

# TOWARDS DOCUMENTATION SUPPORT FOR EDUCATIONAL DESIGN THINKING PROJECTS

Thomas BEYHL, Gregor BERG and Holger GIESE

Hasso Plattner Institute at the University of Potsdam, Prof.-Dr.-Helmert-Street 2-3, 14482  
Potsdam, Germany

## ABSTRACT

The design thinking methodology is an incubator for innovative products and services. Design thinking is based on in-depth interactions with prospective end-users and therefore usually results in products and services desired by end users. At the end of a design thinking project, the final outcome of the project is often presented to the external client, who decides about the realization of the product or service. This presentation includes the final prototype, which fulfils the purpose of illustrating the final idea. Therefore, the final presentation passes on the overall idea, but often neglects design rationales. This problem is especially dire in educational settings, in which students usually perform these tasks for the first time. Consequently, the students only pass on a very limited subset of the knowledge they collected during their design thinking project. Even worse, engineers engaged by the client make their decisions based on incomplete knowledge when realizing the product or service. Thereby, they usually have to make adjustments to the envisioned product or service concerning technical constraints, legal restrictions and economical issues. The engineers may end up creating a less desirable product or service since such changes usually affect its desirability and viability. In this paper we investigate how design thinking projects may be documented to ensure that products and services are realized desirable, viable and feasible. We report on our insights concerning the documentation of design thinking projects in educational settings and outline our envisioned documentation framework for capturing the design rationale.

*Keywords: Design thinking, design knowledge capture, knowledge management*

## 1 INTRODUCTION

The methodology of design thinking is an incubator for innovative products and services. Design thinking is based on in-depth interactions with prospective end-users such as observations, interviews and prototype evaluations [15]. Innovative products and services fulfil the three dimensions of design thinking as defined by Brown [5] (Figure 1a), i.e. desirability, viability and feasibility. Thereby, feasibility describes “*what is functionally possible in the foreseeable future*”, viability covers “*what is likely to become a sustainable business model*” and desirability defines “*what makes sense to people and for people*”. These three dimensions behave like a tripod. If a modification of the innovative product or service affects one of these three dimensions, the other dimensions may also need adjustments – otherwise the tripod falls over. For example, a less desirable or less feasible product may decrease viability. If aspects of the innovative idea have to be changed (Figure 1b) concerning feasibility (e.g. too small to be build), the product or service may become less desirable (e.g. too big to be desirable) and, therefore, also becomes less viable. Therefore, while making adjustments to the product or service, an optimal balance of the three dimensions of design thinking has to be preserved. This requires a reliable documentation of the product or service idea – otherwise, the realizing engineers are not able to keep the optimal balance between desirability, feasibility and viability.

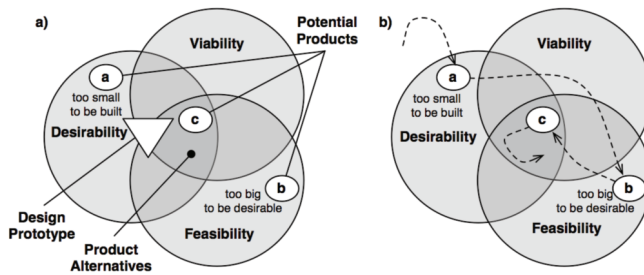


Figure 1. Dimensions of design thinking (adapted from [5], cf. [3])

Design thinking is taught at several d-schools around the world, such as the HPI School of Design Thinking<sup>1</sup> in Potsdam, Germany where the students undergo all steps of the design thinking methodology in cooperation with external clients. Thereby, they experience a journey of successes, failures, insights and *aha*-moments, which consists of wayfinding, i.e. making significant changes such as discarding a prototype almost completely, and navigation, i.e. making incremental changes to a prototype [6]. At the end of the journey, the final outcome of the design thinking project is often presented to the client, who decides about the realization of the product or service. This presentation often includes the final prototype, which fulfils the purpose of illustrating the final idea. Still, by definition this prototype is incomplete [12]. Thus, the final presentation passes on the overall idea, but often neglects the design rationale, which “*is an explanation of how and why an artifact, or some portion of it, is designed the way it is*” [9]. This problem is especially dire in educational settings, in which students usually perform these tasks for the first time. Consequently, the students only pass on a very limited subset of the knowledge they collected during their design project. Their documentation only consists of the *explicit*, i.e. documented, knowledge. The *implicit*, i.e. undocumented, knowledge needs to be re-established later on. Afterwards, engineers engaged by the client have to make their decisions based on incomplete knowledge and, therefore, may not create a desirable and viable product or service feasibly. These engineers have to respect technical constraints, legal restrictions and economical issues. Therefore, they usually have to make adjustments to the desired product or service without affecting its desirability or viability negatively. In design thinking the ideal documentation has to cover the needs of the students driving the process, the management of the d-school, the client’s management, and engineers.

In this paper, we investigate how design thinking projects may be documented to ensure that the innovative ideas are realized desirable, viable and feasible [5]. We report on our insights concerning the documentation of design thinking projects in educational settings and outline our envisioned documentation framework for capturing the design rationale. With this framework, the implicit knowledge of design thinkers can be made explicit and accessible to engineers using traceability approaches [8]. As a result, engineers are empowered to make well-informed decisions based on the captured design rationale.

In Section 2 we present the state of the art of documenting and traceability. In Section 3 we reflect on our experience about documenting in educational settings. Following, we describe the identified needs towards a documentation platform for design thinkers. In Section 4 we propose our documentation framework for documenting in educational design thinking settings. In Section 5 we discuss related work and finally conclude the paper in Section 6.

## 2 STATE OF THE ART

In practice, traceability is applied to different disciplines to follow the lifecycle of animate and inanimate objects [8]. For example, in software engineering traceability helps to understand, manage and verify requirements, analyze the impact of changes, tracking the design rationale behind design decisions and monitoring the project progress [18]. In practice, traceability approaches either create traceability links automatically when artifacts are transformed (e.g. [10]) or recover traceability links heuristically (e.g. [1]).

<sup>1</sup> [http://www.hpi.uni-potsdam.de/d\\_school/home.html?L=1](http://www.hpi.uni-potsdam.de/d_school/home.html?L=1) (accessed Mai 2013)

As stated by Gotel et al. [7] agreed requirements are the result of content transformations, e.g. an interview recording transcribed into an interview summary, which is further used to derive use cases. Thereby, information may get lost. Gotel et al. conclude that “*storing, using and maintaining extensive media-rich materials is far more costly than creating them in the first place*” [7], because relationships between transformed artifacts are not obvious later on as one might accept. These extensive media-rich materials, as also used in design thinking, require additional effort to extract their content into a machine-readable form such as semantic labelling of images using gamification [17]. As the literature conveys, traceability is applied in diverse disciplines [8], because traceability enables the reconstruction of the journey of animate and inanimate objects. However, the traceability link creators are often not the traceability link users and, therefore, see no benefit in supporting traceability [2], [18]. The same applies for the capturing of design rationales [11]. Parnas states “*documentation that is not important to its author will always be poor documentation*” [14]. Thus, immediate benefits have to be provided to design thinkers to motivate them to document [18], e.g. in software engineering traceability links can be used by the trace creators to check whether all elicited requirements are addressed by the implemented software system. Nevertheless, documenting every detail is also impossible. Parnas states that it is sufficient to document the ideal process [14]. Traceability aids to reconstruct this ideal process later on, i.e. what is important to include in the documentation and which aspects can be neglected. While design thinkers adhere to the dimensions of desirability, feasibility and viability within their process, requirement engineers adhere to the dimensions of requirements engineering as defined by Pohl [16], i.e. specification, representation and agreement. Thus, requirements have to be complete, formally represented, i.e. without ambiguities, and commonly agreed upon.

### **3 DOCUMENTING IN EDUCATIONAL DESIGN THINKING SETTINGS**

In our research project<sup>2</sup> we investigated how the handover between design thinkers and engineers can be improved. Thereby, we investigated how design thinking projects are documented in educational settings. We observed that knowledge managers, who guide the students when documenting, provide a set of different tools as best practices, e.g. daily questions to be answered, design logbooks similar to diaries, digital documentation and communication platforms such as wiki systems, file shares, and templates for presentations. The students are encouraged to use these tools. Thereby, the knowledge manager predefines the structure of documentation and communication platforms only up to the project level. Providing students with a well-structured template of what to document is not sufficient, as they only will look at this template as soon as they are required to hand in their results and documentation. Thus, students are responsible to structure their documentation on their own in a manner they, as a team, are comfortable with. For example, they often use a timeline structure (e.g. week 1, week 2, etc.) or a process structure covering the design thinking process (e.g. understand, observe, point of view, etc. [15]). Thereby, the students compose documentation artifacts such as text documents, images, audio and video files, and presentation slides. When uploading these documents to the documentation platform, they do not further comment or annotate these documents. Especially in case of images the missing comments and annotations lead to the situation that the artifacts' content is undiscoverable and cannot be distinguished without looking at them individually later on. During our observations, we further observed that students always document before presentation milestones and at the end of the project, although they are encouraged to document along their process. Thereby, they present their progress several times during the project. The students mainly focus on generating insights, findings, and concepts instead of documenting them. Therefore, time for creating documentation is rare, which has to be considered when planning a documentation tool. Depending on their individual client, some student groups describe their ideas in more detail after the final presentation took place, e.g. in additional meetings or in more detailed project reports, if the client asks for either. However, the documentation of the project's journey is often neglected and only the final idea is described in detail. As in other domains in which traceability is used [2] and design rationales are captured [11], documenting in design thinking is considered as beneficial only for others. Thus, the students are not willing to document their design rationale or any other implicit knowledge they gathered. Especially in educational settings, documenting does not follow explicit

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<sup>2</sup> [http://www.hpi.uni-potsdam.de/giese/projekte/dtr\\_connecting\\_designing\\_and\\_engineering\\_activities.html](http://www.hpi.uni-potsdam.de/giese/projekte/dtr_connecting_designing_and_engineering_activities.html) (accessed Mai 2013)

rules and is performed rather ad hoc. In turn, students do not benefit from it themselves. The students often sketch their knowledge in natural language and visual notations. They mainly work with analogue artifacts, e.g. post-its and paper prototypes, which are captured by digital artifacts, e.g. photos, videos, or presentation slides. This makes it even harder to capture the design rationale due to technical limitations and inherent uncertainty, e.g. imprecise handwriting recognition and ambiguous natural language, respectively. Depending on the students' discipline of study, they perceive the provided tools as difficult to use and instead use tools they are accustomed to. Thereby, they especially use collaborative tools like *GoogleDocs* to work collaboratively on text documents and spreadsheets, *Dropbox* for sharing documents and uploading photos from mobile devices, and *Facebook* to arrange meetings. The combination of these tools embodies additional use cases, which have to be addressed by an appropriate documentation platform. However, these tools and services are not connected to each other, which makes it difficult to establish relationships between artifacts.

#### **4 DOCUMENTATION NEEDS OF DESIGN THINKERS**

The biggest challenge in educational design thinking settings is to get students to document voluntarily by providing immediate benefits for them. Therefore, we investigated the students' needs towards an appropriate documentation platform for such settings. Thereby, we discovered that the provided documentation platform has to support the documentation tools the students would choose or are already accustomed to. Furthermore, the platform has to be intuitive to use without technical understanding and has to respect the design thinking methodology, e.g. it has to provide a visual representation of the collected information (conforming to the brainstorming rule "be visual"). Also, it has to be integrated into the overall process unobtrusively, i.e. without forcing students to adapt to predefined documentation rules – otherwise they will circumvent the provided documentation platform. This freedom leads to information being spread over several sources of information. Therefore, the information spread over several tools and services has to be aggregated at one (virtual) source of information for easy access, backup, cross-linking, and automated reasoning. Thereby, documentation and communication have to be clearly separated, although communication can be about documentation. Depending on who uses the documentation platform, different views need to be supported. Students need to organize their artifacts collected from different tools and services, while the management would like to get e.g. the most important insights and representative images of a project. Further, teaching staff may be interested in regular updates about the progress of their projects. In contrast, engineers are mostly interested in relationships between certain artifacts for reasoning. For example, they would like to answer how much scope is left for the realization of a certain feature of the innovative product or service.

#### **5 DOCUMENTATION FRAMEWORK**

In design thinking diverse artifacts are clustered, summarized, and transformed as part of the design thinking process. Thereby, design thinkers store, use, and maintain extensive media-rich materials. As stated by Gotel et al. [7], explicitly applied traceability helps to capture the relationships between these artifacts, which are otherwise not reconstructible later on. Therefore, we propose to explicitly apply traceability to design thinking, because with the help of traceability links the design thinkers' journey can be reconstructed [4]. We investigated how an appropriate documentation platform should look like and which immediate benefits can be provided by the documentation platform to motivate design-thinking students to document their projects. We propose a documentation framework that can be configured individually to the specific needs of design thinkers and thereby automatically enhances the collected information with traceability information. Thus, an aggregation layer is used to provide one user interface, where the already used tools are connected to. Such a framework has to consist of methodologies, e.g. documentation rituals, as well as combinable software tools, e.g. file shares and wiki systems. The framework character of our documentation tool provides the highest possible freedom to design thinkers in creating documentation, because no specific documentation tool is prescribed. In contrast to off-the-shelf documentation tools, our documentation framework addresses the specific documentation needs of design thinkers. Our documentation framework respects the design thinking methodology and integrates unobtrusively, because the design thinkers can use the tools and services they also used before. Thus, our documentation framework is automatically easy to use, because the design thinkers can use most of the tools and services they are already accustomed to. Moreover, our tool provides artifact organization methods as design thinkers use them everyday when

organizing their analogue artifacts, e.g. when clustering post-its. Thereby, the design thinkers manually create traceability links unobtrusively, which can be used later on by themselves to fake an ideal process (cf. [14]) or even generate presentation slides and handover documents for different readers, e.g. the management or engineers of the client. Moreover, the information already stored within the repository can be used to support the students in the question which aspects of the innovative idea need to be documented by asking the students the right questions.

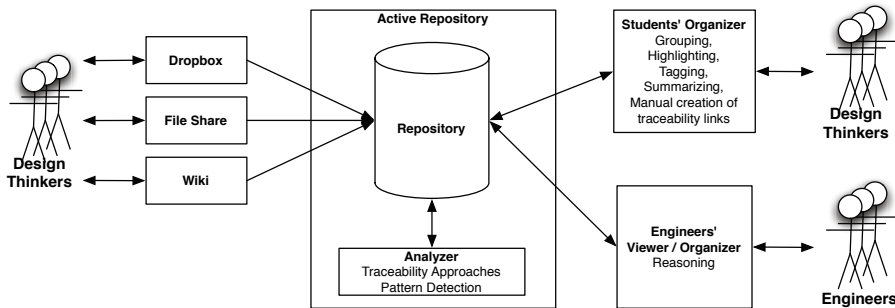


Figure 2. High-level architecture of our proposed documentation platform

Our framework consists of *tool* and *service connectors*, an *active repository* and several *content viewers* and *organizers* as depicted by Figure 2. Design thinkers use the tools and services they are most accustomed to which leads to information being spread over different tools and services. To make this information accessible at one (virtual) source, the information has to be aggregated. Therefore, our documentation framework provides the possibility to connect arbitrary tools and services, which allows the collection of several artifacts stored within external services and tools, e.g. *Dropbox*, file shares, and wiki systems, at a chief source of information. The gathered information is stored within a repository, which backs up the artifacts imported from these external tools and services. Furthermore, the repository enables to store additional information associated to the artifacts. For example, the knowledge manager can group related design thinking projects to semantic units, while students organize their artifacts within a certain project. However, the repository is active, i.e. it automatically enhances the stored information by interpreting meta data and applying traceability approaches, e.g. [13], and, therefore, establishes relationships between stored artifacts and the content of artifacts automatically. The additional relationships between stored artifacts can be accessed by design thinkers as well as engineers later on and make the aggregated information traceable. For example, if the repository already consists of the information that the design thinkers performed a brainstorming session at a certain point in time and additional photos of post-its, which were captured at a similar time, are imported from an external file storage, these photos can automatically be assigned to the documentation of the brainstorming session. This reduces the effort for students to associate the artifacts with the process phase manually. Summarizing, the active repository recovers relationships between artifacts by establishing traceability links and detecting patterns within the stored information. Thereby, the handover gap between design thinking and engineering can be closed, since the stored information is made traceable implicitly by students and explicitly by traceability approaches. The *viewers* and *organizers* visualize the content of the active repository by providing different *views*. The *students' organizer* provides a visual representation of the collected artifacts within the repository. With the help of the students' organizer, these artifacts can be e.g. clustered, highlighted, tagged, summarized, and cross-linked in the same way the students already do it with their analogue artifacts, e.g. post-its, on their whiteboards. The *engineers' viewer* uses the information within the active repository to make them traceable for engineers. Thereby, engineers are able to answer questions about the origin of a certain feature, e.g. which persona persists on the need addressed by a specific feature. The information within the active repository enables the engineers to decide well informed when adjustments of the product or service they have to realize are necessary by making the design decision rationales of the design thinkers visible. Thus, engineers are able to keep the balance between the three design thinking dimensions on their own. Additionally, the information already stored in the repository can be analyzed to evaluate which information is missing, e.g. whether the description of a prototype captured within an uploaded photograph is missing. Besides analyzing

what is missing, the framework may ask the question whose answer provides the highest possible information increase within the limited documentation time of the students to complete the documentation as best as possible.

## 6 CONCLUSION

Our framework provides the highest possible freedom to students when documenting, because it integrates unobtrusively into the design thinking methodology and supports common design thinking methods of organizing artifacts, especially for heterogeneous educational settings. Thereby, the students can use the tools and services they are already accustomed to without being restricted by prescribed documentation methodologies or tools. From a research perspective, our documentation framework enables the exploration of the provided artifacts in the first place to analyze which information can be extracted, which kinds of traceability links can be established and which patterns can be identified within the overall repository content.

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