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universiteit hasselt
www.uhasselt.be
Campus Hasselt | Martelarenlaan 42 | BE-3500 Hasselt
Campus Diepenbeek | Agoralaan gebouw D | BE-3590 Diepenbeek
T + 32(0)11 26 81 11 | F + 32(0)11 26 81 99 | E-mail: info@uhasselt.be

A V-MODEL FOR MORE

An inclusive design model supporting interaction between designer and user

ABSTRACT

Designers aiming to design for all users experience difficulties when realizing this in practice. More insight is needed into practical constraints and potential obstacles regarding inclusive designing. Therefore, this paper proposes a design model of an inclusive design process focussing on the interaction between designer and user information from the start of the project.

The presented model, based on a V-model created in software design, differs from well-known inclusive design models at three general aspects: it emphasises the implementation of user information as an equal, continuous, and separated track; secondly, the interaction between these two tracks is regarded as a key activity; thirdly, a built-in flexibility is provided, enabling the architect to manage an inclusive design process. It is the combination of these aspects, which results in a more supportive model for inclusive designing in the built environment.

This way, more insight can be gained to improve the interaction between designer and user information. Therefore, this model serves the architect in his/her aim towards Inclusive designing.

1 INTRODUCTION

1.1 Inclusive Design (ID)

The ageing population as well as growing interest in more socially relevant design raises global awareness to the important role of social sustainability in society. Inclusive Design (ID) is being used as a possible design strategy to realise this goal. The European Council defines this strategy of Inclusive Design (ID), Universal Design (UD) or Design for All (DfA) as an aim "to make the design and composition of different environments, products, communication, information technology and services accessible, understandable and usable by everyone, to the greatest extent in the most independent and natural manner possible, preferably without the need for adaptation or specialised solutions" (Europe, 2001, p. 17). This description of the three synonyms ID, UD or DfA reflects a holistic approach, focusing on the actual plan for reaching the goal, and includes various design fields without losing its essential meaning.

In order to coordinate this ambition in practice, it is recommended to encourage "designers, architects and engineers to consider the needs of people of different ages, abilities and cultural origins at the earliest stages of designing" (Europe, 2007, p. 4). This suggestion stresses a crucial issue and often forgotten aspect, namely the huge importance of the inclusiveness of the design process itself as this also determines the degree of inclusion of the final design outcome (Herssens, 2013).

1.2 Inclusive design process (IDP)

In order to realise an inclusive design process (IDP), not only an inclusive design attitude is important, but also constantly generating user information throughout the process. "Universal Design*ing*", or Inclusive Design*ing*, was first coined by Ed Steinfeld and Beth Tauke (2002) as a non-stop design and building process with constant user feedback.

To illustrate this, an example is given for an architectural design process. Important design decisions are already made concerning user needs at the very start of the process. For example, the specific location of the building on site and the overall structure of the building are decided during the conceptual phase of the design process. These decisions have a huge impact on user aspects, such as readability of the building, way finding and accessibility. When user requirements are tested in a later phase, this could result in re-designing the building, which could lead to unnecessary additional costs. Constantly testing of different design aspects during all design phases is indispensible. When a building is in use, the degree of inclusiveness can be genuinely experienced. Architects generally do not get feedback on how a building is actually experienced by

its users. Nevertheless, this could provide the designer with valuable knowledge for future projects. A Post Occupancy Evaluation is considered to be a good method in order to gain more insight (Zeisel, 2006). This attention given to users and their experiences throughout the process illustrates what characterises UD*ing*.
In the domain of ID, several authors have suggested key indicators, intended to provide some guidance when designing for a diversity of people (e.g. Lawton, 2001; Preiser, 2001; Steinfeld and Maisel, 2010). The indicators mostly referred to are seven principles of Universal Design, developed by the Center for Universal Design (Connell et al., 1997): (1) Equitable Use, (2) Flexibility in Use, (3) Simple and Intuitive Use, (4) Perceptible Information, (5) Tolerance for Error, (6) Low Physical Effort, (7) Size and Space for Approach and Use. Although these principles may help to evaluate the final design result, "they may be too broad, too generic, and too difficult to apply" when actually designing (Sanford, 2012, p. 71). Indeed, more guidance is needed during the process, when actual design decisions are being made, but a clear map on how to design inclusive solutions is still missing (O Shea et al., 2014).

1.3 Three scopes supporting an inclusive design model

Designers generally confirm the importance of improving quality of life for the greatest number of people as possible by making design more usable and accessible, but there is a clear gap between the awareness of its theoretical importance and its practical implementation (Dong et al., 2003; Zeisel, 2006). One of the reasons for this lack of implementation deals with difficulties designers experience in collecting, selecting, understanding and/or translating user needs into actual design language (Goodman-Deane et al., 2008; Herssens, 2011; Salmen, 2001).
In order to optimize this interaction between designer and user information, solutions should be offered on multiple levels. Merely the development of a new inclusive design tool or method will not be sufficient. Literature confirms that the development of an inclusive design methodology will be a crucial issue in order to close the gap between theory and practice (Dong et al., 2003; Froyen, 2012; Herssens, 2011; Keates et al., 2000; Schulz et al., 2014). Indeed, an inclusive design model for architecture, incorporating this user information, is currently not available.
By developing a more contextualised design model, allowing user information to be more manageable and structured, the increasing complexity of handling a large number of user needs in the development of solutions, could be supported (Aslaksen et al., 1997). Indeed, Gericke and Blessing argue that existing design models too often interpret the design process as an isolated process: "only few models show parallel activities of different stakeholders in order to highlight that design is not executed as an isolated process" (2012, p. 9) Although this design model may be applicable in various design fields, it is developed from an architectural point of view. By outlining a design model for an IDP we search for a conceptual structure that allows a more comprehensive view by clarifying relationships and by better understanding the complex architectural design process with its practical constraints.
This paper proposes an integration and reinterpretation of existing design models in order to develop a usable concept of a design model for an IDP. This model aims to

- analyse how an IDP can address and anticipate to practical constraints of the architect;
- provide the practicing architect with an integrated and systematic way to select and implement the appropriate approaches to generate user information from the start of the design process;
- support researchers in developing the appropriate methods or tools, specifically adapted to the architect's needs and preferences.

These three scopes serve the main objective to increase the implementation of user information throughout the whole design process in a more efficient and effective way, resulting in a more inclusive design result. Before developing an inclusive design model, we briefly address three practical constraints that need to be taken into account when mapping out an architectural inclusive design process.

2 PRACTICAL CONSTRAINTS FOR AN ARCHITECTURAL INCLUSIVE DESIGN PROCESS

2.1 Generating direct and indirect user information

Two main approaches to generate user information in a design process can be distinguished, namely direct user involvement or indirect use of user data (Goodman-Deane et al., 2008). Direct user involvement generates new data by making use of research methods such as focus groups, post occupancy evaluations, interviews, observations, etc. Indirect user involvement relies on

available knowledge, inclusive design tools and methods in order to gain more insight. Although there are a significant number of ways to generate user information, these approaches are not frequently used in practice (Goodman-Deane et al., 2008; Herssens, 2013).
Direct user involvement is an effective approach to collect rich information about the diversity of users. However, a lack of time and budget often makes it difficult for designers to actually involve users into the process (Dong et al., 2003; Goodman et al., 2006; Keates and Clarkson, 2003). Additionally, Dong (2003) states there is a problem with the design attitude towards people with disabilities: unless specifically instructed to do otherwise, designers instinctively focus on designing for someone with physical and skill capabilities similar to their own and have no contact with future users with different capabilities, remaining unaware of their needs (Dong et al., 2003; Eisma et al., 2003; Goodman-Deane et al., 2008; Zeisel, 2006). Finally, when designers do interact with users, they feel it is not their field of expertise (Dong et al., 2003) and do not know how to accommodate their needs into the design process (Keates & Clarkson, 2003). As a result, they make wrong choices or avoid user involvement or user methods entirely (Goodman-Deane et al., 2008). These reasons suggest that merely the use of direct user involvement will not suffice to close the gap between theory and practice.
In the second, indirect approach, existing research results can be applied to gain more detailed in-depth information about users' abilities and needs. However, designers often find it difficult to translate general and rich information obtained from ethnographic research into an actual design language (Boztepe, 2007). Supportive inclusive design methods and tools can nonetheless provide a valid alternative. However, these methods have to be adapted to the design process and to the preferences of designers. Unfortunately, neither of these two conditions are generally fulfilled in design practice (Dong et al., 2011).

2.2 Designers' preferences concerning user information

A second constraint is the fact that designers' preferences have to be taken into account. This is essential to increase the implementation of user information into an IDP. For example, designers prefer visual representations instead of textual documents to get the information they need (Cross, 2006; Dong et al., 2011; Goodman-Deane et al., 2008; Herssens, 2011; Keates and Clarkson, 2003). Moreover, practitioners need 'just-in-time' data, which contains all the necessary elements in a sufficient way without information overload (Keates and Clarkson, 2003). When information is quick and easy to find, time and budget constraints are less problematic and designers will be more stimulated to make the extra effort. Furthermore, designers also prefer intuitive, iterative and stimulating user information, which should be clearly and specifically related to relevant design issues (Goodman et al., 2007). When providing designers with flexible and open-ended user information, their freedom to translate it into creative design solutions will not be limited. Implementing these designers' preferences could facilitate the translation from user information into an actual design solution.

2.3 Architectural design process compared to other design fields

The design model, proposed in this paper, has been developed from an architectural point of view. Literature on design models tends to consider the various design fields as one entity with similar design characteristics. Indeed, there are a lot of similarities when, for example, analysing design activity or design ability. Nevertheless, researchers and designers specialised in their own design field, all have a different focus (Lawson, 2005) and these differences determine the success and usability of a design model. This paper specifically focuses on generating user information throughout an architectural design process, which has implications because of the non-flexibility of the domain.
Architecture is not flexible or easy to adapt once construction has been started. This implies that most design aspects need to be known – and tested - before starting to build the project. However, during designing it is much more difficult to test architecture compared to other design fields. For example, it is feasible to build prototypes for a product or software application, which can then be tested with users. The large scale of buildings, however, makes this nearly impossible, so other types of design output are needed to "test" architecture with users. Virtual simulations of reality, such as scale models or three-dimensional images can create an impression of how reality will look like and design details are sometimes built on scale 1:1. Nevertheless, they cannot serve as a valid test for the whole user experience of a building, although this is necessary for some elements. For instance, sensory qualities (e.g. acoustics) or cognitive qualities (e.g. way finding, readability) of a building are very difficult to test with simulations. These aspects need to be considered for the building as a whole entity and are accordingly very complex to test during designing with direct user involvement. This emphasises once more the importance of indirect user information.

In sum, every design aspect needs a different approach, specific to its characteristics, scale and timing throughout the process. When evaluating the level of inclusion of the final design result, all these aspects need to be taken into account. Therefore, it is necessary to provide the architect with a built-in flexibility to test these elements throughout the design process the way it suits him/her best.

3 METHODOLOGY

A literature review was conducted and recourses were identified beginning with databases (e.g. Google Scholar, Science Direct, Avery) and followed up with reference lists from significant papers, articles and books. Moreover, relevant websites concerning ID were consulted. A non-exhaustive list of existing design models, which considered user information into the process, was assessed for the following design fields: industrial design, software development, quality management, architecture and mechanical engineering.
The practical constraints, as described above, will have implications on an architectural design process and need to be taken into account when mapping out an IDP. User information should be more adapted to the needs of the designer and to architectural design practice in order to close the gap between theory and practice. The next questions, derived from these constraints, form the basis for evaluating these existing design models from different design fields:

- Does the design model incorporate a continuous track of user feedback throughout the design process? (cfr. 1.2 and 1.3)
- Is the design model representative for the specific interaction between architect and user information? (cfr. 1.2)
- Does the design model address practical constraints for generating user information? (cfr. 2.1)
- Are the designers' needs with regard to direct or indirect user involvement answered in this design model? (cfr. 2.2)
- Does the design model provide a built-in flexibility, to test accordingly the architect's needs? (cfr. 2.3)

The collected design models have been analysed and compared to these five requirements in order to reinterpret them and develop a usable concept for a design model generating an IDP.

4 MAPPING OUT INCLUSIVE DESIGN PROCESSES

4.1 Existing inclusive design models

Numerous design models can be found, which propose a strategy to initiate ID in the different design fields. In the following section these requirements for ID are related and applied to an architectural design process. Especially in the field of ICT, design models have been developed from a user-centred perspective. User-centred design can be applied as an approach to ID (Keates and Clarkson, 2003), on condition that the user is to be addressed as the widest diversity of people and not merely as one specific target group.
In 2003, Vredenburg developed a model for IBM that connects an Integrated Product Development (IDP) Process with a User Centred Design (UCD) Process as well as a Business Management (BM) Process on the other hand. This way, the wider picture and the overall strategy can be analysed and important decisions can take the UCD as well as the BM process into account. IBM wanted to integrate UCD as a core enabling process in the IPD process (Dubberly, 2004). In contrast to our goal of emphasizing designer - user information interactions throughout the whole design process, however, UCD in this model is only integrated in half of the phases of the IPD Process.
Herssens developed a model for an architectural IDP, with the emphasis on an iterative process including the user in every phase (Herssens, 2011). This model is visualised by a circular, never-ending process. Herssens opens up a broad perspective for user-intervention. However, more insight in the specific interactions between architect and user information is needed and more knowledge about the type of user information applied during different phases of the design process. Both will be necessary in order to provide better support for the architect, so this should be explicitly incorporated in the model.
The Cambridge Engineering Design Centre has generated a number of design models for Inclusive Design. Both waterfall model (2007) and Integrated Design Log (2012) were developed for an Inclusive Design Toolkit. The latter aims at informing, supporting and accommodating diversity within the field of product design. Another model, is the inclusive review process based on the Markus-Maver map (2003). Whereas the original model focuses on architectural design, it is applied here for a product design process. The 'appraisal phase' of the Markus-Maver model was

replaced by a more detailed assessment procedure throughout a few phases of the design process. Unfortunately, this model of an IDP does not integrate other ways to generate user information. The designer has no flexibility to test the design in a way that is most suitable for the given situation. Yet another model is a software V-model (2004), adapted to an IDP. Keates and Clarkson proposed this model as part of a whole range of collected methods, which they linked together. It emphasises user product interaction and product evaluation (2004). This was the first time a V-model was used to emphasize an IDP. In their model, a track of the V-model is presented as an iterative, circular path. However, the arrows between evaluation and other phases go in only one direction. This implies that there is no direct interaction (or adaptation) possible when evaluating these phases. Moreover, this V-model does not support consultancy during the design phases itself: user evaluation is only provided before and after the design phases. In order to offer a comprehensive approach, Keates and Clarkson add a number of other models to the V-model, which address a variety of different aspects of an IDP (2004).

4.2 A V-model for More

Although existing design models - focussing on an inclusive or UCD process - confirm the importance of integrating users into the process, the specific interaction between designer and user information is not constantly taken into account. Moreover, practical constraints specific to architecture are not addressed in the current inclusive design models. For that reason, the model presented in this paper focuses specifically on the symbiosis of integrating user information and on a creative synergy between designer and user information throughout the design process. Its challenge is to integrate this within one model or entity.
The presented design model is called 'V-model for More'. It is a reinterpretation and integration of four existing models, each translating a different and crucial part of the process. A V-model serves as a general underlay for the proposed model. Whereas the concept of a V-model, where testing weighs equally to designing, opens up new possibilities, the model needs detailed revisioning in order to be applicable to the field of architecture as well. It is a V-model *for More* because of its aim to aspire *more* in order to get the most inclusive result possible out of every design. It also emphasises the non-stop iterative design process which characterises Inclusive Design*ing*. The following part, will describe the development of the model more in detail.

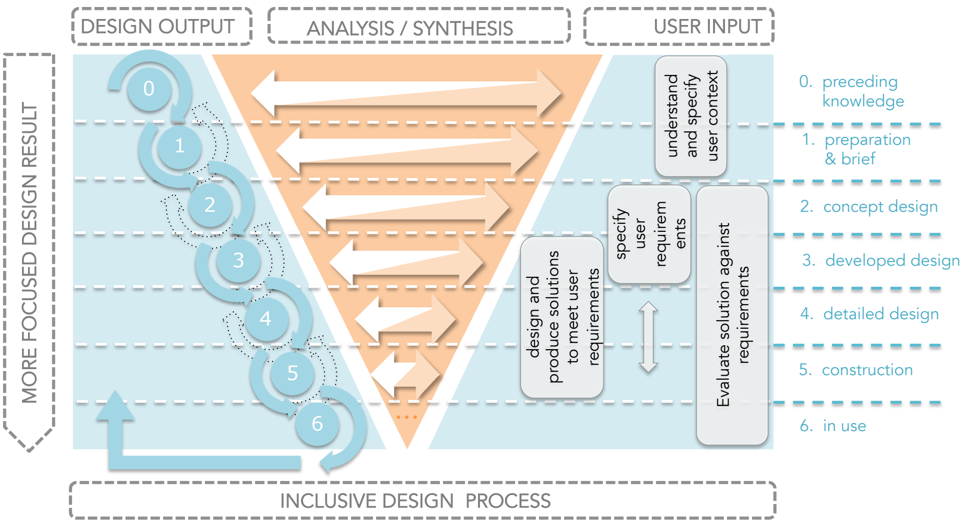

Figure 1 : model of an inclusive design process

4.2.1 Original V-model

Originally developed by Paul E. Rook (1986), the software V-model aims at improving the efficiency and effectiveness of software development. The model has been in use for almost thirty years and its concept is still applied in different design fields. The V-model is derived from a waterfall model (Royce, 1970) and has emerged as a reaction to some maps of the design process, which show testing as only one stage in the entire project. This resulted into a model where testing weighs equal to designing. Consequently, it is this concept of equivalence between testing and designing

and their connection in every design stage, which makes this model so interesting as a starting point for this paper.
However, reinterpretation of the original V-model is necessary because not all of the techniques from System design are transferrable to other design fields (Gericke and Blessing, 2011). First, the clearly defined and hierarchically ordered sequences of the software model needs to change into more flexible stages, corresponding to a designerly way of thinking (Cross, 2006) in the field of architecture. A second major difference concerns the time dimension of the model. In the original model, conceptualizing the test phases occurs simultaneously with the design phases, but the actual testing occurs after designing and 'coding'; as a subsequent process. This is not possible for the built environment. In contrast to the software field, in designing architecture, testing itself also needs to be done during the design phases. Therefore, the time dimension needs to be reversed for the levels of testing. This implies that testing and designing actually occur simultaneously in an IDP. In addition the arrows 'validation-verification' require reinterpretation as the left and right track develop simultaneously for an architectural design and building process and validation or verification is only possible after the process of designing. In sum, the main idea of the V-model is that the tracks of user information and design evolve separately but are constantly linked and gradually come together, resulting in an inclusive design result: The better the interaction, the higher the degree of inclusion.

4.2.2 Designers' process

The process of the designer should be composed in a way that provides the architect the freedom for adaptation and it should suit a personal way of working in a specific project. Therefore the model should be flexible and open for individual interpretation, without losing the main focus towards ID.
The left-hand side of the model (see Figure 1) is subdivided into seven design phases, derived from the RIBA Plan of Work (2013). Whereas the Plan of Work also serves as a framework to contractual documents in architectural projects, minor changes are made to make it more useful as a model for an IDP. Stage zero is replaced by a 'preceding knowledge' phase. Bryan Lawson (2005) explains how designers build up knowledge throughout their career. This knowledge exists out of experiences in former projects and reference material. In the context of ID, it can be supported by sketches, data from focus groups with users, a story of a user-expert, a very successful design solution from a previous project or even an inspirational image, etc. A practiced designer recognises parallels between different design situations and is able to translate them into suited design solutions. Thus, an experienced designer never starts a design process empty-handed. Precedents are considered to be very important as a characteristic of design ability (Lawson and Dorst, 2009). Therefore, a 'precedent knowledge' stage is part of every design process and, similarly, of every IDP. Because focus is put on detailing the complete design in all its inclusive design aspects and thus not only from a technical point of view, the track on 'Technical Design', is renamed as 'Detailed Design'. Phase six, 'Handover and Close Out', is not applicable to this model.
The different stages are connected with loops. Whenever difficulties occur in a design process, it may be necessary to take a step back and reformulate the design problem and solution. An extra loop is made from the end of the process to the beginning. This connection visualises a 'reflection-on-action' (Schön, 1983). Ideally, architects should take the time to reflect on the IDP they went through to find out what kind of approach works best for them to gather user information and what could be improved during future processes. This way, more preceding knowledge can be acquired. This too is an on-going process.

4.2.3 Users' process

A similar approach has been taken in modelling the process of the users. First, although the V-model promotes testing on different levels, a more user-centred approach throughout every phase is necessary. On the right side of the proposed design model (see Figure 1), generating user information takes place in various forms. A user-centred design (UCD) process, as defined in the field of ICT in DIN EN ISO 9241-210, is introduced here (2010): (1) understand and specify user context, (2) specify user requirements, (3) design and produce solutions to meet user requirements, (4) evaluate solution against the requirements.
These four levels of a UCD process offer a good subdivision for all user-related design activities. Different approaches are required according to the type of information needed by the designer. The iterative character of the model remains intact, although some steps will overlap in the design process. This way, the design model is flexible to address the practical constraints, discussed above (cfr. 2). For example, one design aspect needs more specifications about the user context and another part of the design is ready to be evaluated against user requirements. When a

designer needs to return to a previous phase in the design process, it can simultaneously lead to acquiring more user information in a preceding level at the right side of the model. Although this design model wants to visualise and structure the interaction with user information, the possibility is open to shuffle the user-centred phases on the right side, according to the designers' needs in that specific process and for that specific design aspect.

4.2.4 Gradual focus shift from analysis to synthesis

The interaction between the left and right part of the design model develops simultaneously throughout the entire process. As the original terms 'validation-verification' no longer apply (cfr.4.2.1) we suggest using the concept of 'analysis-synthesis'. These concepts have originally been considered to be separate phases of the design process, such as in models of Bruce Archer, Markus-Maver model, Darke, Jones etc. (Wynn and Clarkson, 2005). Koberg and Bagnall (1973) suggested that both analysis and synthesis are present at the beginning as well as at the end of the design process, and that they should therefore be combined. A model developed by Newkirk (1981) visualises this connection and symbiosis between both. In different disciplines, various authors have found that analysis and synthesis emerge together (co-evolution) (Dorst and Cross, 2001; Maher and Poon, 1996; Roozenburg and Cross, 1991). In the field of architecture, studies by Akin (1970), Eastman (1986) and Lawson (2005) confirm this connection. By refining possible design solutions, they are systematically optimised by experience, knowledge and trial (and error) (Clement et al., 2003). Often the problem - or analysis - may not even be fully understood without some acceptable solution - or synthesis - to illustrate it (Lawson, 2005). Also in later research studies, other theories are based on these models emphasising the non-linear process (Clement et al., 2003; Spitas, 2011; Wynn and Clarkson, 2005).
The design activities of analysing and synthesizing are situated in the connection between the left and right side of the proposed model (see Figure 1), visualised by a double arrow. In order to integrate the gathered user information, the designer has to analyse the essential and useful aspects for the particular design project and synthesise it into an actual integrated design solution. This way a new design proposition is developed, which can be presented again to the user in order to get feedback.
In daily practice, user information, generated from different sources, enriches the design process, but it remains the job of the designer to translate this information and integrate it into the project. Apart from a good implementation of the inclusive design solution, various other constraints have to be taken into account. The designer needs to check, for instance, the technical and structural feasibility of the project, the applied legislation, the available budget, the preferences of the client, etc. Without the consideration of all these different aspects, the proposed inclusive design solution cannot be implemented in a sustainable way. Therefore, the double arrow represents the very core business of the designer's job, namely reformulating problem and solution according to new available information, taking into account the various design constraints. This central area resembles the complexity of an IDP.

5 DISCUSSION AND CONCLUSION

In order to increase the implementation of an IDP, focus is needed at different levels. Important contributions can be made to the field by, for example, raising the general awareness for ID, developing new inclusive design methods and tools, gaining more insight in the specific preferences and needs of architects, etc. Although, a lot of research concerning these actions has already been carried out, there is still a gap noticeable between the theoretical importance and the practical implication for the design field (Dong et al., 2003; Zeisel, 2006). Therefore, this research takes initial steps in connecting the design process to an overall inclusive design methodology. Providing designers with methodologies, as well as methods, tools and recommendations, they can better cope with the challenges resulting from an environment characterised by complexity (Gericke and Blessing, 2011). By connecting all these levels, a more flexible implementation of a design model can be created.
For these reasons, this paper proposes a design model for an IDP. This model serves as a step closer to an inclusive design methodology and to provide researchers, as well as architects, with more guidance and structure to link actions at all levels. A design model of an IDP can offer architects more direction to select, structure, manage and translate different types of user information into an inclusive design result. Additionally, such a model can ease planning and increase communication. For researchers, it can also facilitate knowledge transfer in order to get more insight in the specific interaction between architects and users. This way, the inclusiveness of the design result can be improved in an efficient and effective way.

Therefore, this paper proposes a reinterpretation of the V-model based on existing design models in order to develop a usable concept of a design model for an IDP. A V-model for an IDP is further developed towards a more interactive solution, adapted to architecture and ID. This emphasizes that design equals testing. Both are visualised as two separated, but converging processes. One represents the design process and the other track resembles all types of generating user information. Nevertheless, it is the synergy between both that takes a central place in the model. Both the designer and user are essential to aim for an inclusive design result. And it is the central link – the iterative process of analysis/synthesis - between them, which makes an IDP, and consequently the inclusive design result, successful or not.
This model serves as a starting point to enable future studies on the integration of different types of user-input and their interaction. The model is developed based on predetermined scopes (cfr. 1.3) and guiding questions (cfr. 3). As this is a theoretical paper, the proposed model is a framework that needs further validation in practice. When the model will be applied in practice, the following aspects are important to analyse more in detail: (1) implementation of practical examples to validate the model; (2) providing intended support for architect; (3) specific implications on the inclusiveness of the design result; (4) providing a better knowledge for researchers in order to develop suited inclusive design tools and methods.

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