual, cognitive and motor actions. It is therefore possible to combine them during design.

Taking the 7-level approach as the framework for the development, the IDC can be adapted to monitor the progress of the design by indicating the population coverage achieved by different design choices. Effectively, the 7-level approach can be thought of as designing for each axis on the cube. The modification necessary to use the IDC for this is a straightforward re-labeling of the axes to reflect Levels 3 to 5 of the 7-level design approach. The resultant Inclusive Design Cube is shown in Figure 3.

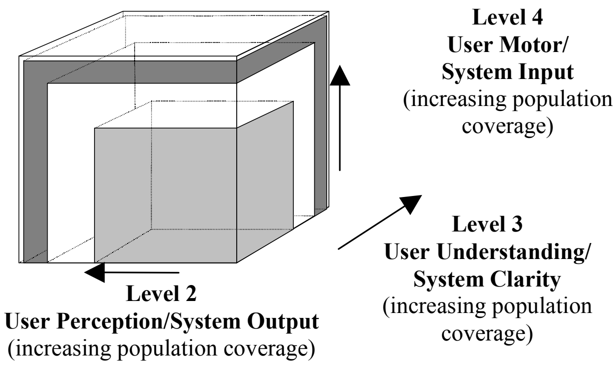

Figure 3. The IDC for use with the 5 level approach.

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