UNDERSTANDING INNOVATION

Hasso Plattner
Christoph Meinel
Larry Leifer
*Editors*

# Design Thinking

## Understand – Improve – Apply

Springer

# Understanding Innovation

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Editors

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# Foreword

In 2005, the Hasso-Plattner-Institute of Design at Stanford University in California began to teach Design Thinking to engineering students. The philosophy behind this venture was the conviction that it is possible to train engineers and scientists to become innovators. Design Thinking has since become a highly recommended course in the Stanford engineering curriculum. The method of Design Thinking melds an end-user focus with multidisciplinary collaboration and iterative improvement and is a powerful tool for achieving desirable, user-friendly, and economically viable design solutions and innovative products and services. In 2007, a second School of Design Thinking, operating under similar premises, was established at the Hasso-Plattner-Institute (HPI) for IT Systems Engineering in Potsdam, Germany. It has been equally successful in attracting students and external partners from industry, the public sector, and society, and producing innovative products and services solutions.

My motivation behind initiating the HPI-Stanford Design Thinking Research Program was the desire to understand why and how the Design Thinking method works on a scientific basis. Through joint research projects, we try to figure out which factors ultimately contribute to the success of this type of innovation in all areas of life. In order to implement innovation processes in industry and the public sector, we must strive to improve our understanding of them.

My main interest is to see the Design Thinking method used in IT/engineering and to understand how it inspires creative multidisciplinary teamwork across faculties; whether and how spatial, time, and cultural boundaries can be overcome; and how it can be meshed with traditional approaches in the field of engineering. We might also be able to propose different organizational structures for design teams in corporations.

It has also been a mystery to me for a long time why the structure of successful design teams differs so substantially from traditional corporate structures.

I am delighted and proud to see this transatlantic research cooperation thrive and develop into a potent academic force in the field of innovation research, and I am confident that answers to some of these questions can be found – and to an extent – have already been found. This volume presents the first comprehensive collection of the research studies carried out by the HPI-Stanford Design Thinking Research Program and is an excellent starting point for the new Springer series on "Understanding Innovation."

Potsdam/Palo Alto *Hasso Plattner*
May 2010

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# Design Thinking Research

**Christoph Meinel and Larry Leifer**

"We believe great innovators and leaders need to be great design thinkers. We believe design thinking is a catalyst for innovation and bringing new things into the world. We believe high impact teams work at the intersection of technology, business, and human values. We believe collaborative communities create dynamic relationships that lead to breakthroughs." These are the visions of the first two schools of Design Thinking, the d.school at Stanford University in the Californian Silicon Valley and the D-School of the Hasso-Plattner-Institute in Potsdam, Germany. With overwhelming success these schools educate young innovators from different disciplines like engineering, medicine, business, the humanities, and education to work together to solve big problems in a human centered way.

The open and radical culture of collaboration practised there inspires both intellectually and emotionally, and creates an environment where people from different areas such as big companies, start-ups, schools, nonprofits and the government can participate in working and learning with us on projects. But what is the intellectual basis for this successful educational approach? Exactly these types of questions are scientifically approached in our HPI Stanford Design Thinking Research Program, whose first results are presented in this volume.

## 1 The Philosophy of Design Thinking

Everyone loves an innovation, "an idea that sells." Unfortunately, this is an outcome, not a process for achieving the goal. How does one go about increasing the probability of successful innovation from the research, development, and marketing investments one makes?

For the last years we have asked one guiding question: "What are designers and engineers really thinking and doing, when they create products, services, and enterprises?" Building on insights from our research we have designed new tools, activities, and values that improve the individual, team, and enterprise-wide capacity for design innovation.

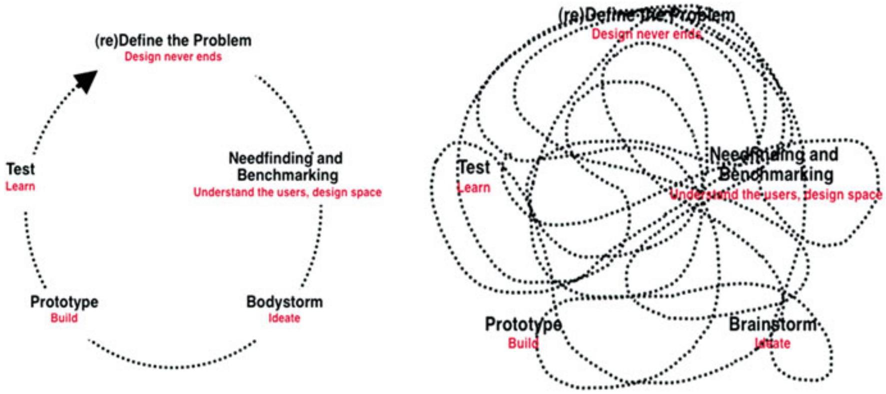


**Fig. 1** Design thinking is commonly visualized as an iterative series of five major stages. To the left we see the standard form. To the right we see something closer to reality. While the stages are simple enough, the adaptive expertise required to chose the right inflection points and appropriate next stage is a high order intellectual activity that requires practice and is learnable

We have seen that a powerful methodology for innovation has emerged. It integrates human, business, and technological factors in problem forming, -solving, and -design: "Design Thinking." Its human-centric methodology integrates expertise from design, social sciences, engineering, and business. It blends an end-user focus with multidisciplinary collaboration and iterative improvement to produce innovative products, systems, and services. Design thinking creates a vibrant interactive environment that promotes learning through rapid conceptual prototyping (Fig. 1).

Design Thinking is about the creation of, as well as adaptive use of a body-of-behaviours and values. This goal stands in sharp contrast to, while complimentary to, the predominant disciplinary model based on the creation and validation of a body-of-knowledge.

## 2 Rules of Design Thinking

We now have evidence in support of several design thinking activities that have long been considered important, but were lacking an explanation and understanding for their truth. Of these, the most global truth lies in the fact that every physical product delivers a service; that every service is manifested through physical products; and that without an insightful enterprise strategy, it matters little that one has products or services. Findings include the following four "rules of design thinking."

## 2.1 The Human Rule: All Design Activity Is Ultimately Social in Nature

There are studies that substantiate the assertion that successful innovation through design thinking activities will always bring us back to the "human-centric point of view." This is the imperative to solve technical problems in ways that satisfy human needs and acknowledge the human element in all technologists and managers.

## 2.2 The Ambiguity Rule: Design Thinkers Must Preserve Ambiguity

There is no chance for "chance discovery" if the box is closed tightly, the constraints enumerated excessively, and the fear of failure is always at hand. Innovation demands experimentation at the limits of our knowledge, at the limits of our ability to control events, and with freedom to see things differently.

## 2.3 The Re-design Rule: All Design Is Re-design

The human needs that we seek to satisfy have been with us for millennia. Through time and evolution there have been many successful solutions to these problems. Because technology and social circumstances change constantly, it is imperative to understand how these needs have been addressed in the past. Then we can apply "foresight tools and methods" to better estimate social and technical conditions we will encounter 5, 10, or even 20 years in the future.

## 2.4 The Tangibility Rule: Making Ideas Tangible Always Facilitates Communication

Curiously, this is one of our most recent findings. While conceptual prototyping has been a central activity in design thinking during the entire period of our research, it is only in the past few years that we have come to realize that "prototypes are communication media." Seen as media, we now have insights regarding their bandwidth, granularity, time constants, and context dependencies.

The "make it tangible" rule is one of the first major findings of the design thinking research program documented in this book.

## *2.5 HPI-Stanford Design Thinking Research Program*

The HPI-Stanford Design Thinking Research Program was started in 2008 and is financed by the Hasso Plattner Foundation.

*Program Vision.* The research program engages multidisciplinary research teams to investigate the phenomena of **innovation** in all its holistic dimensions scientifically. In particular, researchers are encouraged to develop ambitious, long-term explorations related to the innovation method of design thinking in its technical, business, and human aspects.

The HPI-Stanford Design Thinking Research Program is a rigorous academic research applied to understanding the scientific basis for how and why the innovation method of design thinking works. Researchers in the program study e.g. the complex interaction between members of multidisciplinary teams requested to design innovations. Beyond understanding, here the goal of the program is to discover metrics that predict team performance and facilitate real-time team performance management. The program invites to design, develop and evaluate innovative (analogue and digital) tools that support teams in their cooperative creative work eventually even bursting time and space boundaries. Another program interest is to explore the use of design thinking methods in the field of information technology and IT systems engineering. An important feature of the domain is the need for creative collaboration across spatial and temporal boundaries. In the context of disciplinary diversity, how do design thinking methods mesh with traditional engineering and management approaches, specifically, why does the structure of successful design teams differ substantially from traditional corporate structures.

The Program engages multidisciplinary research teams with diverging backgrounds in science, engineering, design, humanities, who are passionate about developing ambitious, long-term explorations related to design thinking in its technical, business, and human dimensions.

*Program Priorities.* Following the strong cooperation in offering the first design thinking education programs, the two d.schools, at Stanford University in Palo Alto, California, and at the Hasso-Plattner-Institute in Potsdam, Germany, the focus of the design thinking research program is on collaboration between researchers of Stanford University and the Hasso-Plattner-Institute, Potsdam, Germany. Multi-year funding favours projects that set new research priorities for this emergent knowledge domain. Selection is based on intellectual merit and evidence of open collaboration. Special research interests are in the following points-of-view and their guiding questions:

- What are people really thinking and doing when they are engaged in creative design innovation? How can new frameworks, tools, systems, and methods augment, capture, and reuse successful practices?
- What is the impact on technology, business, and human performance when design thinking is practiced? How do the tools, systems, and methods really work to get the innovation you want when you want it? How do they fail?

# 3 The Program Book

*Design Thinking: Understand – Improve – Apply.* As the title of the book stresses, a system's view is taken that begins with a demand for deep, evidence-based understandings of design thinking phenomena. Given new knowledge and the body-of-behaviours needed to apply that knowledge we strive to improve design thinking and adapt its processes to the evolving socio-technical context of our education and business worlds.

*Part I: Design Thinking in Various Contexts.* The first chapter explores the usefulness of design thinking in IT development processes. The authors Tilmann Lindberg, Christoph Meinel, and Ralf Wagner from the Hasso-Plattner-Institute provide a comprehensive description of the design thinking process and its various steps and elements and analyze how design thinking helps to obtain a multi-perspective comprehension of a complex and ambiguous problem. They explain the interdependency and iterative alignment of problem space and solution space. The authors explore how comprehension of a problem along design thinking principles can help overcome the familiar problems that arise from a traditional, predominantly technical perspective in the development process. The most blatant and well-known of said problems is the creation of technically perfect and highly sophisticated products or services which turn out to be either incomprehensible or undesired by the user. The integration of the user's perspective – which ultimately defines the economic viability of a development – is critical. The chapter also outlines how organizational structures might need to be modified in order to successfully incorporate design thinking principles into development processes in the IT industry.

The **second chapter** by Philipp Skogstad and Larry Leifer presents an innovation process model which elucidates the way engineering designers and managers interact and under which circumstances they succeed. The authors' research emphasizes the crucial importance of experimentation. The model chain "plan => execute => synthesize" can be seen as a variation of important elements in the design thinking process, in particular problem research, rapid prototyping, and iteration. Based on their experiments the authors show how the feedback process is expressed either as approval/feedback or as censorship and delineate how these options influence the further design process.

The authors of the **third chapter**, Martin Reimann and Oliver Schilke of Stanford University, explore the psychological and neurological dimension of the design thinking process and the role of aesthetics and creativity within the process. The goal is to understand the underlying neural processes of the increased creativity which has been proven to manifest itself when the design thinking process has been applied. This chapter's outstanding practical relevance lies in the exploration of potential strategies and methodologies that firms can implement to foster greater creativity among their designers and product managers.

*Part II: Understanding Design Thinking.* Another important element for understanding design processes is an exploration of the role of media in said processes. In the **fourth chapter** Jonathan Edelman and Rebecca Currano of Stanford University evaluate a media-model framework which categorizes types of media and provides a guide to discerning the major characteristics and differences between them. Thus, design teams are enabled to make a more economical and purposeful choice of media used in the various stages of their design process. The research shows how media-models can help navigate the variety of shared media available to designers and provide a new approach to successful Business Process Modelling, an application which is explored in detail in chapter eleven.

In the subsequent **fifth chapter**, Julia von Thienen, Christine Noweski, Ingo Rauth, and Christoph Meinel from the Hasso-Plattner-Institute explore the relationship between theory and practice in design thinking. This inquiry lies at the heart of design thinking research and its advancement as an academic discipline with sound methodological approaches and empirical validity. Design thinking research should constantly question and refine design thinking theory, much in the same way iterative prototyping constantly improves design solutions. The authors have conducted experiments in order to test two common assumptions design thinkers entertain: (1) that multidisciplinary teams are more innovative than mono-disciplinary teams, and (2) that designer teams with training in the design thinking process are more innovative than untrained teams. While these assumptions proved to be largely correct in terms of design solutions, a different picture emerged with regard to utility deliberations. In combination with an assessment of communication within design teams, the research identified certain contradictions which should stimulate refinements in design thinking theory.

Another significant parameter of understanding the design process and the applicability of design thinking is national culture. This relationship between design practice and innovation on the one hand, and culture on the other hand, is explored in the **sixth chapter** by Pamela Hinds and Joachim Lyons of Stanford University. The authors apply ethnographic research methodologies and arrive at their conclusions through extensive field interviews and observation of designers. In their multiple case study design, they juxtapose American and Chinese designers and in addition to that, make a broader comparison between Europe, Asia, and the US. One of the preliminary results is a confirmation of the idea that there are no universal "best practices" for the design process, or – by extension – for the implementation of design thinking in various cultural contexts.

Concluding the first two parts of the book that deal with understanding design thinking in various contexts and on multiple levels is a study on the efficacy of prototyping under time constraints. The **seventh chapter** by Steven Dow and Scott Klemmer of Stanford University pursues the question of whether repeated prototyping and re-design provides a tangible advantage opposed to quicker realization of a finished design with only one round of prototyping. The experimentation results showed that designers in the iteration condition, i.e. with multiple rounds of prototyping, outperformed those who only prototyped once. Prior experience with iteration proves to be a positive performance indicator as designers tend to discover more flaws and constraints and try new concepts. This is valuable data for design companies which always operate under tight time constraints in the race for early market entry with innovative products.

*Part III: Tools for Design Thinking.* Design thinking will never be optimal in the sense of an absolute compendium of natural science facts. It will always be subject to improvement and adaptation to changing circumstances, both human and environmental. There is always a better way and our talent, as design thinkers, will lie in our "adaptive expertise." The adaptive nature of design thinking is at the root of its value in confronting uncertainty and ambiguity, in confronting the future. Improvement is most often associated with the creation of better tools. Papers in Part III are focused on design thinking tool development and validation. Information technology plays a critical role. The space we work in is also a major determinant of our behavioural performance. The development of "metrics" is very important to human and technical systems performance improvement.

A major performance parameter is communication behaviour among design team members. Information and communication technology has the potential of constantly improving design performance and efficiency. The team of Matthias Uflacker, Thomas Kowark, and Alexander Zeier from the Hasso-Plattner-Institute has developed a software tool which collects data and analyzes communication processes in technology-enabled design spaces. In **chapter eight** the authors present their new insights into the complex characteristics of real-time online interactions among design team members and elaborate on the multiple dimensions of capturing design team communications. The research proves the notable differences of communication patterns between high-performance and low-performance design teams and introduces a reliable diagnostic tool for design team success, making it highly relevant for recruitment and process structuring in industry and research.

A newly developed tool for transporting the working mode and physical environment of design thinking into a remote collaboration environment is presented in **chapter nine**. The author team around Raja Gumienny and Christoph Meinel from the Hasso-Plattner-Institute has developed and tested a prototype, the "Tele-Board," that builds on a remote digital white board setup and integrates life-size video with the possibility of simultaneous manipulation of artifacts on a digital white board. Thus, essential elements of design thinking processes, like, for example, the clustering of ideas, are mirrored in a remote collaboration environment. In many ways this new tool allows for the combination of the advantages of analogue and digital design thinking practice. While maintaining the time-tested physical working mode of the design thinking process in a digital space, it adds digital functions, for example easy, systematic, and unobtrusive documentation by saving the various stages of the design thinking process.

The potential of communication robots for improving the design process of geographically distributed teams is introduced in **chapter ten** by David Sirkin of Stanford University. Similar to the "Tele-Board" research, this project also addresses the barriers of effective collaboration which usually requires physical presence, body language signals, and the ability to point to and act upon artefacts. The author shows how expressive tele-operated robotic avatars can be integrated into designers' workflow, mainly in the conceptual and the prototype development. The avatars can help in overcoming the sensory void usually impeding effective exchanges in globally distributed teams. They establish a resemblance of a physical presence and facilitate more direct communication.

The various tools developed in the HPI-Stanford Design Thinking Research Program have significant business potential and have, in part, already been patented. We expect that the desire for such tools will increase further as globalized design processes become more and more common.

*Part IV: Design Thinking in Information Technology.* Design thinking has always been about "practice," the real world creation and deployment of products, services, and enterprise systems. Our research program makes the difference between deploying last year's best practices and those informed by our research, to be next generation practices. They will come complete with evidence, real world metrics, and a program for continuous innovation and discovery. Papers in Part IV are focused on these applications and their validation.

The **eleventh chapter** explores the application of the design thinking process to business process management which is or should be a matter of concern for each and every company. The knowledge, analysis, and optimization of business processes are preconditions for efficient and successful operation and process modelling is the first step towards knowing and ultimately streamlining said processes. Alexander Luebbe and Mathias Weske from the Hasso-Plattner-Institute have used design thinking principles to develop a method for improving the modelling process. In their chapter they recount the iterative experiments with design thinking factors, such as physical elements (plastic building blocks as tangible prototypes), methodological guidance, and intensive end-user/participant involvement and present the results and relevance of this experimentation for successful application in real-world companies. Confirming what Steven Dow and Scott Klemmer have shown earlier in this book, the performance (in this case the optimization of a business process model) improved with iteration.

Another application area for design thinking is software development. In the **twelfth chapter** Robert Hirschfeld, Bastian Steinert und Jens Lincke from the Hasso-Plattner-Institute integrated design thinking elements in order to further improve the already advanced and progressive agile approaches to software development which are user and code centric and allow for instance problem solving due to a high-quality code base. Design thinking has much to offer in this context, not just to develop more innovative software, but also to aid distributed development which is getting more and more common. The research team integrated both the application *ProjectTalk* and the development environment extension *CodeTalk* into a platform which supports remote-collaborative software development, thereby facilitating independent yet simultaneous interacting with shared tools and improved communication among software design team members.

The final chapter of this section and our book also deals with the application of design thinking onto software development. In the **thirteenth chapter** Gregor Gabrysiak, Holger Giese, and Andreas Seibel from the Hasso-Plattner-Institute specifically address the problem that tangible prototypes are not feasible for complex software systems, in particular because of financial and time constraints. As an answer to this problem, the researchers have developed an innovative and cost-effective scenario-based approach to prototyping such systems. They generated interactive simulations for end users, thus exploring the application of two major pillars in design thinking: early and rapid prototyping and user involvement, even in a non-tangible environment.

## 4 In Summary

The heart of the design thinking process lies at the intersection of technical feasibility, economic viability, and desirability by the user. Accordingly, the inquiries of design thinking research extents to all aspects related to these three dimensions. With regard to the scope of the research presented in this book, we are confident that an important step has been made towards a thorough, scientifically viable exploration of the design thinking process.

We are thankful to all who have contributed to the book. These are not only the authors but also Dr. Karin-Irene Eiermann, Denise Curti, and Ingo Rauth. Karin-Irene and Denise successfully managed the program and various community building activities and workshops that have considerably contributed to the success of the HPI Stanford Design Thinking Research Program. We are particularly thankful to Karin-Irene Eiermann and Sabine Lang for her work in preparing this book.

We sincerely hope that you will enjoy and benefit from the content, format, and intent of this book. We hope to instigate and contribute to scholarly debates and strongly welcome your feedback. Your first opportunity to contribute directly is to submit papers to the newly launched "Electronic Colloquium on Design Thinking Research (ecdtr)". We invite you to visit this innovative platform of dynamic and rapid scholarly exchange about recent developments in design thinking research: http://ecdtr.hpi-web.de/

# Part I
# Design Thinking in Various Contexts

# Design Thinking: A Fruitful Concept for IT Development?

**Tilmann Lindberg, Christoph Meinel*, and Ralf Wagner**

**Abstract** In our research project *Collaborative Creativity of Development Processes in the IT Industry*, we pursue the question how design thinking can help to enhance the innovativeness in IT development and which individual and organizational factors facilitate or encourage this. In this chapter, we outline what the contribution of design thinking to engineering thinking can be, how it is related to akin IT development approaches (e.g. agile development), and what our initial insights on the didactic and organizational implications are.

## 1 Introduction: On Problem Solving in Design and Science

> "Most outsiders see design as an applied art, as having to do with aesthetics, unlike a solid profession unto itself, with technical knowledge, skills, and responsibilities to rely on. Insiders to design, by contrast, talk of innovative ideas, coordinating the concerns of many disciplines, being advocates for users, and trying to balance social, political, cultural, and ecological considerations."
>
> Klaus Krippendorf (2006, 47)

It seems to be the nature of design that it is not always easy to understand what this term actually means. As the initial quotation exposes, people in design themselves have not only a broader view on their discipline, they also see themselves in a different role than outsiders do: not merely in the position of dealing with aesthetical aspects of forms and products, but of taking on a general role of coordinating disciplines, stakeholders, and the manifold environmental matters within product development processes. The following argumentation reduces this point to central differences in problem solving in design as well as in science and technology.

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Comparing problems tackled in well-established sciences as astronomy, quantum mechanics, or computer science with those in design, it seems obvious that design problems are closer to the everyday life. What does a backache reducing office chair look like? What form should a computer interface have to be accessible for elderly people? What do we have to do to avoid injuries through battery acid in developing countries? The motivation to find answers to those questions is not to gain scientific knowledge or to discover new technical possibilities (even if design clearly takes advantage of both). Rather, it is the need to create ideas and find solutions (products, services, systems), which are as viable as possible for certain groups of users. By that, design intends to offer a very concrete solution to a complex problem that is socially highly ambiguous and hence neither easy nor certain to comprehend. Design problems thus – using a term by Horst Rittel – are close to *wicked problems*, blurred in character and not definitely definable (Rittel 1972).

People in design have developed problem solving skills that allow them to deal with such kind of problems successfully. This however calls for a dissimilar mode of thinking than taught in the curricula of the established sciences. Solving wicked problems does not acquire the analytical inductive/deductive scheme pursued in science that follows an epistemological logic to achieve knowledge about scientific truth, since designers only strive for enhanced viability and novelty of products (Dewey 1997, 79; Martin 2009, 63). Scientific problems generally will be answered by theories, concepts, taxonomies, or models, and only become finally accepted when they depict a problem analytically in all its dimensions. Still, this demands not only long-term efforts to put into research and analysis but also to reduce the complexity of a stated problem to such an extent that it is finally *non-wicked*, thus entirely describable. Yet for design problems, this would be a misleading approach: first, as designers have to deal with problems pragmatically and come up with solutions in much shorter periods of time than scientists do; second, as designers do not have the possibility to reduce the complexity of a problem because design problems are made up of exogenous perspectives that finally decide about the solution's viability: the user's, the client's, the engineer's, the manufacturer's, the law-maker's, the environmentalist's, the employee's, etc. (Lawson 2006, 83f).

It becomes obvious that design unavoidably has to take on a coordinating role within this context of multiple stakes, because they have to rely on the knowledge of others as long as they want to approach general viability of solutions. To do so, there emerged professional learning strategies in design: cognitive patterns to grasp multiple knowledge and multiple perspectives of others for the purpose of synthesizing and creatively transforming the knowledge to new service or product concepts. In contrast to analytical thinking in science, we call those strategies *design thinking* (Brown 2008; Dunne and Martin 2006; Lindberg et al. 2009).

To understand how those strategies work, it is useful to work with two fundamental pairs of terms: the problem and solution space on the one hand, and diverging/converging thinking on the other hand.

The distinction between the problem and solution space elucidates the dualistic approach of design thinking.[1] Whereas in science the focus lies in general on exploring the solution while the initial problem is given, design treats both the problem and the solution as something to be explored. This indeed characterizes design thinking as an approach for professional learning. The distinction between diverging and converging thinking however shows how designers approach both spaces (Lawson 2006, 142f). Learning alone, certainly, is not enough in design as the knowledge acquired is at the same time a means to come up with viable as well as novel solutions. Thus design thinking is always an interplay between diverging exploration of problem and solution space and converging processes of synthesizing and selecting. Contrary to thinking styles predominant in science, the knowledge processed in design thinking has to be neither representative (as in inductive thinking) nor entirely rationalized (as in deductive thinking), rather it serves to obtain an exemplary but multi-perspective comprehension in order to deal creatively with the ambiguity of wicked problems. Building upon this argumentation, design thinking can be put down to three basic characteristics (see also Fig. 1).

- *Exploring the problem space*: When exploring a problem space, design thinking acquires an intuitive (not fully verbalized) understanding, mainly by observing exemplary use cases or scenarios, as opposed to formulating general hypotheses or theories regarding the problem; and synthesise this knowledge to point of views.
- *Exploring the solution space*: Design thinking asks for a great number of alternative ideas in parallel and elaborates them with sketching and prototyping

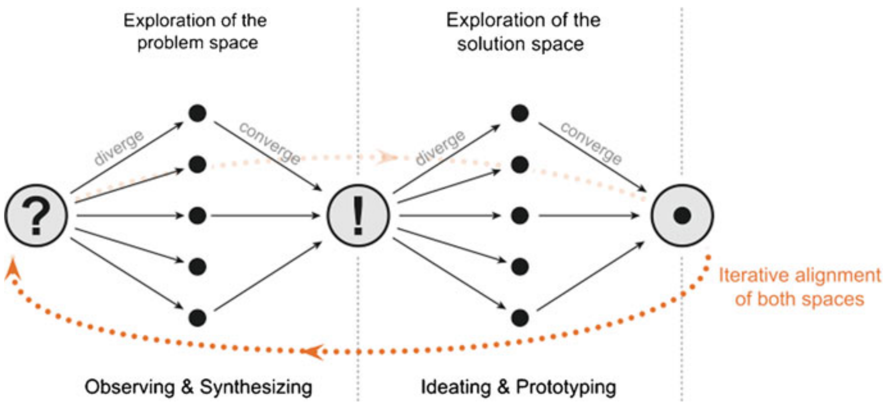


**Fig. 1** Problem and solution space in design thinking

[1] A concept of the "problem space" was first introduced by Newell et al. (1967), although with a different meaning, as they locate the representation of possible solutions in the problem space without regarding a separate solution space. This conceptualization does not appear sufficient for our purpose, as the distinction between learning about the problem and learning about the solution in design thinking could not be depicted.

techniques. In this manner, ideas are being consciously transformed into tangible representatives.

- *Iterative alignment of both spaces*: These representatives of ideas and concepts facilitate communication not only in the design team, but with users, clients and experts as well. Thus, design thinking helps to keep in touch with the problem-relevant environment and can use this information for refining and revising the chosen solution path(s).

Accordingly, design thinking engenders a system of checks and balances to ensure that the conclusive solution will be both innovative and suitable for the social system that the design problem addresses.

## 2 Understanding the Problem: Overcoming the Dilemma of Analytical Thinking in IT Development by Design Thinking?

As outlined in the preceding section, there are crucial differences concerning the quality how problems are characterized and approached in design and in science. The paradigms of problem solving in science originated in epistemology, the studies of finding out what is true or not, and led to a strong focus on analytical thinking. The paradigms of problem solving in design though originate in finding out what novel solution fits best in a social or technical system. The discussion about how to bring both paradigms together is particularly valuable in areas with a strong tradition in analytical thinking but which are nevertheless related to design responsibilities.

In our research project *Collaborative Creativity of the Development Processes in the IT Industry*, we explore the capabilities of design thinking to broaden the problem understanding and problem solving capabilities in IT development processes. We pursue in particular the question in which cases the application of design thinking to IT development is valuable (or not) and what the individual and organizational implications for teams and organizations are. Hereby, we draw upon an in-depth case study research with international IT companies. In our first year, we conducted 36 qualitative guideline interviews with IT experts on the one hand and design thinking experts on the other who were involved in design thinking-based IT projects both in the United States and in Germany.

In the following section, we will discuss the background and the peculiarity of our research focus.