Design Thinking as Mindset, Process, and Toolbox

Experiences from Research and Teaching at the University of St.Gallen

Walter Brenner, Falk Uebernickel, and Thomas Abrell

Abstract Design Thinking is a development that has recently attracted significant attention in the management discourse. The Institute of Information Management at the University of St.Gallen, the academic home of all three authors, has been conducting Design Thinking teaching and research for 10 years. In this study, Design Thinking is defined as: mindset, process, and toolbox. As a mindset, Design Thinking is characterized by several key principles: a combination of divergent and convergent thinking, a strong orientation to both obvious and hidden needs of customers and users, and prototyping. As a process, Design Thinking is seen as a combination of a micro- and a macro-process. The micro-process—as innovation process per se—consists of these steps: "Define the Problem", "Needfinding and Synthesis", "Ideate", "Prototype" and "Test". The macro-process consists of milestones manifested in prototypes that must fulfill defined requirements. As a toolbox, Design Thinking refers to the application of numerous methods and techniques from various disciplines: design, but also engineering, informatics, and psychology. Today, a growing number of companies, consulting firms, and universities use Design Thinking, continuously enlarging and re-defining its meaning. At University of St.Gallen, Design Thinking is taught as a problem-based course, together with research partner companies, with more than 40 projects successfully completed over the past 10 years. Research in Design Thinking at the University of St. Gallen focuses on aspects of modeling the Design Thinking processes and corporate entrepreneurship. In the near future, Design Thinking is expected to be deployed as an innovative method in corporations and also become an integral part of management education, particularly innovation. In addition, it will be developed further at the interface of design, design management and engineering sciences.

Keywords Design Thinking • Information management • User-centered innovation

W. Brenner (✉) • F. Uebernickel • T. Abrell
Institute of Information Management, University of St.Gallen, Unterer Graben 21, 9000 St.Gallen, Switzerland
e-mail: walter.brenner@unisg.ch; falk.uebernickel@unisg.ch; thomas.abrell@unisg.ch

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Introduction

Design Thinking is a term that has is used internationally in a multitude of scientific books, articles, seminars, management talks and consulting firm offers. A closer examination reveals a lack of clarity about what Design Thinking is, which potential it has, and how it can be applied and learned. Building on this, the aim of the article is to describe how we apply and teach Design Thinking at the Institute of Information Management of the University of St.Gallen.

In this article, we define and illustrate Design Thinking as a future-oriented innovation method based on examples. First, we introduce a few examples of Design Thinking projects. In the following section, we elaborate on the nature and origins of Design Thinking, differentiating between Design Thinking as mindset, process, and toolbox. Then, we describe Design Thinking in teaching and information systems and subsequently present Design Thinking activities at the Institute of Information Management of the University of St.Gallen. An outlook for the future summarizes the article.

Design Thinking can be defined as a field, in which many scientists and practitioners from various disciplines work and publish. Within such an extensive field, this article is not exhaustive; it documents knowledge and experience at the University of St.Gallen, which is influenced by the activities at the Stanford University, particularly from the Design Research Center and the d.School (Hasso Plattner Institute of Design Thinking).

Examples of Design Thinking

Design Thinking's potential is illustrated by four examples from different fields, demonstrating some parts of the Design Thinking process and proving that companies can find new solutions with Design Thinking, even in fields where significant research and development has been carried out in the past.

No more fear—pirate journey in the MRI (Kelley and Kelley 2013, p. 13f): Children facing an examination in an MRI-scanner (MRI = Magnetic Resonance Imaging) are scared. The anxiety of parents who know, or at least guess, what their children will experience, is transferred to the children, meaning that approximately 80 % of the children must be sedated to make the examination possible. Through Design Thinking, General Electric found a way to lower the percentage of children needing sedation by working on the children's experience. With only optical changes to the MRI scanner, General Electric was able to change the children's perception and reduce anxiety. In practice, the company does not change the product's complex technological base, but instead designs a story around it that the children experience, supported by graphics. The children are intrigued and not

as frightened; less sedation is needed. General Electric applied this principle to a number of medical devices like the CT-scanner.

Flemo—private car sharing (Design Thinking project at the University of St.Gallen): car sharing is becoming an interesting alternative to buying or leasing a car. In 2011, Audi AG asked the Institute of Information Management of the University of St.Gallen to develop innovative ideas for car sharing. Together with the University of Modena and Reggio Emilia, Flemo was developed: a concept for car sharing in the private environment. The basic idea behind Flemo: multiple family members, neighbors or friends share a car. The source for this solution was intensive conversations with customers all over the world, where it became apparent that car sharing in the private environment can be an efficient way of reducing cost and improving ecological behavior. Private car sharing reduces certain risks: people sharing a car know each other, motivating them to take care of the car. Flemo is centered on an app connected to the car electronics via a box. Through this app, the user can set the maximal reach of the car, maximum speed, reserve the car and do the billing. In December 2014, Audi AG began trial runs of a similar concept with the name "Audi Unite"[1] in Stockholm, Sweden. Again, this project shows how important it is to talk to existing and future customers and identify their needs. With the help of the Design Thinking process, it was possible to find new innovative solutions. In this example, Design Thinking combined customer needs with innovative new technology.

Start—soccer player registration (Design Thinking project at the University of St.Gallen): Soccer is probably the most popular sport in the world, with almost 300 million people playing soccer regularly in 209 countries. Approximately 40 million players are registered in an association that officially organizes soccer. In summer 2012, the FIFA (International Federation of Association Football) contacted the Institute for Information Management at the University of St.Gallen to find a solution for electronically registering the 300 million soccer players worldwide. Together with the University of Zurich and the Pontificia Universidad Javeriana in Columbia, we developed an open platform called "Start" that enables local associations to register players and organize soccer matches. Once again, the researchers talked to executives and football players all over the world. In those conversations, it became clear that most football players wanted to organize football on their own. User-centered research gave FIFA unprecedented insights into the needs of and problems with registration of soccer players in local associations.

Sociapply—a new way of recruiting coworkers (Design Thinking project at the University of St.Gallen): Haufe Lexware is a medium-sized German software company, a market leader for software for small enterprises. A key issue for companies like this is recruiting staff. Haufe Lexware asked the Institute of Information Management at the University of St.Gallen for help in finding a new solution for this challenge. In many interviews with executives of small companies

[1] https://www.audiunite.com/se/service/sv_unite.html, retrieved on 18 December 2014.

and job applicants, it became clear that the concept "co-workers recruit co-workers" offered good possibilities for an answer. On the basis of this idea, the team built a solution using Facebook as a base and tested it with several companies. Using Facebook allowed the companies to address both the pool of people searching for a new job and those not searching. The idea of Sociapply was further investigated after the end of the university project, the concept was further refined and is available today as a product of Haufe Lexware. This example shows the power of Design Thinking as it combined social networks, unsolved problems of companies, and ideas from people currently searching for a new job.

The Nature and Origins of Design Thinking

Tim Brown, CEO of IDEO, one of the leading innovation consulting firms from Palo Alto, California using Design Thinking, defines it as "a discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity" (Brown 2008, p. 86). Another definition stems from the Kelley brothers. Dave Kelley, the founder of IDEO, has been working at the Stanford University engineering department where Design Thinking has been developed over the past 40 years by Leifer[2] and others. Kelley and Kelley (2013, p. 24f) define Design Thinking as "a way of finding human needs and creating new solutions using the tools and mindsets of design practitioners." If we combine these two definitions, central aspects of Design Thinking are revealed. Design Thinking starts with human needs and uses suitable technologies with the aim of creating entrepreneurial value through customer value. These definitions show that Design Thinking can be a contrast point to "analytical" management (Shamiyeh 2010).

When examining the origins of Design Thinking research, one must distinguish between research on Design Thinking in the management and design discourse (Hassi and Laakso 2011), or more broadly to research within discipline of design and further (Johansson-Sköldberg et al. 2013), including engineering sciences.

In the discipline of design, research about professional designers' practice has been conducted since Simon's (1969) fundamental work "The Sciences of the Artificial". Despite this, research on Design Thinking in management has been largely independent from research conducted in design (Hassi and Laakso 2011). To acknowledge this, Johansson-Sköldberg et al. (2013) distinguish between "design thinking" and "designerly thinking". Designerly thinking is used to describe professional designers' practice (Johansson-Sköldberg et al. 2013). Design Thinking, on the other hand, is used to describe design practice and design competence practiced for and with non-designers (Johansson-Sköldberg et al. 2013) in the management context (Hassi and Laakso 2011). The term "Design

[2] https://profiles.stanford.edu/larry-leifer, retrieved on 22 January 2015.

Thinking" has received widespread attention in the design community since Rowe's (1987) book with the same title. Design Thinking in management has been developed quite independently from design research (Hassi and Laakso 2011) and is often criticized as being merely anecdotal (Johansson-Sköldberg et al. 2013). Empirical work is thus necessary to complement anecdotal evidence about successful use of Design Thinking (Hassi and Laakso 2011). In the management context, Hassi and Laakso (2011) categorized Design Thinking into practices (closely related to our category of Design Thinking as a toolbox), thinking styles and mentality components. Thinking styles and mentality components refer to our "mindset" category, while we add one dimension—Design Thinking as a process to educate future design thinkers.

The interest in, and eagerness to apply Design Thinking, most notably in IT and management demands a clear understanding of the concept without oversimplification (Dorst 2010). This article gives interested practitioners a first overview of the concept.

When using the term "Design Thinking", one recognizes a linguistic problem. In German, **Design** can be defined as the creation of a "nice" appearance, while **Design** in English can be used as both verb and noun. To design is to "do or plan (something) with a specific purpose in mind" (Oxford Dictionaries 2015). Because of this, Design Thinking projects are often (mis) understood as classical projects conducted to improve product aesthetics and attributed to, thinkers like Colani[3] or followers of the Bauhaus school.[4] This interpretation of the term Design Thinking is misleading for two reasons: on one hand, Design Thinking is an innovation method in which design as aesthetics can play a role, but is not more important than other attributes, such as functionality or usability. On the other hand, Bauhaus followers have created not only timeless objects, but also placed emphasis on using new materials, new technologies and industrial mass production possibilities.

Based on the definitions of Brown and Kelley, from the engineering department at Stanford University, where the ME310 course[5] is conducted (discussed in detail later) and our own activities in Design Thinking,[6] three forms of Design Thinking became important in our environment over the past 10 years:

- Design Thinking as Mindset
- Design Thinking as Process
- Design Thinking as Toolbox

[3] http://www.colani.de/, retrieved on 19 December 2014.

[4] http://www.bauhaus.de/de/, retrieved on 19 December 2014.

[5] http://web.stanford.edu/group/me310/me310_2014/, retrieved on 19 December 2014.

[6] http://dthsg.com/ retrieved on 19 December 2014.

Design Thinking as Mindset

The world of Design Thinking and design thinkers is characterized by principles essential for the method's success. Due to space restrictions in this introductory article, it is impossible to elaborate all these in detail. Thus, we focus on the most important principles.

The first and most important principle is: *Innovation is made by humans for humans*. This simple sentence is the guiding rule for all other principles, as well as for Design Thinking as process and toolbox. Design Thinking is a deeply human-centered method. At the root of every innovation are human needs. If those needs cannot be met through the new solution, the innovation process must be repeated. Innovation processes are made by and for people. As a consequence of the human-centeredness of design thinking various steps of the innovation process are executed differently than in traditional innovation processes. Those steps and settings include interaction, emergence and solving of conflicts during the process, as well as physical spaces where the innovation process takes place that must reflect a different "nature" in their spatial design.

Combining of divergent and convergent thinking is another important principle. Design thinkers enhance the solution space through following unconventional paths, i.e. thinking divergently. At different points in the innovation process, existing, fixed frame conditions are "crashed". Through this radical procedure, new solutions are created, often opening a door to the future. It must be noted, however, that in this divergent phase, many project partners and customers hesitate after recognizing the enormous creativity of the solution and its distance from the original project brief; they temporarily doubt Design Thinking and almost stop believing that the project could be successful. When engaging in convergent thinking, a few feasible solutions emerge.

"*Fail often and early*" facilitates human learning. Design Thinking is based on experimentation with many new ideas. In some projects, more than 100 solution ideas are created and many fail. Through early testing with end customers, design thinkers realize when ideas cannot solve the problem brief. Design Thinking, in practice, means coming up with many ideas and testing them with end customers to learn what works.

Another central principle of Design Thinking is: *build prototypes that can be experienced*. In the innovation process, building prototypes is very important. This principle conflicts with many traditional development methods in information management. Most methods to develop information systems lead to abstract models. These are, often through a step-by-step process, refined to lower abstraction layers. Many decision makers do not understand such models. Design Thinking goes in another direction. Fast and easily comprehensible prototypes are built that allow a new idea to be tested. For a large European bank, we could test whether it made sense to offer banking services in trains. To test prototypes, we modified a train compartment with six seats to create an improvised banking counter and observed customers' reactions. Over the last several years, we built hundreds of

physical prototypes, used role playing and made videos. We differentiate between different resolution prototypes: those with low resolution are often only sketches or paper mock-ups, while high-resolution prototypes can be, for example, programmable interfaces.

The principle *test early with customers* is closely connected with the principles discussed above. The faster a new idea can be tested with users, the sooner one knows which aspects of an idea are suitable. Design Thinking forces innovators to be in constant and direct contact with end customers. This extreme form of customer orientation is one of the central success premises of Design Thinking.

Another principle of Design Thinking is: *design never ends*. This means, work must proceed iteratively in cycles. Whenever a solution idea has been tested, questions will be posed about whether it contributes to a solution for the original problem brief and whether the initial problem brief was the right one. Through constant usage of the innovation process that we describe later in this article in more detail, the Design Thinking team builds up knowledge and experience about the problem, as well as both obvious and hidden needs of customers. This knowledge enables development of extremely customer-oriented solution ideas.

The last principle in this article is: *Design Thinking needs a special place*. To conduct Design Thinking projects successfully, special spaces are required: designed according to the teams' needs and equipped with the right materials. The engineering department at Stanford University conducts its Design Thinking projects in a loft that we "copied" in St.Gallen, shown in Fig. 1.

Fig. 1 The Design Thinking Loft in St.Gallen, retrieved on 22 January from http://dthsg.com/get-involved/

In this loft, each Design Thinking team has its own booth that they can use exclusively during the entire project time, any time of day. In the loft, one can conduct team-internal meetings; materials and tools are available to build prototypes. Communication tools, such as video conferencing are available. The red couch belongs to this loft just like standing tables, stools and writable walls—elements of the typical Design Thinking room equipment.

Design Thinking as mindset is characterized by the simultaneously playful and solution-oriented combination of these principles. Experienced design thinkers recognize those principles as "given" and use them to create innovative and customer-oriented solutions. Our colleagues from Stanford University, especially Leifer, sum up the playful aspect of Design Thinking with the phrase "Letting it happen".

Design Thinking as Process

In our Design Thinking projects with students and practitioners over the past 10 years, we realized that applying the principles alone—without structure—is too demanding for novices. To address this, we developed a two-stepped process model consisting of a micro and macro process, together with the engineering department of Stanford University.[7] Before we describe the process model in detail, we would like to point out that specific methods and tools are used while going through the process steps. These are described later in this article, in the section "Design Thinking as toolbox".

The micro process, [also called Stanford Design Innovation Process[8] or at the Hasso Plattner Institute in Berlin just Design Thinking Process (see Plattner et al. 2009, p. 113f)] is the central process of Design Thinking. Figure 2 shows the micro process we apply in St.Gallen, in research and practice.

The micro process as pictured in Fig. 2 is based on the principles described before. During a Design Thinking project, the micro process is conducted several times. The first process step "Define the problem" means that a so-called challenge, the problem brief, is worked out. The challenge describes the problem-to-solve in form of a question. One example for a challenge could be: "How will learning at universities look in 2020?" The art in formulating a challenge is to find a good compromise between focus and necessary breadth that leaves enough room for innovations. The second step, "Needfinding & Synthesis", is aimed at revealing end customers' needs. We differ between obvious and hidden needs. In Design Thinking projects, teams often succeed in revealing hidden needs that eventually contribute to providing innovative and competitive solutions. In the second process

[7] http://dschool.stanford.edu/, retrieved on 19 December 2014.

[8] http://web.stanford.edu/group/me310/me310_2014/about_design_process_big.html, retrieved on 19 December 2014. These websites provide an idea of Design Thinking education at Standford University's Engineering Department.

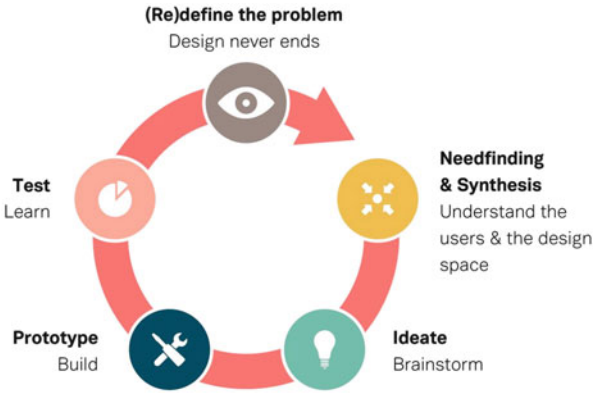

Fig. 2 The Design-Thinking-micro process, adapted from Stanford University (2016)

step, the team builds up expertise in the topic under scrutiny. Expert interviews, literature and web search help to reach a knowledge level needed to have fruitful talks with customers. In the third step, "Ideate", teams are encouraged to find solution ideas through brainstorming. The brainstorming needs to be conducted so that solutions are envisioned based on previous steps, not decoupled from the needs of customers. The aim of the step, "Prototype", is to build prototypes that can be tested in the next step with customers. As mentioned earlier, we differ between different resolution prototypes. The range of prototypes that we built within the past 10 years is large, ranging from wood constructions over paper mock-ups to information systems simulated on paper. One prototype stood out. About one year before the iPhone hit the market and long before the iPad, we developed a prototype for a portable computer very similar in form, appearance, and weight to the later iPad. In the next step, "Test", prototypes are tested with end customers. In many projects, we tested prototypes in market places, railway stations and airports with end customers. For many people, leaving the safe territory of company premises to test prototypes somewhere with end customers is a big obstacle. For the success of a Design Thinking project, this step is of central importance. There is an important reason why "Test" and "Learn" are connected in Fig. 2. While testing, Design Thinkers get important clues whether a prototype works, or reasons why it does not. Following the step "Test", it has to be verified whether the original problem brief was the right one: more concretely, whether the innovation fulfilled obvious or hidden needs of customers. If a positive answer is given, a new micro process can begin. If the answer is negative, the challenge needs to be reformulated based on the new insights.

The macro process (developed at the University of St.Gallen, Institute of Information Management), as pictured in Fig. 3, underlies all structures in the entire Design Thinking project. It is divided into seven process steps[9] coupled to the different kinds of prototypes built in the course of a Design Thinking project.

[9] http://dthsg.com/phases/, retrieved on 19 December 2014.

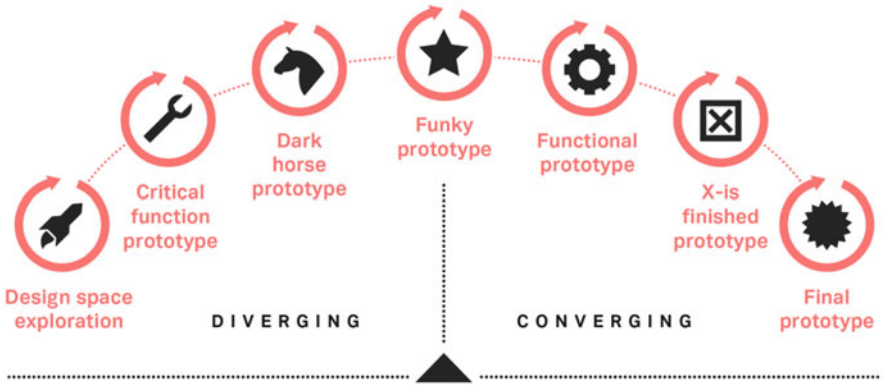

Fig. 3 The Design Thinking macro process, adapted from DT at HSG (http://dthsg.com/phases/, retrieved on 20 February 2015)

In each of the prototype-oriented macro steps, the micro process is conducted several times. In addition, the macro process is divided into a divergent and convergent phase.

The first step of the macro process "Design Space Exploration" explores the so-called design space, based on the challenge. In this step, literature and web research, as well as talks with experts, are recommended. Design thinkers must first gather their own experiences of the relevant industry sector specified by the challenge. If a challenge aims, for example, at car rental, it makes sense to rent and return cars from different rental agencies to experience and explore. It can be also helpful to go through an atypical process, like filing a complaint, to see how a company reacts. In the second step, "Critical Function Prototype", the first prototypes are developed. First solution prototypes are built based on the critical functions revealed in the previous step. In the next phase, a so-called "Dark Horse Prototype" is developed. The name of this prototype comes from horse racing. The "Dark Horse" is the horse that nobody bets on, yet it wins. For the "Dark Horse", the innovation process is started from the beginning—even though critical function prototypes already exist. Before starting with this step, boundary conditions found during design space exploration, already the basis for critical function prototypes, are deliberately disregarded. The solution space is extended and room emerges for new, even more innovative solutions. The dark horse prototypes often scare novices because of their sheer creativity and almost completely disregarded boundary conditions. We learned from our colleagues at Stanford University—and can by now also confirm through our own experience—that, in many cases, central ideas of the prototypes ultimately deployed by the research partner companies are based on the dark horse prototypes. One can imagine the difficulties for a project team—that had already built a critical function prototype—to start all over again. This reboot is particularly counterintuitive for many deadline-driven middle managers, who favor developing the first solution into a final product. With the step "Funky Prototype", the divergent phase is closed. This step aims to merge the best ideas from all

prototypes developed thus far into one prototype, building toward the final prototype. The design team needs to deploy all prior insights, starting from the needs of customers, into a prototype. The step "Functional Prototype" marks another important step to a detailed solution concept. Requirements and boundaries of the final solution are fixed. It is crucial to decide, based on prior prototypes and insights, which solution ideas and which prototypes should be part of the final prototype (Schindlholzer 2014). The Functional Prototype needs to be much more specific than prior prototypes, providing clear insights into customer acceptance and which needs can be satisfied. The requirements of the "Functional Prototype" are strict. The more realistic these prototypes are, the better the insights of the customer tests. The next step is the "X-is-finished-Prototype", which serves to detect one key functionality ("X") and what effort is required to realize the final prototype (Schindlholzer 2014). This step helps the Design Thinking teams discard unrealistic components identified in prior steps. In this step, the team decides which parts can be included in the final prototype. The "Final Prototype" comprises all functions necessary to satisfy realizable customer needs. This prototype's degree of detail needs to be extremely high, so that comprehensive testing with customers is possible. In the past 10 years, many final prototype of Design Thinking process were so extraordinarily detailed that research partner companies, typically big European companies, deployed ideas from the projects. The final prototype needs to be sufficiently impressive to produce a "wow" effect from the decision makers, virtually forcing them to pursue the Design Thinking project idea. The final prototype is accompanied by a presentation showing the process and attributes of the solution. Incidentally, during the last 10 years, numerous videos were also created to clarify and explain projects to a general audience.

Design Thinking as Toolbox

Design Thinking works only when tools and methods used are aligned with this new way of thinking. Schindlholzer (2014, p. 121f) offers a first overview of methods and tools used over the past 10 years at the Institute of Information Management at the University of St.Gallen. There are different method collections, both aimed at practitioners (e.g. Stickdorn and Schneider 2011; Kumar 2012; Martin and Hanington 2013; Lidwell et al. 2004) and academics (Hassi and Laakso 2011).

The range of 47 methods and tools described by Schindlholzer (2014, p. 121f) range from guidelines to design workspaces to methods to define personal strengths and weaknesses, from moderation methods to hints about how 3D printing can be used to build prototypes. In our experience, deployment of appropriate methods is one of the core success factors of Design Thinking projects. The methods and tools used in Design Thinking projects originate from very diverse areas, like quality management, research in creativity and design, research in communication, ethnography, and informatics. It is impossible to describe all the methods and tools

used in Design Thinking projects, but we describe seven tools that give an impression how Design Thinking projects work.[10]

- **Stakeholder Map**: Stakeholders of a project are any internal and external groups or persons currently, or in the future, directly or indirectly affected by the project (Thommen 2012). In management sciences, many approaches (especially the stakeholder-approach, Thommen 2012) begin with a holistic analysis of stakeholders, that can be distinguished from a solely shareholder-oriented firm strategy (Rappaport 1986). The stakeholder map attempts to identify all parties that are relevant for the problem brief. In our Design Thinking projects, we realized that it is important to identify extreme users. Experience in stakeholder mapping shows that it is important to broadly define the term "stakeholder". For example, in a business-to-business environment, it is essential to involve the end customer as stakeholder.
- **Empathy Map**: The empathy map is a method often used at Stanford University d.School.[11] The empathy map analyzes talks and interviews with stakeholders, especially end customers. These talks are categorized into four categories: "Say" (quotations and central terms), "Do" (observed behaviors), "Think" (assumptions of thoughts) and "Feel" (emotions).
- **5-Whys**: The 5-Whys-Method was invented by the founder of Toyota, Sakichi Toyoda (Ohno 1993, pp. 43–44). Today, it is an important element of "root-cause-analyses" of lean management and is also utilized in Design Thinking. The 5-Why method's basic premise is: in the course of analysis, participants repeatedly ask "why", leading everyone deeper into the root-cause of a problem or some similar phenomenon. The number of Why-Questions is not limited to five, as the name suggests. Instead, the number five is an indicator that it is important to ask multiple times "*Why*".
- **AEIOU-Method**: According to our research, this method was invented by Rick Robinson, Ilya Prokopoff, John Cain and Julie Pokorny. Other sources in the internet cite Mark Basinker and Bruce Hannington as inventors. Originally, it was used to code ethnographic data. The AEIOU method defines dimensions to structure a problem: "Activities", "Environment", "Interactions", "Objects" and "Users". Because this method is used often in Design Thinking, dedicated project templates facilitate its use.[12]
- **Persona-Method**: The persona method comes originally from the research area of human-computer-interaction. Personas are, according to Cooper, artificial, invented persons [see Cooper (2004), Schindlholzer (2014, p. 148f)].

[10] We would like to point out that the list of methods and tools is neither complete nor representative. We selected for this introduction a few tools to give a first glimpse into the tools that are used during Design Thinking projects.

[11] https://dschool.stanford.edu/wp-content/themes/dschool/method-cards/empathy-map.pdf, retrieved on 22 January 2015.

[12] http://www.drawingideasbook.com/images/AEIOU_worksheets.pdf, retrieved on 22 January 2015.

As archetypes, they embody the behavior or personality characteristics of a group of persons, e.g. digital natives of the age 16–19. These personas are named—for example Bob, Himo, Mari-Lu. The naming of personas facilitates their use in the Design Thinking process.

- **Observation**: The observation of stakeholders, especially customers, is a proven method to reveal obvious and hidden needs (Schindlholzer 2014, p. 142f). During, or after, the observation of a person, clarifying questions can be asked. When shadowing, researchers accompany a person over a longer period of time as closely as possible. Through the intense and uninterrupted contact, one can observe the use of a product or service, as well as activities before and after, which are often very important and may lead to reformulation of the challenge.
- **Storytelling**: This method originally comes from marketing and is based on the idea that a well-told story captures more attention than a lengthy PowerPoint presentation. Within Design Thinking projects, storytelling is used to present innovative ideas or solution possibilities effectively (Quesenbery and Brooks 2011; Schindlholzer 2014). In many Design Thinking projects, videos emerge, parallel to the prototypes, showing the prototype in a real-life situation or within a process. These videos can be seen as one form of storytelling.

The methods and tools in the toolbox of a design thinker cannot be easily assigned to single steps in the micro or macro process. The experienced design thinker uses from the repository (with more than 100 methods) those appropriate to the situation.

The Design Thinking Team

We spoke on several occasions in the previous sections about design thinkers and Design Thinking teams. Meinel and Leifer (2015) state that Design Thinking is centered on innovators, arguing that the team is of outstanding importance. Design Thinking teams work differently than project teams that we know from software development. One particular challenge is the combination of divergent and convergent thinking—and the mindset and openness that this demands from the team.

The heterogeneity of teams demands openness. Design Thinking teams need to be heterogeneous in various dimensions to be successful. Dimensions of heterogeneity comprise the mixture of men and women and the cultural and ethnical background of design thinkers. Especially in international and even more in global projects, the team needs a good mix of personalities from different countries and cultures. Another dimension of heterogeneity is educational background. In our experience, for projects that target product or service innovations, business people, engineers, and software engineers are good teams. A management-oriented educational facility such as the University of St.Gallen can learn from engineers and software engineers. In the future, it will be even more important to get closer to

obvious and hidden needs and to integrate designers, ethnographers, anthropologists, and psychologists in the teams.

Another dimension of heterogeneity deserves special attention. Design Thinking teams benefit enormously when personalities with different traits are merged. During our university projects, we perform personality tests, such as the Clifton-Strengthsfinder[13] (Quesenbery and Brooks 2011; Schindlholzer 2014 p. 171f) and Teamology (Wilde 2009) or the Myers-Briggs-Test (Briggs-Myers and Myers 1995) with our students. These tests, despite being controversial, give us important clues to the personality profiles of design thinkers and allow us to staff the teams with different personality profiles. We are aware that it is impossible to conduct such tests in many companies.

For Design Thinking teams, so-called T-shaped professionals (Brown 2009) are warranted; they are in-depth specialists in one field, but are knowledgeable in a range of others. This knowledge structure enables action in an area as a competent specialist and discussion in a range of other fields on a high level. The experience of ten years of work with design thinkers teaches us that it is hard to find people with a T-shaped profile. It is easier to find specialists than generalists.

The heterogeneous composition of teams is, on the one hand the fundament for innovation, but on the other hand, also the reason for conflicts. It is a narrow path in a conflict between constructively discussing for a better solution and arguing. The more heterogeneous a team is, the more probable conflicts and arguments are. To counter this, we have developed considerable competence for conflict resolution to prevent that (in principle) positive disputes escalate into personal, unsolvable conflicts. The collaboration between engineers and software engineers and business people can often lead to severe conflicts.

Application Areas: Design Thinking in Teaching and Information Systems

Teaching in Design Thinking is strongly influenced by Stanford University, where lectures and courses were first developed in the 1960s. In the engineering department, there were already 1960 courses about “Creative Design” and a “Product Design Program” was offered together with the fine arts department. Even though Design Thinking at Stanford University began in the engineering department, it subsequently spilled over into other areas like product design, robotics, microelectronics, human-computer interaction, learning, bio design and, recently, also to venture design. Design Thinking activities were later bundled in the Center for Design Research as an integral part of the engineering department. One example of research on integrating creativity into the engineering curriculum was conducted by Faste et al. (1993). When we speak of the engineering department in this article, we

[13] http://www.strengthsfinder.com/, retrieved on 26 January 2015.

mean primarily the Center for Design Research. The d.School at Stanford University, funded by SAP co-founder Hasso Plattner, also developed from the Center for Design Research, but works on an interdisciplinary basis between the faculties.

From a present-day perspective, very early trends in informatics could be linked to Design Thinking. Informatics (as well as later information systems) started to develop information systems in the 1960s. In German-speaking areas, the works of Oesterle (1981) and Balzert (1982) deserve notice. The basis for scientific work, with the development of corporate information systems, was done by Simon (1969), with his seminal work "The Sciences of the Artificial". Many of these works connect to Design Thinking, when one follows Simon's logic.

Design Thinking is also increasingly important in management (Rhinow and Meinel 2014; Shamiyeh 2010; Grand and Jonas 2012). When the Institute of Information Management began to collaborate with Stanford University 10 years ago, we were the only business school in the network of this elite university. The lack of understanding about our engagement in Design Thinking was significant, on the engineering side as well as from our management and information management colleagues. But now, the situation has changed. Many companies are under enormous pressure to become innovative. Many executives realize that Design Thinking—along with other methods—is one promising avenue to become more innovative. Martin (2009) introduces the example of Procter & Gamble, to illustrate what a significant influence Design Thinking can have, not only on the innovation process, but also on the entire corporation. IDEO works more and more on strategy. Mimicking IDEO, many strategy consulting firms build up Design Thinking units. However, we realize that many of these consultants do not understand or master Design Thinking principles and foundations described in this article. Instead, classical innovation, strategy or re-engineering projects are conducted that are merely labelled as Design Thinking.

One aspect of the business and management field where we operate requires more detail: Design Thinking as one approach to corporate entrepreneurship, which is entrepreneurship within large corporations (Kuratko et al. 2011). In one study conducted as part of our Design Thinking research at the Institute of Management, Abrell and Uebernickel (2014) researched whether Design Thinking is a suitable instrument for corporate entrepreneurship. The expert interviews conducted for this research show that the strong focus on customer needs is very helpful for corporate entrepreneurship; strong customer orientation can even lead to changes in the company culture. The culture of listening has an especially big influence on new products and the improvement of existing products and services. Design Thinking increases the understanding about why products and services of a company are used and why not. Many companies suffer today because the time an innovative idea about a product or service takes to reach the market is too long. Design Thinking helps to accelerate this process.

Design Thinking is also of growing importance in information systems development. Work on using Design Thinking in software development has been underway at informatics faculties, for example the Computer Science Department at

Stanford University or the Hasso Plattner Institute at the University Potsdam, for many years. In various engineering areas and for the design of human-machine interfaces, Design Thinking can lead to innovative solutions, especially in the early phase of the software development process. On the basis of these experiences, SAP (one of the largest software companies in the world) has begun using Design Thinking as one of their central methods when developing software.

Design Thinking at the Institute of Information Management at the University of St.Gallen

The activities in Design Thinking at the Institute of Information Management at the University of St.Gallen can be categorized as teaching and research.

Our engagement in Design Thinking began with the establishment of a course modeled on the ME310 course[14] at Stanford University, within the frame of so-called research-, practice- and venture projects in 2005/2006. This practice-oriented teaching instrument allowed us to copy the ME310 course in many respects. SAP financed the first batch, with the challenge for this debut Design Thinking project in St.Gallen to develop a prototype to facilitate executives' access to their own software. Meanwhile, the Design Thinking course is being held in 2015 for the 10th time and more than 40 projects with students have been conducted, financed by large and medium-sized corporations from Switzerland and Germany, and today, China. The structure of the course is oriented to the Design Thinking macro process. It always begins in September, lasting until the end of the spring term at the end of May. All participating students fly at least twice to Stanford University in Palo Alto during the course. The first visit in fall is dedicated to training in Design Thinking and the second trip at the beginning of June revolves around the final presentations, together with the complete network of universities that also have Design Thinking projects in their curriculum. For this Design Thinking course, we established a Design Thinking loft based on the facilities in Stanford in St.Gallen at the Institute of Information Management. The loft is available for students 365 days a year, 24 hours a day—which is unique in St.Gallen. In addition we have—financed through the participating research partner companies—established a teaching and coaching team for the course. This team is large enough that we can offer our students a staff-to-student ratio almost as good as that of our role model in California. The highly motivated students, the Design Thinking loft, and the good staff-to-student ratio contribute to the research partner companies' enthusiasm for the course quality. In 2015, the University of St.Gallen will invest substantially in Design Thinking education and will build another Design Thinking lab. As mentioned above, teaching activities at the Institute of Information Management are embedded into a worldwide network, the so-called SUGAR network, consisting

[14] http://web.stanford.edu/group/me310/me310_2014/, retrieved on 22 January 2015.

mainly of technical universities also offering teaching activities based on the Stanford University ME310 course. At the end of 2014, the following universities were engaged in this network: Aalto University in Helsinki, Paris-Est d.school at École des Ponts, Hasso Plattner Institute at the University of Potsdam, University of St.Gallen, Karlsruhe Institute of Technology, Norwegian University of Science and Technology in Trondheim, Pontificia Universidad Javeriana in Cali, Swinburne University of Technology in Melbourne, Trinity College Dublin, Tongji University in Shanghai, Universidad Nacional Autónoma de México, Università degli studi Modena e Reggio Emilia in Modena, Stanford University, Universidade de São Paulo, University of Science and Technology of China and University of Zürich.

It seems that Design Thinking teaching in St.Gallen will expand and grow. Starting in the spring term 2015, we will extend our offer in Design Thinking. Together with Grand, a strategy researcher, we will offer an "Entrepreneurial Management" course.

In Design Thinking teaching, we collaborate with companies in three ways; most importantly, through the Design Thinking course described above. Another collaboration is Embedded Design Thinking. In this collaboration route, we conduct sessions in partner companies like Deutsche Bank (Brenner and Witte 2011, pp. 167–192) in rooms similar to the Design Thinking loft in St.Gallen innovation projects. This intense collaboration leads to establishing a Design Thinking culture in partner companies and also allows that confidential projects can be conducted. Another type of collaboration is executive education and we are slowly entering this market. We do not conduct consultancy projects at the Institute of Information Management; a separate consulting firm for this work has been set up.

Because we have focused on teaching, we have conducted very limited research in Design Thinking during the past 10 years. For those interested in more information, Schindlholzer (2014), who developed a coaching-oriented approach to Design Thinking based on Method Engineering, as well as the works of Vetterli (e.g. Vetterli et al. 2012) to Embedded Design Thinking and the works of Abrell (e.g. Abrell and Uebernickel 2014; Abrell et al. 2014; Abrell and Durstewitz 2014) who researches Design Thinking and Corporate Entrepreneurship are worth mentioning. Design Thinking and Corporate Entrepreneurship is explained in more detail in a separate chapter.

Outlook

Design Thinking is an innovation method that has become stronger and more established. This trend is expected to continue over the next ten years in numerous areas, as well as management faculties. With more innovation-oriented education, Design Thinking has the potential to be right at the center of teaching and research at some universities. Design Thinking cannot be viewed completely independently, or directly in competition with other management disciplines. The customer orientation basic to Design Thinking has always been at the heart of marketing. Changes

in company and innovation culture, like those initiated by Design Thinking, take place in traditional fields in strategy and innovation research. The proximity to engineering sciences, mechanical engineering, electrical engineering, and informatics offer enormous opportunities for the development of management education. For information management we demanded, based on our experiences with Design Thinking and together with many colleagues from the German-speaking countries, user orientation as new field of research (Brenner et al. 2014). With this background, the research program at the Institute of Information Management has been changed in 2015 to position user orientation as a central target in the future (Leimeister et al. 2014). Design Thinking offers important potential for research and teaching, along with one fascinating central tenet: with all its strengths and weaknesses, opportunities and threats, Design Thinking is completely interdisciplinary.

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