#12
USER-CENTRED DESIGN AS A MODEL-BASED CO-CREATION PROCESS

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12.1 Introduction

Due to digitization in almost every aspect of our lives, we are dealing more and more with contradicting requirements on technology-based services which are provided by companies, education institutions, or governmental bodies. Design with users, design for users, and voice of the customer techniques (involving the customer in the definition of the products or services) become very important in industry, especially user acceptance is key. Methodologically, everything is possible, but not everything is successful. We need the right approach for a user-centred development of innovative products. To avoid the gap between the use and design of systems, sociotechnology can be utilized as a guiding approach (Emery & Trist, 1960). Based upon the principles of participation at all stages of development processes, user-centred methods have proved themselves as very useful means of facilitating open and cooperative settings. Co-creation and mutual understanding among users and designers make it possible to design and develop successful systems that are acceptable to their users, both in their shape and look-and-feel, and in their functionality. This is a promising way to create sustainable systems for real use.

First of all, we have to understand why we should focus on users in design processes (Ritter et al., 2014). The answer is very simple: we want to create a system or technology that is intended for human use, no matter how much artificial intelligence is helping to carry out certain tasks automatically or semi-automatically, usually non-transparently, in the background. We want to design and develop an effective, safe, efficient, scalable, and—the most important among all requirements—enjoyable and usable system for people, in which users can experience what they know well because they have experienced

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similar things so far in their lives, based on that what they can remember. That is why we need to understand them, their characteristics, skills, experiences, commonalities, differences, and their use context, in which they will perform certain tasks by using the system or technology we provide. Understanding users entails specific methodological knowledge and skills on behalf of designers, focusing on ways of getting to know the potential users of an intended system, and furthermore, of involving them intelligently in the design process as much as possible. The process of understanding in order to inform the design for users involves the following actions (Ritter et al., 2014, p. 4):

- knowing how to observe and document what people do, by using appropriate methods,
- understanding why people do what they do, by gaining insights about people's intrinsic and extrinsic motivations,
- understanding and predicting when people are likely do things, by identifying people's behavioural patterns,
- understanding how people choose to do things the way they do them, by studying the options people have as well as the constraints and resources that are given.

All these actions require certain knowledge and skills on behalf of designers to establish the appropriate methodology, research, and design setting at the right time. User-centred design (UCD) helps to achieve not only a better understanding of users but also involving them throughout the whole design process. The consideration of human characteristics and capabilities as central factors in the design process (Preece et al., 2015) facilitates the creation of better accepted and sustainable systems, which are moreover, used.

Successful systems are the ones that go beyond individuals' requirements and capabilities by also explicitly considering the social interactions and environments of their users. Here, sociotechnology is the necessary framework to base the design on. To address all these aspects in a design process is not easy. We need to know what we have to ask when in the course of design projects. For instance, we have to find out who is going to use the system or technology and why. What are the goals of users? Are users willing to put effort into learning how to use the system or technology? How often are they going to use the system or technology? Will they use it alone or together with others? Besides the 'who' question, we have to ask why, how, and when the system or technology will be used. These questions are central, especially during the evaluation and experimentation stage with potential users of the system or technology. UCD methods like brainstorming, storyboarding, creating cultural probes, use scenarios and personas, mockups, low- and high-fidelity prototypes, and then later when design process progresses to user tests, thinking aloud evaluation sessions, focus groups, etc. are all very useful concepts to apply when answering these questions.

In the next section, we will summarize firstly the principles of sociotechnology that provide the base for a user-centred design process, e.g., to create embodied interactions to increase user experience while interacting with the systems provided. Secondly, we will introduce the user-centred design approach by showing their characteristics, especially in innovative design processes. In this section, we will explore the role of different kinds of

models to facilitate Design Thinking methods in user-centred design processes. Finally, we conclude with some discussion points.

12.2 From sociotechnology as a principle to embodied interaction

Emery and Trist (1960) introduced the term sociotechnical systems to describe the complex interaction between humans, machines, and the environment aspects of the work system. The goal is to consider people, machines, and context when designing and developing such systems. Bedham et al. (2000) described sociotechnical systems as having five main characteristics:

- Systems should have interdependent parts.
- Systems should adapt to and pursue goals in external environments.
- Systems have an internal environment comprising separate but interdependent technical and social subsystems.
- Systems have equifinality. In other words, systems' goals can be achieved by more than one means. This implies that there are design choices to be made during system development.
- System performance relies on the joint optimization of the technical and social subsystems. Focusing on one of these systems to the exclusion of the other is likely to lead to degraded system performance and utility.

Baxter and Sommerville (2011) introduced the term of sociotechnical system engineering to address the need to deliver the expected support for the real work in organizations. With sociotechnical system engineering they mean 'the systematic and constructive use of sociotechnical principles and methods in the procurement, specification, design, testing, evaluation, operation and evolution of complex systems' (p. 4). It is still a common problem that systems often meet their technical requirements but are seen by their users as failures because they do not deliver the expected support for the real use. To avoid producing failure in system engineering, sociotechnical principles and methods should be used in design and engineering processes. This can be facilitated by applying user experience design methods while designing new systems or interactions, especially when it comes to offering engaging and enjoyable interaction for users. 'Ubiquitous computing environments need to be responsive to people's needs, but also need to provide engaging and aesthetic experiences' (Banyon, 2019). Besides focusing on usability to achieve the best functionality and effective usage of systems, designers must think about maximizing users' pleasure while interacting with the systems they design, which can also be improved further to facilitate a certain (desirable) lifestyle imposed within the design of an object or interaction provided. A successful user experience requires the consideration of all senses in the interaction with systems aiming for high usability and acceptance by their users. To achieve this, we need embodiment in interaction mechanisms, at least to a certain degree, if not completely. Embodiment in this sense focuses purely on interaction with the objects themselves; as Dourish (2004) explains '… we take activity and interaction with the real phenomena of experience to be central, rather

than focus on internal or purely cognitive interpretations.' This shows us that embodied interaction does not need any translation (van Rheden & Hengeveld, 2016, p. 349). Its specificity embeds meaningful input and output for users. Users control what is relevant for the activity. They decide what is needed for the interaction, not the object or the system itself. Of course, one of the goals of designers should be to achieve a high degree of seamless embodiment in the interaction, which again requires a precise mapping of bodily expression to the expression of the device's output. At best, this results in an arranged or coordinated way of acting that is smooth, gentle, and natural.

The question at the heart of this paper is how to ensure a successfully realized user experience in a new design. In other words, how to proceed in a design project in a way that understands the target users and their context, including their past experiences, and to consider this insight in the design of artifacts and interactions provided as part of the new design. My answer to these questions is to apply modeling in all phases of the design process by creating models of all findings gathered after studying the target users and their past and current contexts, as well as by preparing and accompanying the design process as a reflective and self-critical practice. In the next section, we will show which models are needed to facilitate a co-creation process in a UCD project, by putting users at the centre of attention.

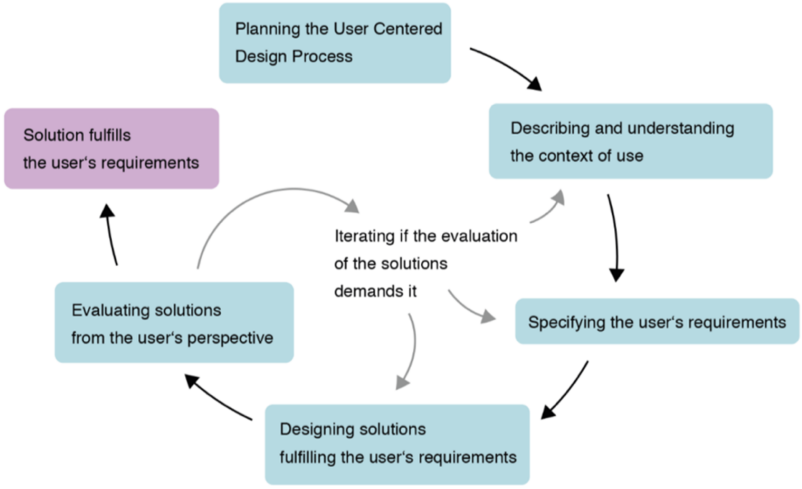

Figure 12.1: ***The iterative process of user-centred design (Adapted from ©DIN EN ISO 9241-210, 2019, p.21)***

12.3 User-Centred Design as a Model-Based Co-Creation Process

User-centred thinking is about creating a direct link between the current and future users (Baek et al., 2007; Wallach & Scholz, 2012). Gould and Lewis (1985) defined three

principles for a UCD process: early focus on users and tasks, to gather knowledge about the social, cultural, personal, and all other types of characteristics of users; empirical measurement, gained by capturing and analyzing user feedback; and iterative design, based on iterations after each user feedback. The iterative process of UCD allows for approaching a final product step by step, by reducing development risks and avoiding dismissing big parts of the achieved components or results (Figure 12.1).

Besides involving users in design processes, we believe that Design Thinking (Cross et al., 1992; Eastman et al., 2001) is a very helpful approach in designing sociotechnical systems. 'Design thinking is a human-centred approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success' (Tim Brown, IDEO). Design Thinking as a framework provides a set of methods that are used in UCD processes. If we take Design Thinking as an approach seriously and apply (all) its methods thoroughly throughout the whole design process, we can easily follow the goal of understanding everyday practice and its actors. This would furthermore lead us to the design of systems that consider the context of use, user experiences, and the necessary technology support as a substantial part of the sociotechnological approach. Our objective in designing systems is being innovative and improving user experience. We think this can only be done by understanding the actors, their actions, their use context, and, of course, by including them as experts in the design process.

Exploring the Design Thinking methods that are necessary to set up and carry out a UCD process, we end up creating artifacts in each step of the design process (Tellioğlu, 2016, p. 24). These artifacts are both enablers and hosts of the evolving design ideas. In the course of design processes, especially if they are user-centric, several models are created (Figure 12.2).

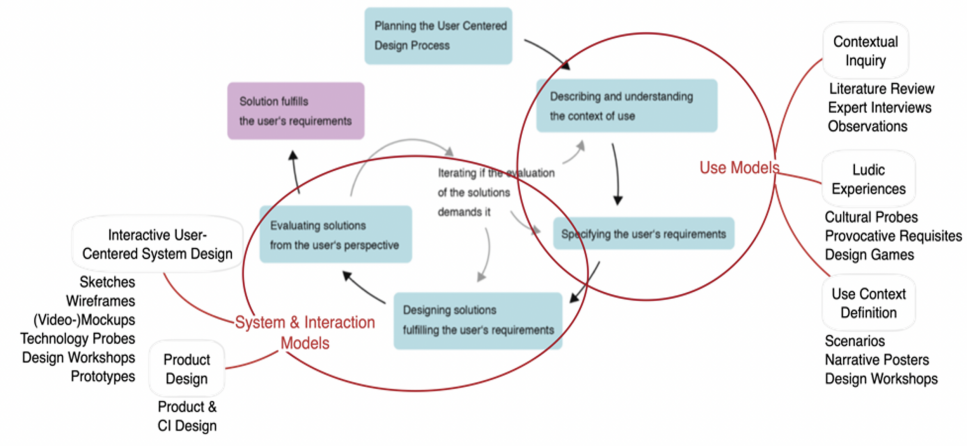

Figure 12.2: ***User-centred design in relation to use, system, and interaction models, and assigned methods***

In a UCD process, contextual inquiry, the capturing of ludic experiences, and use context definition are needed to describe and understand the use scenarios, and furthermore to specify the users' requirements based on their abilities and conditions. Later on, designing and evaluating solutions for users requires the design of an interactive user-centred system and the following product design. The following models help to support these processes:

- *Use models* are personas, scenarios, use cases, flow models, storyboards, or narrative posters, mainly presented as models and descriptions by using a standard modelling language like UML (Unified Modelling Language). The aim of these models is to detail and describe the design not only for the design team, but also to make it accessible for others who are not actively involved in but related to the design process. Use models help to address several requirements and answer the following design and specification questions: Who are the final users? What are the interaction and interface elements? How does the layout, user interface, and interaction look like? What does the user do? What does the product do? What are the use scenarios and use contexts? What are the use qualities? What are the specifics of the product? What is the positive impact of the product? In which cases does the product help users? What are the features of the product? Who would like to have the product? Is it feasible? ...
- *System models* are interface and interaction visualizations, technology probes as well as (hi-fidelity) executable 2D or 3D prototypes showing how the original idea looks like in action in the envisioned context. *Interaction models* are product descriptions and presentations with final corporate identity elements, demonstrating the use and features of the product, pricing, and measures for dissemination. They show the idea of the final product or service by referring to its technology features, interfaces, architectural elements, and its real time use. System and interaction models help designers to deal with the following (re)design, interaction, and evaluation questions: What type of layout elements are needed for surfaces, interfaces, colours, etc.? What are the dimensions and scales of the product? Are there variations in the design? What are the functions that are usable and show affordance? How are ergonomic factors considered in the design? Which technologies should be used to implement the idea? Which (embodied) interactions are implemented? Which part will be implemented with Wizard of Oz, by just enabling unimplemented technology to be evaluated by using a human to simulate the response of a system? Which material, tools, hardware, etc. will be used? What are the sketches, wireframes, technology probes, and prototypes? Are there different visualizations? How is the product documented? What are the user references and technical documents of the product? How are intermediaries or the final product evaluated? What is the evaluation set-up and what are the points to evaluate? How are evaluation results translated into (new) requirements and changes to the existing requirements? ...

Our claim is that if designers do not create such models, they will fail their design purpose. The above-mentioned models offer a holistic view of the design objects and processes by helping both the designers and the users. They help address and fulfil the requirements for designing (embodied) interactions for better and improved user experience. *Use models* are applied to study and understand the target users, their habits,

wishes, mental and physical conditions, settings of use, and desires. Furthermore, they enable experimentation with the users to find out how to engage them and how to motivate them to remain active in the application of the design object. *System and interaction models* continue with designing usable artifacts as parts of the whole system under development, based on the knowledge and experience gathered and provided by use models. They facilitate design corrections by means of co-creation processes carried out together with target users by ensuring the achievement of maximum usability, clarity, pleasure, and satisfaction of users while interacting with the system. Embodiment can be an important part of the interaction mechanism designed. Finally, all meaningful input and output actions and interactions are realized during the product design by considering additional aspects of usage, such as control and customization of the system by its users.

12.4 Example of a model-based co-creation process

In this section, we present an example to illustrate how this methodology and the abovementioned models can be applied in a real design project. ReHABITAT-ImmoCHECK+, a research project funded by BMK,[1] has developed the conceptual basis of a gender and age sensitive set of instruments for illustrating the development potential of vacant or not fully occupied single family detached houses. This potential could be generated by redensification and by fostering innovative forms of living together. Furthermore, this set of instruments permitted an assessment of the houses. On the one hand, it aimed to support persons (the users of the designed product) in a phase of reorientation regarding their living and housing situation; on the other, it provided banks with decision guidance in the granting of credits. UCD was applied throughout this project, which resulted in a satisfactory and successful solution, both for the residents and for surrounding stakeholders. Figure 12.3 shows the intermediary results (use as well as system and interaction models) created in several design workshops with all involved persons in the project: a) 2D bricolage of the house; b) a brick presentation of the house; c) emotional and behavioural expectations from the house; d) the ground-plan of the house as a Lego construction; e) design workshops with users to plan the 'new' house; f) the use perception of the house and its areas; g) the representation of the 'new' house with different use aspects; h) the use context mapping based on the usage of the house; i) the visualization of the usage of the house from the other inhabitants' perspective, which varied in most cases significantly among the inhabitants of the same house; j) the scenario to implement in the technological solution; k) the sketch of an entry point interface; l) a wireframe and low-fi mock-up of the usage representation of the house; m) the prototype of an interactive solution to create the house plan based on usage; n) the final product landing page to enable multiple users to enter data into the system; o) the interface to build a simple representation of the house to facilitate a common understanding between all stakeholders involved. This example shows how the single models build the base for the next step in the process, and how the design evolves over time through the active participation of the stakeholders. Most importantly, it shows the process by demonstrating the different types of models created.

[1]Federal Ministry Republic of Austria Climate Action, Environment, Energy, Mobility, Innovation and Technology, https://www.bmk.gv.at/en.html

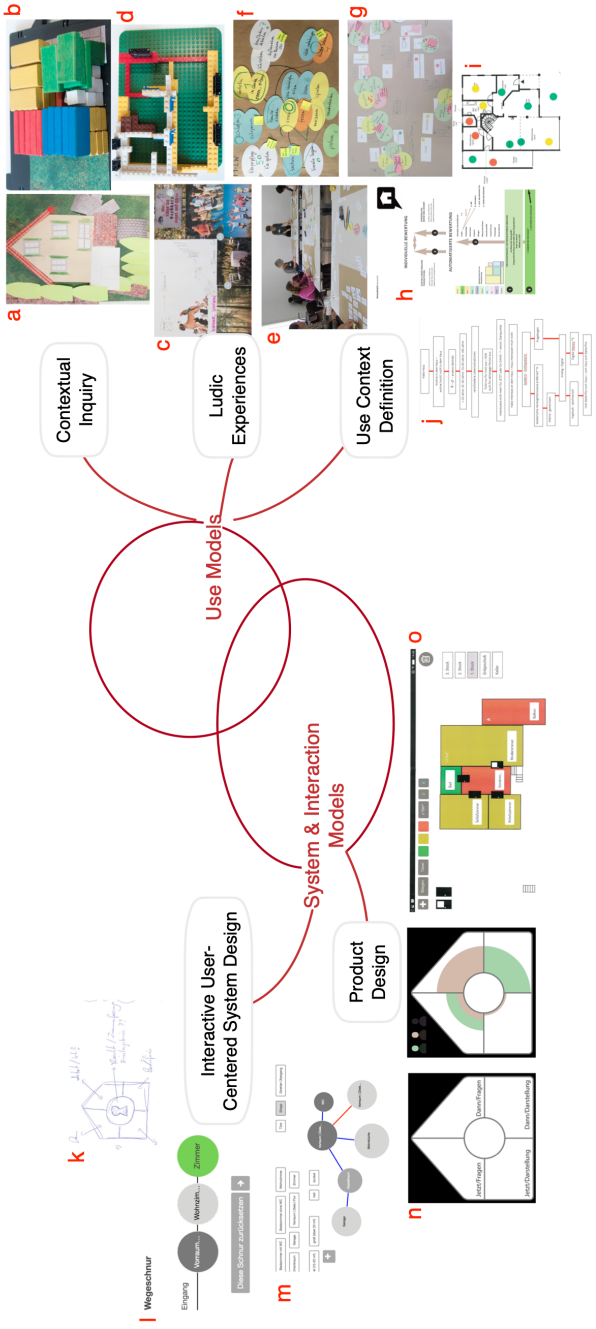

Figure 12.3: ***Artifacts created as models during the User-Centered Design process in the project ReHABITAT-ImmoCHECK+***

12.5 Conclusions

In this paper, we introduced user-centred design as a dynamic multidimensional process utilized by several Design Thinking methods and UCD artifacts. The whole design process is an iterative circle of intertwined factors, namely of people (users, designers, other stakeholders), particular design phases, and artifacts as intermediaries or final results to represent certain design aspects and parameters. The iteration of a UCD process is accompanied with user studies for design and for evaluation, which need different methodological approaches in each design phase. In UCD projects, usability studies have to be seen as integral parts of design processes. This fact makes usability studies to important activities which enable the creation of the products and shape their future use in real settings (Bødker, 2000).

We presented how a UCD process can be established and how a design process can evolve from the very beginning until the definition and presentation of the product design. A careful combination of by now well-established Design Thinking methods makes it possible to design systems for improved user experience. It remains crucial, however, to create the right intermediaries while focusing on users during the design process. The generated design artifacts host implicit knowledge about the target users, their contexts, and all other factors that are relevant for the design process, mainly to make the right design decisions throughout an entire project. Use, system, and interaction models are very powerful artifacts that help to achieve this goal when applied correctly at the right time while designing. There is no strict rule stating that all the methods contributing to create the models presented in Figure 12.2 should be used in any type of design projects. Each project is unique, and designers have to select the most suitable methods for their particular project. This paper only helps to show the possible and useful ways of doing user-centred design.

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