A DESIGN PROCESS FOR CREATIVE TECHNOLOGY

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ABSTRACT

Creative Technology is a new bachelor programme at the University of Twente. Goal of Creative Technology is to design products and applications that improve the quality of daily life in its manifold aspects, building on Information and Communication Technology (ICT). The application domains range from recreation to work, from entertainment to learning and from health to art. A paradigm of Creative Technology is to make use of existing technology in novel combinations –in contrast to developing new technology.

In this paper we identify and elaborate the Design Methods of Creative Technology in a consistent overview. On one side, the focus on human daily life suggests that user centred design approaches from Industrial Design and Interaction Design are relevant for Creative Technology. On the other side, the development of prototypes will make use of "classical" engineering design principles. Between these areas of design is a field that is not covered by other disciplines: the exploration of the potential of existing ICT technology, focussing on applicability for the user. To foster this process, our design method is a balanced combination of Divergence-Convergence and Spiral models of design practice.

The purpose of this model is mainly for education. However, for Creative Technology as a multi-disciplinary field, it is also relevant to position itself in contrast to the neighbouring disciplines, which in our context are Industrial Design Engineering and ICT.

Keywords: Design Methods, Design Process, Creativity, Smart Technology, New Media

1 INTRODUCTION

Creative Technology is a new bachelor programme at the University of Twente. It is also a design discipline on a multidisciplinary basis. Its goal is to develop new and innovative products, applications and services. The designed products are for human usage that improves quality of life in all its different facets, in work and recreation, in health and entertainment, in learning or in art. The design material is technology, ranging from new media to smart technology, using videos and sound, internet, all kinds of programmable platforms, sensors and actuators. One core paradigm is that the potential of existing technology is not yet fully explored and Creative Technology tries to tap from this potential. Creative Technology is a relatively new discipline that is still in the process of being defined. Making design methods explicit is one corner stone in the definition of the field.

Creative Technology has overlap with a number of established design disciplines, such as Industrial Design, Human-Media Interaction, Graphic Design, Interaction Design, Engineering Design, and more. Accordingly, Creative Technology also integrates design steps and methods from these overlapping disciplines. In the curriculum the variety of methods is reflected by the expertise of the lecturers, who are also rooted in different disciplines. In the project oriented education environment [1] students learn about design methods in a series of integrated project courses that form about a third of the study load. The other courses focus on knowledge and skills in specific domains, such as programming, graphic design, electrical engineering, business and more.

The goal of this paper is to arrange the set of relevant design methods in a coherent structure while emphasizing the parts and steps that are specific to Creative Technology. The result is (a concept of) a design method, built on observations from project courses within the curriculum and methods adapted from the related disciplines. The benefit of explicating a design method is manifold. For students the design method can serve as guideline in their design processes, for planning, implementation and also for documentation of projects. It also provides clear intermediate points for feedback and evaluation which are important in an educational setting. From the point of view of course design, we notice that different project courses emphasize different phases or aspects of the design process. The positioning of each project course within a larger perspective on design methods allows to develop a more complete and consistent perspective on design in our programme, and also supports fine-tuning of existing content. New lecturers come, in most cases, from one of the (mono) disciplines relevant for our programme. For them, understanding the role of their expertise and design methods within an overall picture of Creative Technology is essential to develop courses adjusted to the programme. Next, embedded in a technical faculty, we continuously have to explain what Creative Technology is, what it can achieve, and, especially, to what extent its methods differ from the well-known engineering approaches. Finally, the definition of Creative Technology as a discipline is an ongoing process. The work presented here is therefore also meant to provide a reference point in the discussion.

2 A CREATIVE TECHNOLOGY DESIGN PROCESS

The design process of Creative Technology that we suggest is illustrated in figure 1. On the highest level it consists of four phases; Ideation, Specification, Realisation and Evaluation. Each phase starts and ends with a defined set of (intermediate) results. Before we go into the details of the four phases, we want to elaborate on a few existing classical approaches that provide key elements for our method.

2.1 Divergence and Convergence Models

A classical model for creative design processes consists of a divergence phase, followed by a convergence phase, described already by Jones [2] in 1970. In the divergence phase the design space is opened up and defined. The breadth of the design space is typically determined by a number of factors: lateral thinking techniques allow to shift the perspective on the starting question and foster the creativity of the designer, but also her experience and the richness of her cultural background can open the view on “unexpected” solution domains. The converging phase can be described as the process to reduce the design space, until a certain solution is reached. Each reduction of the design space is a design decision based on the requirements and available knowledge. However, many design decisions have to be taken on the basis of incomplete knowledge. Therefore the experience of the designer, her preferences and also her openness to take risks, shape the solution space. A classical model including these phases is the one of Roozenburg and Eekels; “divergence and convergence in the innovation process” [3, 4]. Also in Saffer's book on interaction design [5] a sequence of divergent and convergent phases is explained. In our Design Method divergence and convergence is integrated in the phases of ideation, specification and realisation. Before and after each phase lies a defined set of items, which form natural caesuras within the process (one exception will be elaborated below). Each set of items is a starting point for a divergent sub-process or an endpoint for a convergent sub-process, or both.

2.2 Spiral Models

The main argument for spiral models is an analysis of the design steps that design professionals take in their processes. The sequence of steps shows a variation that does not allow for claiming a logical order [4]. They all share however, the components of problem understanding and definition, project planning, idea generation and evaluation. Spiral models are related to the nested problem solving of Wieringa [6, 7] in the sense that each design problem unfolds a sequence of questions that is specific to the starting problem and the context. In nested problem solving, the interwovenness of design questions and knowledge questions is emphasized, which guide along an individual path in the design process. A design question (e.g. “how to design a defrobnicator?”) raises subsequently a knowledge question (“what is the state of art in the design of defrobnicators and related products?”). A knowledge question (“does a cover from smart material improve the user experience of the product?”) raises a design question (“how to design an experiment with which the knowledge question can be evaluated?”), et cetera. A design method based on a spiral model is the Eindhoven Transformational Design Process [8] pictured in figure 2. In this process, all design steps are interconnected and can be traversed in any suitable order, where each step includes a reflection phase. It is for our context a very relevant reference, as the design goals and design material of the educational programme of Industrial Design in Eindhoven are closer to Creative Technology than most other programmes. Whereas we agree on the ingredients of this design process, we feel the need for a more structured one, with more defined intermediate points that give a grasp on the educational process. In this aspect we are oriented towards beginners in design who are best suited with more guidance, rather than experts [9].

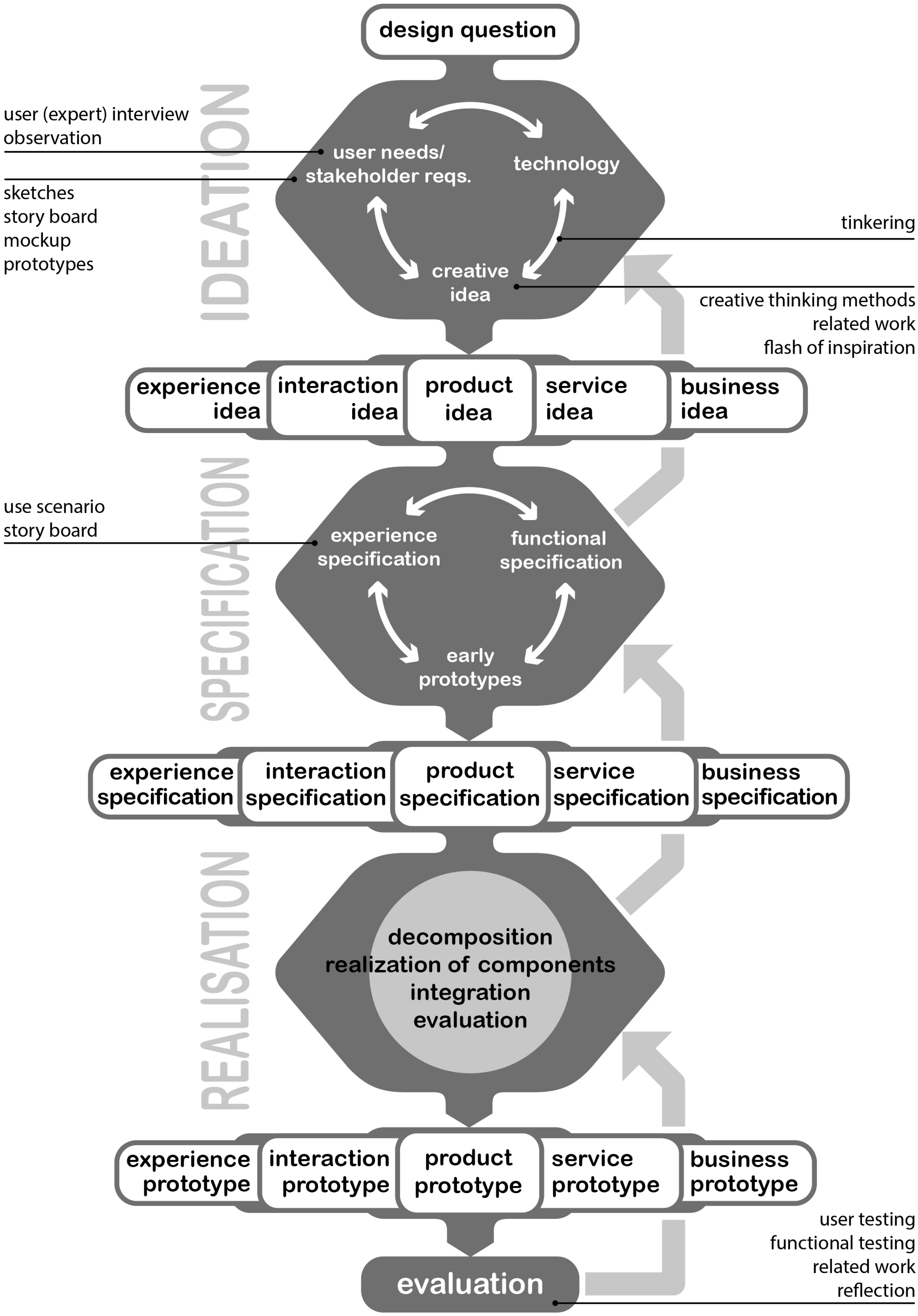

Figure 1. A Creative Technology Design Process

In our design method the spiral concept is reflected within each of the phases of Ideation and Specification. Within these phases the elements and their connecting arrows can be regarded as specific instances of the elements in the reflective, transformative design process [Figure 2, left].

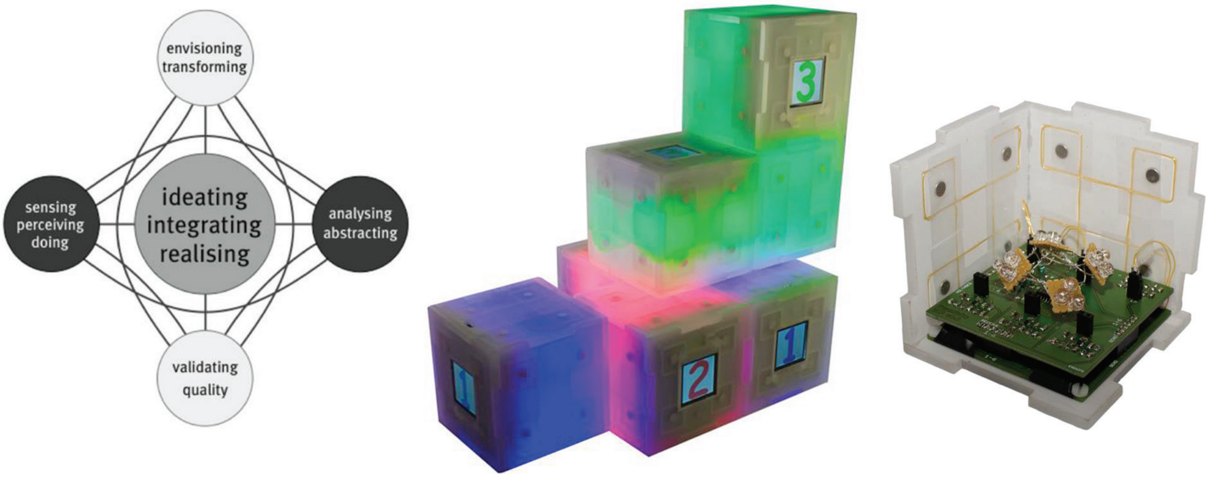

Figure 2. The Eindhoven Reflective, Transformative Design process (left) and two views of the "counting blocks" prototypes by Jelle Dijkstra [10,11]

3 THE CREATIVE TECHNOLOGY METHOD

In the following we will describe the four phases of our design method in more detail. As an illustrating example we take the *counting blocks* bachelor project of Jelle Dijkstra [Figure 2].

3.1 Ideation Phase

Starting point of a Creative Technology design process may be a design question in form of a product idea, an order from a client, or a creative inspiration, similar as in related design disciplines. Specific for Creative Technology is that technology can be a starting point or motivating force in the ideation phase. The process that starts with technology is called tinkering, and has as goal to identify novel applications for existing or new technology [12]. In this sense the approach bridges between technology and user needs, which is in this form not provided by any other discipline.

The spiral form of the ideation phase as suggested here shares the problem definition, acquisition of relevant information and idea generation with similar approaches. Creative ideas may have many sources. They may come from a flash of inspiration, or be the result of one of the lateral thinking techniques as by de Bono [13] and others. With this work we share the conviction that creativity can be trained to a certain level, and is more often the result of hard work than the kiss of the muse.

Another source of inspiration is related work (which plays different roles in the different phases). Adaption of existing solutions may be on a conceptual level (e.g. transferring an Amazon-like book recommendation system to a physical book store, where lights signal a client that a book may be interesting to her), or on a technical level (e.g. by using an energy monitoring system, that should raise awareness for energy leaks in one's home, as a monitoring system of the energy consumption of an elderly person, indicating that the elderly is active and well, or not.) Evaluating early ideas with clients or users applies similar techniques as other user centred design techniques, using mock-ups, sketches, user scenarios or story boards. Interviews with clients, users or user experts characterize the needs, describe the problem setting and provide requirements. Result of the Ideation Phase is a (more) elaborated project idea, together with the problem requirements. Ideas on experience, interaction, as well as a service and business model are also part of the result.

In our illustrating example of a bachelor project, the initial design question of the student was to equip a well proven toy with educational content, in contrast to designing an educational toy. During the ideation phase the student visited a Montessori school and a day care (user needs, requirements, investigation of present (educational) toys), and came up with lists of popular toys and lists of possible educational contents. These actions together formed the divergent part of the ideation phase. In the convergent phase he decided for a user group (children in pre-school age), an educational content (counting abilities), and a toy (building blocks). This then defined the transition point to the following specification phase.

3.2 Specification Phase

Characteristic for the specification phase is that a number of prototypes are used to explore the design space, and that a short evaluation and feedback loop is applied. Functionality influences the user experience, and demands on the user experience may require change of the functionality. These causalities are evaluated by using prototypes, with users, or possibly by the designer herself. Prototypes are subsequently discarded, improved or (partially) merged into new prototypes. The evaluation may also lead to a new functional specification, in its turn leading to a new prototype.

The large number of prototypes built and evaluated is a major difference from the Engineering Design approach, where typically one prototype is built and improved until the final design is reached. Also the kind of prototypes is different: as the user experience is a driving factor here, prototypes are often reduced to single or few aspects of the overall future product that is responsible for a certain kind of experience. The distinguishing characteristics with respect to Industrial Design is the interplay between technology and user experience. According to the different design material, the prototypes in Creative Technology often contain electronic components, such as microcontrollers, and show some dynamic behaviour.

In our illustrating example of a bachelor project, the functionality of the counting blocks should be that they can count their colour matching neighbours. To make early prototypes, displays of mobile phones were used to show the numbers. A user test at the day care showed that the children could read large numbers on the displays well. A functional requirement was that neighbouring blocks can communicate with each other. A coil construction was designed, where coils in neighbouring blocks can allow data transfer, if they are positioned in the correct way. To support the correct way of positioning blocks (user experience), magnets were added to the blocks in such a way that they snap in the correct position. Also the light colour had to be changeable, such that only neighbouring blocks of the same colour group together. It was decided to change the colour by a knock or fast movement.

3.3 Realisation Phase

When a product specification is given, we can follow in the realisation phase the proven methods of engineering design, that are characterized by decomposition of the start specification, realisation of the components, integration of the components and evaluation. Prominent design models including these steps are the Waterfall Model and the V-Model. These models are typically linear, allowing for backtracking in case of "wrong" decisions. Phases of divergence and convergence are not explicitly elaborated, and might be identified in high abstraction level in shape of the entire phase. Evaluation within this phase has to validate whether the end product meets the subsequent specifications. Not yet included in the model are the realisation processes of the business and service specifications.

In our example, the student took a decomposition step first, analysing the components necessary for the realisation, like communication, connection, CPU, powering, charging, tilt detection et cetera. For each part he came up with a list of possible solutions (which is in fact also a divergence phase), and selected a subset consistent with the requirements. Next, he realised the components, by buying (electronics), building (casing, coils), and programming (protocol for communication via the coils). Eventually six prototypes were built as shown in figure 2.

3.4 Evaluation Phase

Evaluation may address a number of aspects. Functional testing is typically already included in the realisation phase, but could also have a place here, and may address earlier functional requirements. Certainly, it has to be evaluated whether all the original requirements identified in the ideation phase are met. User testing is the most obvious method to verify whether the decisions taken satisfy the user requirements and facilitate the experience intended. Related work at this point has the function to position the own result in the context of existing work. Finally, reflection is the basis for personal and academic progress. Here, we do not have the "classical" student reflection in mind ["If we had started earlier we would have been able to finish the product in time."], but a personal attempt to make implicit decisions explicit and to reconsider one's own (implicit) standards, as elaborated by Visscher-Voerman and Procee [14].

In our example, the student finally observed children from pre-school playing with the blocks. He could confirm that the children talked about the numbers, but played more with the colour changing possibilities. They also used the toys as mere building blocks, which was either one intention of the concept: building a toy with educational benefits, rather than building an educational toy.

4 DISCUSSION & CONCLUSION

Our design process model combines the concept of divergence and convergence with a cyclic concept. Convergence at a small number of defined intermediate points is useful in an educational context. They separate the overall trajectory in more comprehensible units than a global divergence-convergence approach or an overall cyclic model. Intermediate goals structure the process, allow for more specified steps in the planning, and also define feedback moments. The cyclic elements take the variety of paths in the design process into account, that are driven by the nested questions of problem solving and are specific to the character of each individual design project and the designers involved.

Relevant for us is to distinguish our process from classical Engineering Design in the emphasis on divergent and convergent phases, as well as on the circular process steps. Whereas both may play a role in Engineering Design, the emphasis there lies more on a linear process with possibilities for backtracking. Moreover, the design space exploration using multiple prototypes that are evaluated against a user experience is not present in the classical Engineering Design process. On the other hand, the distinguishing factor from Industrial Design is the continuous interplay between technology and requirements, especially for user experience.

Although we present just one example for illustration, the design method we suggest builds on observations of multiple project courses given in the curriculum, integrating methods from related design disciplines. We ordered the set of identified methods in a coherent way, and give possible explanations substantiating of the kind and arrangement of the design steps. From a scientific point of view we have treated the steps of observation, ordering and explanation, the latter as first step to the forming of a theory. As remarked rightly by Dorst [9] for the development of a design method, theory forming and evaluation would also be obligatory steps in a proper scientific treatment of the subject. At this state however, we take a pragmatic point of view, and hope that the explication of a Creative Technology design method gives the opportunity for discussion and development, which is needed as a basis for further steps in the definition of the discipline.

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