Universal Design Patterns: Designing a Web-Based Tool with Architects

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Abstract. The implementation of Universal Design in architectural practice requires a number of tools that provide support to designers throughout the design process. This paper discusses how architects, as end-users of the DST, are involved in the development process of a new web-based tool based on the Universal Design Patterns concept. Through Universal Design Patterns, a concept based on Christopher Alexander’s Pattern Language, users can contribute new insights about the existing built environment, while architects can discuss the inclusive qualities of new design solutions or find useful design guidance. Involving the architects in developing the Universal Design Pattern concept into a web-based design tool is essential to establish a structure for the Universal Design Patterns that is compatible with the designers’ way of thinking about design problems. Building on the results of a survey involving 406 architects and a comparative study of existing DSTs for Universal Design, this paper focuses on the results of a series of interviews and a card sorting technique that provided the basis for a first data-structure for the Universal Design Patterns tool. Subsequently, the methodology for testing this model with architects is discussed. In conclusion, some thoughts are given on the potential benefits of not only testing new DSTs with designers, but involving them actively from the early development stages.

1. Introduction

With demographic ageing as one of the major drivers, social awareness of existing barriers between peoples’ needs and the built environment has grown.
considerably in recent years. The same shift of focus can be observed in architectural design, where practice is starting to move away from designing for the non-existing average man or woman, towards designing for the real diversity of people. A new design paradigm has gradually emerged, replacing the "design for special needs" approach to human diversity with a new Universal Design (UD) paradigm. UD aims to stimulate new, creative solutions that will contribute to a better quality of life for all users, including people with permanent or temporary disabilities.

The implementation of this new design paradigm into design practice requires detailed knowledge of the needs of the relevant diversity of people. However, gathering this information and making it available to designers in a way that supports the design process is not without difficulty, as literature review shows; and it might require the development of additional DSTs based on new concepts.

2. Literature review

Several studies have tried to identify possible barriers to the incorporation of UD principles in design practice in many design disciplines. Results show designers are often lacking motivation for the implementation of UD, because it is still equated with "Design for special needs" and "functional but ugly" design solutions [1]. Furthermore, time and budget restrictions prevent designers from looking into the UD aspects of the design beyond legal requirements [2]; and although designers often wish to have direct contact with users, the current design process does not accommodate user involvement [3]. Moreover, designers fear that taking a wide variety of user needs into account will act as a creative restraint [4]. Finally, existing design information often focuses on one user group in particular, preventing design solutions from becoming truly universal [2].

When looking at the requirements for the support of UD in design practice, some research has been carried out. While designers need information about users, it is critical that "end user information should include all relevant aspects of product interaction. However, (...) industrial designers have no wish to plough through many pages of data to find snippets of information" [2]. Therefore, the information should be inspirational and unrestrictive, and consist of possibilities, not rules; the information should be presented in an easily accessible format [3, 5]. Overall, designers express a preference for web based information, because it is perceived as current, relevant and open-ended [4, 6]. Support tools for UD should give an overview of UD design issues, provide understanding of user needs through sufficiently detailed data, and help determine who will be excluded from use by the design choices made [7]. Additionally, a tool that offers further collection, ordering and communication of new project based data is stated as a
valuable possibility for experienced designers and novices alike to share and exchange information [6].

Although few studies have been carried out in the field of architectural design in particular to confirm these findings, a recent survey including 406 Flemish architects indicates that architects largely share the needs of other designers. Results show that architects are motivated to implement UD principles, but currently, there are not sufficient tools available to them [8]. Additional information should focus on the design of public buildings and environments rather than the design of dwellings, and should provide descriptive information rather than prescriptive rules [9].

In summary, new tools to support UD in architectural practice are needed, and should provide the architect with a clear overview of relevant user needs for the broadest possible range of users, as well as inspiration for possible design solutions. Architects should also be able to determine the effects of their design choices on the Universal Design quality of the project. This information should be relevant and up-to-date, preferably organized in a web-based format. Based on these criteria, Patterns could be appropriate as a design tool for UD in architectural practice.

3. Universal Design Patterns concept

For Christopher Alexander, the entire community of users works by means of innumerable large and small, formal and informal "structure preserving transformations" of the built environment to accommodate human needs and aspirations in a meaningful way [10]. He developed a pattern language [11] as a generic system to nurture and to guide human building processes. Both Alexander’s pattern language and the more recent specific initiative of a group of software architects to develop collective design patterns [12] provide inspiration for the development of patterns as a tool for the implementation of UD in architecture [13].

A UD Pattern provides relevant design information in a specific structured way. The first part (conflicts) contains detailed descriptions of problems that can occur between users and built environments, while the second part (resolutions) shows empirically supported architectural/technological solutions. The conflicts accurately capture descriptions of the "why" for each design parameter, and designers can consult them to determine to what extent a specific design option might have a dis-abling / en-abling effect on functional use. The resolutions are tentative, and remain open to innovative concepts.
As shown in Figure 1, patterns are most often hierarchically associated with larger scale and/or smaller scale patterns, that give information on the same "theme". Three scales of UD Patterns are defined to form a database of interrelated UD Patterns. The large scale patterns (macro) describe a specific setting of the built environment in general, while the intermediate scale patterns (meso) describe semi-autonomous parts of these settings, and their relation to other such parts. Small scale patterns (micro) focus on individual elements or aspects, and provide a detailed description of its characteristics.

Figure 2 represents the conceptual model of the proposed UD Pattern database. The figure reveals that three distinct parties are involved in the process of generating and updating UD Patterns [14] :

• The Research & Development Team. A multidisciplinary team of specialists from different medical and paramedical backgrounds, with architects, interior architects, engineers, product designers, communication specialists, IT specialists, and psychologists.

• Users / Experts. A user / expert can be anyone who has developed natural experience in dealing with the challenges of our built environment [15].

• Designers and Decision-makers in the process of building production [16]. Universal Design Patterns are primarily developed as supportive tools for those who design, construct and maintain the built environment.
The conceptual model was designed to help bridge the existing communication gap between users and designers by giving them a common database of information for the designers to draw upon and for the users-experts to add to and review. Moreover, designers are encouraged to analyse the formulated conflicts, use them creatively in their designs, and document these new technological and morphological solutions for the users-experts to assess. When a sufficient degree of consensus is reached, the research and development team may add the new solution to the resolutions, creating a cycle of continuously updatable patterns.

However, in order for the database to function, the UD Patterns themselves should be structured and presented in a way that is directly usable by both the designers and the users-experts. This is a unique aspect of UD Patterns, as opposed to other Pattern databases, where the users of the database and the suppliers of the information generally have common backgrounds. To make sure the UD Patterns are compatible with the distinctly different points of view of both the designers and the users-experts, both groups are closely involved in the development of the database from the early stages.

4. Methodology

This paper describes the ways in which the designers, as the primary users, have already been involved in the development of the database. Users-experts have
also been consulted, but their part in the development process will not be described in detail.

First, from the results of a large-scale survey and a series of semi-structured interviews with architects, along with a comparative study of existing DSTs, a list of 18 topics was derived that are most relevant to architects when implementing UD in the design process.

Relevant topics were selected by first comparing the structure of over 30 existing DSTs for UD, and selecting the items that reoccurred most often. They included items relating to the description of user characteristics or needs (e.g. anthropometric data) on the one hand, and items relating to the description of the built environment (e.g. horizontal circulation, wayfinding, etc.) on the other. Although these two types are not always mutually exclusive, the focus on either the user or the built environment is generally clear, and this distinction is of direct relevance to the UD Pattern concept, as mentioned above.

Selected topics from the comparative study were then compared with the results from case studies of 5 architectural design processes in which the UD elements was a main concern, and semi-structured interviews with the designing architects of these case studies. This resulted in a final list of 18 topics. This final list is a selection based on the most common "knowledge items" on which architects require specific UD-related information when designing with UD in mind.

Fig. 3. Example of card sort results (mapping items on the design process).
Next, these 18 topics were presented to 9 architects in a card sorting exercise, to provide insights in the relative importance of each of these items and the role of this topic in the design process itself.

The respondents ranged from novice to experienced in the profession in general and in UD in particular. They were first asked to classify the 18 topics as unimportant, less important, important or very important. After completing this exercise, they then mapped the same items onto a simplified linear representation of the design process, based on the RIBA plan of work [17], chosen for its familiarity to the architects.

Subsequently, semi-structured interviews with 8 architects, again with mixed experience levels, yielded more information about the importance and understanding of UD and DSTs in current architectural practice. They were asked to talk about their experience with UD, and the ways in which they implement it throughout the design process.

Finally, a paper version of 3 UD Patterns was shown to a focus group consisting of 9 access consultants (among whom there were 4 architects, a structural engineer and an interior designer). These access consultants are all involved on a daily basis in working together with architects on accessibility issues of the design and renovation of dwellings or large public buildings, and can thus be considered experts on the architects’ knowledge-needs. Moreover, 2 practicing architects without specific experience of UD also took part in the focus groups, which aimed at gathering information about architects’ preferred representation of the information within UD Patterns.

5. Results

5.1. Cardsorts

Figure 4 reveals the relative importance of the selected topics present in the card sort.

Horizontal circulation and the approach to a building exceed 90% importance, closely followed by wayfinding. Access to a building, accessible public space, user needs, vertical circulation and detailed design of sanitary facilities are all also "very important" aspects of UD in the design process (over 80%). Almost all other topics were rated "important" overall (over 60%), with only facilities for rest and products & furniture being considered of "less importance".
However, some discrepancies could be observed between designers experienced in UD, and those with limited experience in this field. Architects that frequently take the UD aspect into consideration found products & furniture significantly more important in comparison to their colleagues. The same tendency also applies for the items "user needs", "wayfinding" and "inspiring examples". Respondents with more years of experience in architectural practice tend to feel "materials", "wayfinding" and "inspiring examples" are less important items in the design process.
Figure 5 represents the distribution of UD items in the design process. The thickness of the line indicates, for each item, its relative importance in a phase compared to its importance in other design phases. The items are listed in order of importance, with the most important item at the top of the figure. The figure clearly shows that the most important items are all dealt with early on in the design process. In fact, the top five items are all part of the first two design phases, as are two more items in the top half of the list. Only products & furniture are exclusive to the later stages of the design process. Materials are also predominantly part of the later design phases, but respondents who are more experienced in UD also consider this item at the very beginning of the design process.

### 5.2. Interviews with designers

All interviewed architects seem to be familiar with the concept of UD, and define it as "more than basic accessibility". However, when talking spontaneously about how they incorporate UD into their projects and design processes, only people with disabilities and the elderly are mentioned as relevant user groups. Specifically, wheelchair users and people with a visual impairment are named. Only one respondent mentioned taking the needs of "pregnant women" into account.

Most respondents consult with access consultants and use regulation as a reference during the design process. Only one respondent mentions ever
consulting the end-users for a project, while two others clearly state that "contacting end-users and compiling information should be done by specialists".

When talking about the tools they use, several respondents mention the importance of a link with legislation so "the designer can compare legal requirements to broader possibilities offered by the tools". In addition, respondents would also like to see good examples illustrating the information provided. All information should be provided in a concise text supporting predominantly visual representations wherever possible.

Besides general knowledge of spatial requirements and anthropometrics, all designers mention wayfinding and clarity of spatial organization as important topics. Most also mention horizontal and vertical circulation, as well as flexibility. About half of the respondents use colour and texture to enhance the UD qualities of their designs. Only a few mention specific technologies like a loop system for the hearing impaired.

5.3. **Focus groups**

Respondents feel the overall structure and legibility are key factors to the usability of the proposed UD Patterns. The development of a clear and uniform visual language to convey the relevant information would greatly improve the practicality of UD Patterns. In addition to this, respondents mentioned the current paper version contains too many repetitions: "all information should only be mentioned once, under the appropriate topic". However, just having a web-based version with clickable links will go a long way towards improving the usability of the UD Patterns.

When talking about the structure of the UD Pattern database, the respondents felt using the right topics and a clear hierarchy of information, using several consecutive layers, from general information to product details, would help streamline the tool for use in practice: "make it so you can go deeper and get more information as the project’s progression requires it".

The respondents would like to have access to specific user-related information, when designing for specific user groups, as one respondent stated: "there should be a general Pattern and more specific patterns... when for instance, you are designing for people with autism, you look at the general Pattern first, but you can also get more specific information later on". Another respondent adds to this "the information should be readable in different directions, and also searchable for specific usergroups, when special needs have to be taken into account, in addition to general UD requirements".

Finally, links with legislation, good examples and product information would improve the usefulness of Patterns, as it would be "very interesting to see what the legal requirements are, in addition to the descriptive information provided by
the Pattern. In fact, this is essential, as architects "have to comply to the regulations anyway", according to one respondent.

6. Discussion

The quantitative data gathered from a large-scale survey, combined with insights gained from semi-structured interviews where some of the questions raised by the results of the survey were answered, provided a solid base of user information to start the development of the UD Pattern database.

After a first analysis, yielding 18 important topics, a card sort exercise provided more information about the relative importance of each of the selected topics. Combined with the results of the mapping exercise, clear knowledge needs for architects during the design process were revealed. First, a lot of the information is needed very early on in the design process, when the designer is thinking conceptually, and guidelines should be abstract and general in nature at this stage. In addition to this, while materials and textures are important topics, they are often decided on rather late in the process, when most other design decisions have already been made. However, some respondents with more experience in UD consider materials from the early stages of the design process. This means it might be useful to provide this information as a separate topic rather than combined with dimensional and spatial attributes of the elements described. Finally, the topics rated most important in the card sorting exercises, since they also were prominently mentioned in the interviews as well as being the most common elements in the case studies, will be developed for use in the web based prototype, to make the prototype as relevant as possible to the architects that will test it, even when the information it contains will necessarily be limited.

From the interviews, it was clear that while architects are aware of UD, they still find it difficult to think of a relevant diversity of users to keep in mind. In the conflict part of the UD Patterns, an overview of all the user groups incorporated in each pattern will be provided to make this information more explicit. Another clear suggestion was the use of visual information and inspirational examples, which will be attached to the UD Patterns to be used not only as illustrations, but also as a possible starting point for discussions and reviews by users-experts.

Finally, the focus group yielded a specific request for a "general" UD Pattern before going into specifics, as this fits the design process better, and also makes sure repetitions are kept to a minimum. The respondents also requested a uniform visual language for the Patterns, which will also be taken into account for the development of the prototype.

In summary, all of the methods - the survey, case studies, card sort, interviews and focus groups - provided not only useful, but more importantly consistent, guidelines for the development of the UD Pattern database as a tool for architects.
As a result, the structure, content and presentation of the UD Patterns should be more compatible to the architects’ way of working, making the UD Pattern database a useful additional tool for the implementation of UD in architectural practice.

7. Conclusion and further work

Involving architects in the development of a new tool from the early stages can be done in a number of different ways: through a survey, case studies, interviews, card sorts or focus groups. Each method yields a different type of information, and it is the combination of the results from all of these approaches that provides a broad perspective of the needs of the end-users to support the development of hypotheses for a first trial version of the web based UD Patterns database.

Further work will include the testing of this prototype with user-experts through focus groups and interviews, as well as real-life testing by architects through case studies. In addition to this, interviews with architects and controlled online tests are planned.

References