Understanding Innovation

Hasso Plattner
Christoph Meinel
Larry Leifer *Editors*

Design Thinking Research

Measuring Performance in Context

Springer

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Editors

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Preface

The third volume of our series on Design Thinking Research presents the comprehensive collection of research studies carried out by the HPI-Stanford Design Thinking Research Program. This is a joint program of the Hasso-Plattner-Institute of Design at Stanford University in California and the Hasso-Plattner-Institute (HPI) for IT Systems Engineering in Potsdam, Germany.

The concept of Design Thinking refers to the methods and processes for investigating challenges, acquiring information, analyzing knowledge, and positioning solutions in the design and planning fields. As a style of thinking, it is generally considered the ability to combine empathy, creativity, and rationality in analyzing and fitting solutions to context. The overall goal that stands behind all those activities is to generate innovations.

There are several main factors that are crucial in the development process of Design Thinking. One is definitely the role of teamwork and the impact it has for the outcome of the process. Unified commitment, a collaborative climate, and the reception of support and encouragement by the team members are a prerequisite of all kinds of successful collaboration.

Teamwork requires dedication, coordination, and people skills. Teamwork is usually defined as a joint action by a group of people, in which each person subordinates his or her individual interests and opinions to the unity and efficiency of the group. Certainly, this does not mean that the individual is no longer important; however, it does mean that effective and efficient teamwork goes beyond individual accomplishments. The most effective teamwork is produced when all the individuals involved harmonize their contributions and work toward a common goal which is being put into practice in this program.

A further considerable factor when it comes to Design Thinking and its impact is the element of education. The term "education" implies the notions of learning, preparing for successful leadership and personal achievement, as well as opening the mind to new ideas and methods. Education in its best way should open the mind, and the process itself involves creating and solving our own challenges.

Another meaningful component of this program, as well as of this present book, is the facet of innovation. Innovation means – literally translated – improvement or renewal. This is a universal concept that is as old as mankind and every generation adapts it to their needs and requirements accordingly. To have an idea and to make it feasible is called an "invention." Whether an invention actually turns out to be an innovation only becomes clear when it is actually accepted by the users.

In order to make an invention work, it is crucial that the right instruments are chosen. These have a great and important impact on how Design Thinkers perceive the world around them, how they think, feel, and communicate. It was in 1964 when Marshall McLuhan coined the phrase "The medium is the message."

The actual core message behind the phrase that is constantly quoted and often misinterpreted is that we largely miss the structural changes in our affairs that are introduced subtly, or over long periods of time. Whenever we create a new innovation, many of its features and qualities are fairly obvious to us.

We often know what its advantages and disadvantages might be. But it is also often the case that after a long period of time and experience with the new innovation, we look back and realize that there were some effects of which we were entirely unaware at the onset.

Like the message that McLuhan had in mind when he coined that phrase, it is not primarily the content of the innovation, but the change in interpersonal dynamics that the innovation brings with it. It is crucial to not only look beyond the obvious but to seek the nonobvious changes that are enabled or enhanced by the innovation. In other words, an innovation is anything from which a change emerges. It often takes years or even decades before an invention becomes an innovation and before it becomes apparent to everyone.

I am pleased to witness the development of this book series over the years, and it is a rewarding experience for me to see this third volume coming to life.

May it be a fruitful contribution to the ongoing debate on Design Thinking.

Potsdam/Palo Alto Hasso Plattner
March 2012

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Design Thinking Research

Christoph Meinel and Larry Leifer

1 Design Thinking as Hunting for Big Ideas, AND, Transporting Them Home to the Organization

1.1 Understanding Innovation Is About Knowing How to Measure It

The path of design thinking is filled with various idea-fragments (Baya 1996; Meinel and Leifer 2011; Sonalkar 2012). One of the core challenges faced by design-thinking teams is to navigate through this sea of fragments, to keep all fragments in their sights while constantly testing alternative configurations in pursuit of a concept worth investing in. During each design thinking operation, we are certain to face challenges. One important finding in all design thinking research projects is that deep design thinking is a synthesis challenge more than it is an ideation challenge. The path is constantly being molded and re-shaped by events and findings. Several steps along the way are sure to be different than on any previous search. Way finding is an adventure that enthralls the design thinker and the researchers who observe closely. In time, we face a moment in which a clear path forward unfolds. It is that point in the cycle where synthesis and divergent thinking, analysis and convergent thinking, and the nature of the problem all come together and resolution has been captured. In design thinking processes there is no

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solitary action or procedure that actually defines the process. There are as many different design processes as there are design thinkers.

In this edition of "Understanding Innovation," you will find research reports about many different lines of study into the nature of the syntheses process with a keen eye to measuring team performance in three distinct scenarios.

1. **Co-located control**: The first is in the semi-controlled environment of co-located teams in "d.school" courses at Stanford University and the Hasso Plattner Institute in Potsdam.
2. **Distributed control**: The second context is that of largely uncontrolled distributed teams in design-courses within Stanford's ME310-Global Network.
3. **Business embedded**: The third context is that of corporate teams in the wild, an environment that is largely unobservable in the research sense while tending to be over-controlled for innovation purpose.

The advantage of the first two scenarios is observability, access to the players, and the relative absence of intellectual property protection concerns. Different experimental settings can easily be implemented and tested, a hypothesis can be formulated, discussed, and affirmed or eventually rejected. The advantage of the third context is the opportunity, however difficult to achieve, for validation in real-life business practice.

The recurrent theme in this edition is the difficulty we face in making performance measurements with robust causality in the face of uncontrolled variables. However, for the committed design researcher, difficulty is a call to duty, an opportunity, an incentive to "get creative", and this is definitively true for all our researchers and PhD students in the HPI-Stanford Design Thinking Research Program. Getting creative in this context is to synthesise new and better experiments with new and more sensitive instruments to sort the "wheat from the chaff," as some of our ancestors once quipped. In ongoing projects and their related research questions, all the research teams involved are looking from various angles and multiple points-of-view in order to triangulate findings in a way that maximizes repeatability while retaining generality.

Our researchers value the notion that they, themselves, must be involved in the design process and related technology in order that they might be in the right place, at the right time, and have right point-of-view to capture insights for connected technology development. They recognize the importance of societal factors and the needs of consumers as individuals and members of society. They are mindful of the link between critical technical functionality and critical user experience. In order to look at those issues from all perspectives and in order to give a multifaceted assessment to the research questions we have been delighted in working with great teams of engineers, computer scientists, humanists, educationists and cultural scientists. In the second edition of our series, we introduced the "Innovation Hunter-Gather" metaphor. Hunters-gatherers are looking for specific solutions to specific problems. This model has emerged from our ways of thinking, discussing, and testing to increase the probability of successful innovation from research, development, and marketing activities. This model has proven useful as a means

to communicate the core ideas in design thinking. It emphasizes that there are different roles to be played in the activities of innovating. There is a time to hunt and a time to gather. There are times to seek the next big thing and times to deliver the next big thing. The "Hunter-Gather Model" that we designed describes the dynamics of design thinking. The model that we have elaborated in the second book "Design Thinking Research – Studying Co-Creation in Practice" is about enfolding events, awareness, observation, and real time intervention. We were and still are hunting for ideas that sell. And, another important aspect in our ongoing endeavour is to solve problems, perhaps even to remove problems through design thinking, and to create new products and remarkable services. Design thinking has taken root and continues to help shape our pursuit of understanding. We prefer now to shorten the label and focus on the "Hunter Model." Findings reported in this edition have refined our instruments, focused our attention on critical design team activities, and strengthened their correlation with performance. Still to come will be findings in volume 4 where early evidence suggests that the hunting model may be as or more valuable for the task of bringing big ideas and design thinking "back home" to the organization. We promise surprises to come.

Please join us in our continuing hunt for understanding, efficacy, and validation.

2 The HPI-Stanford Design Thinking Research Program

Having started in 2008, the HPI-Stanford Design Thinking Research Program is fully supported and financed by the Hasso Plattner Foundation.

2.1 Program Vision

This research program engages multidisciplinary research teams. Scientifically they investigate the phenomena of innovation in all its holistic dimensions. Researchers are especially encouraged to develop ambitious, long-term exploration projects that integrate technical, economical, as well as psychological points of view using design thinking tools and methods. The HPI-Stanford Design Thinking Research Program is a dedicated academic research effort focused on understanding the scientific foundations of how and for what reasons the innovation methods of design thinking work.

Beyond descriptive understanding, the goal of this program is to develop metrics that allow assessment and prediction of team performance in order to facilitate real-time performance management. Researchers are encouraged to design, develop and evaluate innovative (analogue and digital) tools that support teams in their creative work. One program focus is on exploring the use of design thinking methods in the field of information technology and IT systems engineering. An important feature of this domain is the need for creative collaboration across spatial and temporal boundaries. In the context of disciplinary diversity, the question of how design

thinking methods mesh with traditional engineering and management approaches is addressed. Why does the structure of successful design teams differ substantially from traditional corporate structures?

This program involves multidisciplinary research teams from diverging backgrounds such as engineering, design, a broad range of the humanities as well as sociology and education. A prerequisite to being passionate about developing ambitious, long-term, discovery research projects is the need to expand our understanding of design thinking in its technical, business, and human dimensions.

2.2 Program Priorities

A strong cooperation in the offering of both design thinking education programs is a priority. Both of Schools of Design Thinking at Stanford University and the Hasso Plattner Institute in Potsdam focus on fostering collaboration between researchers of Stanford University and the Hasso Plattner Institute.

Multi-year funding favors projects that set new research priorities for this emergent knowledge domain. Projects are selected based on intellectual merit and evidence of open collaboration. The following guiding research questions are of special interest:

- 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?
- What is the impact on technology, business, and human performance when design thinking is practiced?

The overall topic of **Design Thinking as Hunting for Big Ideas, and, Transporting Them Home to the Organization** leads the way through this book, the third volume in the series *Design Thinking Research*, which is part of the *Understanding Innovation* Series by Springer Publishing.

2.3 Part I: Design Thinking Research in the Context of Co-Located Teams

The second chapter, entitled "Assessing d.learning: Capturing the Journey of Becoming a Design Thinker," by authors **Shelley Goldman, Maureen P. Carroll, Zandile Kabayadondo, Leticia Britos Cavagnaro, Adam W. Royalty, Bernard**

Roth, Swee Hong Kwek and Jain Kim explores the relationship of learning design thinking and assessing that progress. It addresses the question: How can one understand what is learned in design thinking classes and how might assessments contribute to that process in authentic ways? The study follows a reciprocal research and design methodology where basic research and the design of assessment solutions are ongoing, reciprocal, and related to each other in organic ways. The research team discovered that the learning of design thinking dispositions and mindsets is an emergent journey – with various levels of sophistication, transformation, application, and integration. They introduce the concept of m*indshifts* to represent the developing and nascent epistemological viewpoints and instincts that are strengthened while becoming a design thinker.

The third chapter by **Birgit Jobst, Eva Köppen, Tilmann Lindberg, Josephine Moritz, Holger Rhinow, Christoph Meinel** bears the title "The Faith Factor in Design Thinking: Creative Confidence Through d.school Education?" and looks into the idea of 'creative confidence' as an objective of design thinking education as taught at the d.schools in Potsdam and Stanford. Creative confidence refers to one's own trust in his creative problem solving abilities. Strengthening this trust is a main goal of d.school education. However, there have been only few efforts to develop the concept of creative confidence in design thinking on a deeper and measurable level. To substantiate this discussion, the team led by Birgit Jobst compares creative confidence with the concept of self-efficacy and discusses it in the context of d. school education.

The authors of the fourth chapter, **Steven P. Dow, Julie Fortuna, Dan Schwartz, Beth Altringer, Daniel L. Schwartz** and **Scott R. Klemmer**, take a closer look at prototyping dynamics in their chapter entitled "Prototyping Dynamics: Sharing Multiple Designs Improves Exploration, Group Rapport, and Results". Their assumption claims that prototypes ground group communication and facilitate decision making. However, overly investing in a single design idea can lead to fixation and impede the collaborative process. In a study, participants created advertisements individually and then met with a partner. In the *Share Multiple* condition, participants designed and shared three ads. In the *Share Best* condition, participants designed three ads and selected one to share. In the *Share One* condition, participants designed and shared one ad. Sharing multiple designs improved outcome, exploration, sharing, and group rapport. These participants integrated more of their partner's ideas into their own subsequent designs, explored a more divergent set of ideas, and provided more productive critiques of their partner's designs.

Chapter 5 is captioned with the title "Towards a Paradigm Shift in Education Practice: Developing Twenty-first Century Skills with Design Thinking". In this chapter, the authors **Christine Noweski, Andrea Scheer, Nadja Büttner, Julia von Thienen, Johannes Erdmann** and **Christoph Meinel** deal with the topic of science, business and social organizations, which all describe a strong need for a set of skills and competencies, often referred to as twenty-first century skills and competencies. For many young people, schools are the only place where such competencies and skills can be learned. Therefore, educational systems are coming

more and more under pressure to provide students with the social values and attitudes as well as with the constructive experiences they need to benefit from their opportunities and contribute actively to the new spaces of social life and work. Contrary to this demand, the American as well as the German school system has a strong focus on cognitive skills, acknowledging the new need, but not supporting it in practice. The authors ask why this is so.

Authors **Adam Royalty, Lindsay Oishi** and **Bernard Roth** explore the pathways to adaptive innovation in Chap. 6. Their article entitled '"I Use It Every Day": Pathways to Adaptive Innovation' analyses why the demand for creative and adaptive workers grows, and why universities strive to develop curricula that enable innovation. A pedagogical approach from the field of engineering and design, often called design thinking, is widely thought to foster creative ability; however, there is little research on how graduates of design thinking programs develop and demonstrate creative skills or dispositions. This chapter proposes a new model for the development of creative competence through design thinking education, and investigates alumni outcomes from a graduate school of design thinking. The authors explore potential mechanisms by which students develop these capacities and foreshadow future analysis of obstacles to innovation in the workplace.

2.4 Part II: Design Thinking Research in the Context of Distributed Teams

Chapter 7, entitled "Tele-Board in Use: Applying a Digital Whiteboard System in Different Situations and Setups," has been written by the authors **Raja Gumienny, Lutz Gericke, Matthias Wenzel,** and **Christoph Meinel.** Tele-Board is a digital whiteboard system that helps creative teams working together over geographical and temporal distances. The nature of Tele-Board's synchronized setup allows every connected partner from anywhere in the world to join in the action. Tele-Board is rooted in traditional metaphors, which are easy to implement and come naturally to the user. Additionally, it is possible to follow a common thread in the development of ideas from their inception to conclusion. With the History Browser, the path of creative development can be retraced, reiterated and resumed – from any point in time – a huge benefit in ordering work and reaching conclusions. In this article, the author team reports on several situations and setups in which Tele-Board was used by different teams. They demonstrate how the software suite can be used with various hardware setups and show how well the tools work in practical application.

The authors of Chap. 8, **Greg L. Kress and Mark Schar**, take a closer look at "Applied Teamology: The Impact of Cognitive Style Diversity on Problem Reframing and Product Redesign Within Design Teams". Their chapter reflects on the words of Professor Larry J. Leifer that "all design is redesign". As designers collect information about a problem, they form a mental frame of the problem space

that is the scaffolding around which to build a solution. When presented with new information, successful designers can "reframe" the problem and the solution as part of a successful iterative cycle. The authors propose the Stanford Design Thinking Exercise (SDTE) as a measure of reframing behavior and design team effectiveness. They found that the SDTE is a robust frame for measurement of reframing change, in that it reports a range of reframing results across a participant population group. However, attempts to align the instrument with participant cognitive characteristics were unsuccessful, indicating that more work needs to be done to understand specific indicators of reframing.

Author **Jonathan Edelman** looks into "Qualitative Methods and Metrics for Assessing Wayfinding and Navigation in Engineering Design" in Chap. 9. He follows the assumption that designing can be viewed as a body of behaviors. Fundamental to several design behaviors is Path Determination. Path Determination describes the moments when designers choose what they will take up for development as well as how they experience their perceptual horizon. Their research suggests that there are two primary modes of Path Determination, Wayfinding and Navigation. Each of these has been correlated with different outcomes in redesign scenarios. Wayfinding correlates to making significant changes to an object, while navigation correlates to making incremental changes to an object. In this chapter, he presents a novel methodology for capturing and observing Wayfinding and Navigation behaviors, as well as several metrics for measuring these behaviors.

2.5 Part III: Design Thinking Research in the Context of Embedded Business Teams

In the tenth chapter, entitled "The Designer Identity, Identity Evolution, and Implications on Design Practice," authors **Lei Liu** and **Pamela Hinds** deal with the preliminary results of a study on designer identity, including what a designer identity is, how it evolves as a result of ongoing work-related interactions, and how it may influence design work practice. In their ethnographic research, they closely observed 12 in-house designers as they did their work in a major Chinese communication technology company. They found that designers identified with the design occupation in different yet non-mutual-exclusive ways, and that the way in which designers identified themselves influenced their creative thinking, brainstorming processes, and interactions with clients.

The authors **Martin Steinert, Hai Nugyen, Rebecca Currano and Larry Leifer** deliver insight at "AnalyzeD: A Virtual Design Observatory" in Chap. 11**.** This chapter describes the launch year activities of the analyzed project where the team led by Martin Steinert aimed to quantify engineering design behavior to such an extent that uses statistical algorithm to discover, describe and model fundamental design thinking behavior paradigm. This project is a joint research endeavor with

the EPIC chair of Prof. Hasso Plattner at the Hasso Plattner Institute (HPI). As main result from the Stanford side, they were able to generate several proofs of concepts on gathering and analyzing design process data from various sources and in various data quality. Collaborating with a leading CAD software supplier, they were able to first extract every single engineer-system interaction and second, using genetic algorithms, they were able to statically identify patterns without an a priori model assumption.

In Chap. 12, entitled "When Research Meets Practice: Tangible Business Process Modeling at Work", the authors **Alexander Luebbe and Mathias Weske** are comprehensively deliver insight into a modeling approach they created and that is used by people in organizations to create and discuss business process models that represent their working procedures. This is an alternative to established approaches in which process modeling experts create business process models for the organization based on input from domain experts. They have changed this by empowering the domain experts to model their business processes themselves. This approach consists of a simple to use haptic toolset and the facilitation for its application. In the first stage of their research, they have shown that their approach, called tangible business process modeling (t.BPM), can be used to co-create process models with novice modelers. In a subsequent laboratory experiment, they found out that t.BPM is superior to interviews for process elicitation because people are more engaged with the modeling task and the result is better validated.

In Chap. 13, entitled "Towards a Shared Repository for Patterns in Virtual Team Collaboration," the authors **Thomas Kowark, Philipp Dobrigkeit**, and **Alexander Zeier** comprehensively analyze the platform they established and that provides 'out-of-the-box' monitoring capabilities for virtual team environments and enables the sharing and evaluation of recorded collaboration activities within a larger research community. Building on lessons learned from previous applications, they now present a refined and extended version of this platform. Its core feature is the possibility to share abstracted parts of the collected team collaboration networks with other users of the platform and, thus, broadens the basis for the validation of their influence on team performance. In this way, these network sequences might be raised in status from being just coincidently reoccurring collaboration behavior to collaboration patterns (or anti-patterns), whose occurrences are strong indicators for the possible success of teams.

Chapter 14 is titled "Adopting Design Practices for Programming". The authors **Bastian Steinert, Marcel Taeumel, Damien Cassou**, and **Robert Hirschfeld** are elaborating their article based on the assumption that developers are continuously designing their programs. In the same way, developers strive for simplicity and consistency in their constructions like practitioners in most design fields. A simple program design supports working on current and future development tasks. While many problems addressed by developers have characteristics similar to design problems, developers typically do not use principles and practices dedicated to such problems. In this chapter, the author team is reports on the adoption of design practices for programming. First, they propose a new concept for integrated programming environments that encourages developers to work with concrete

representations of abstract thoughts within a flexible canvas. Second, they present continuous versioning as our approach to support the need for withdrawing changes during program design activities.

In Chap. 15, the authors **Gregor Gabrysiak, Holger Giese** and **Thomas Beyhl** give insight into their research topic, entitled "Virtual Multi-User Software Prototypes III". In design thinking and software engineering, prototypes play a crucial role in validating insights, needs and requirements. Still, the effort necessary to create these prototypes depends on multiple factors, such as the number of people involved with the design thinking project. Especially for multi-user software systems, the effort of creating validation artifacts is too high to be feasible for multiple iterations, thus, inhibiting design thinkers to inexpensively try different ideas early and often. To overcome this problem, the team led by Gregor Gabrysiak investigated the usability and feasibility of virtual prototypes – animated simulations of formal models which can be derived automatically without additional costs. This article reports on their advances during the 3 years of the design thinking research project concerned with Virtual Multi-User Software Prototypes.

In the last chapter of this book, Chap. 16, captioned "What Can Design Thinking Learn from Behavior Group Therapy" the authors **Julia von Thienen, Christine Noweski, Christoph Meinel, Sabine Lang, Claudia Nicolai** and **Andreas Bartz** look into the similarities of Behavior Group Therapy and Design Thinking. Some widely-used approaches in Behavior Group Therapy bear a striking resemblance to Design Thinking. They invoke almost identical process-models and share central maxims like "defer judgement" or "go for quantity". Heuristics for composing groups (mixed!) and preferred group sizes (4–6) are very much alike as well. Also, the roles ascribed to therapists are quite similar to that of Design Thinking coaches. Given these obvious analogies, it is most natural to ask what the two traditions can learn from one another – and why it is that they are so strikingly alike. This article by the author team led by Julia von Thienen ultimately hopes to inspire further investigations by giving examples of how Design Thinking may profit from taking a look at Behavior Group Therapy.

3 Summary

Understanding the evolution of innovation, and how to measure the performance of the design thinking teams behind this innovation, is the central motive behind the research work reported in this book. Challenged by these fundamental concerns, all the contributions in this volume report on different approaches and research efforts aimed toward obtaining deeper insights and a better understanding into how design thinking transpires. In highly creative ways, different experiments were conceived and undertaken with this goal in mind. The results achieved were analyzed and discussed to shed new light on the focus areas. We hope that you, as our reader, enjoy this discourse on design thinking and its multi-faceted impact. Besides looking forward to receiving your critical feedback, we also hope that when reading

these reports you too will get caught up in the fun our research teams had in carrying out the work they are based on. All authors are very much interested in entering into or continuing a dialogue with you. We would be grateful if you could share your insights, impressions and ideas with us.

Understanding innovation, understanding how design thinking fosters innovations, that is the motivation for all the research work is reported in this book.

We are thankful to all who have contributed to the book. These are not only the authors but also Martin Steinert as well as untold helping hands from friends within the Stanford design and engineering community and the HPI. They all have successfully managed the program and various community building activities and workshops, all of which has contributed considerably to the success of the HPI Stanford Design Thinking Research Program.

We are particularly thankful to Sabine Lang for all her work in preparing this book and supporting its editors tremendously. We are very grateful for her various contributions that were a capital share into making this book happen.

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. You can contribute directly by submitting papers to the **"Electronic Colloquium on Design Thinking Research" (ecdtr)** which you can find here: http://ecdtr.hpi-web.de.

We invite you to visit this innovative platform of dynamic and rapid scholarly exchange about recent developments in design thinking research and to join in the dialog with us.

Part I
Design Thinking Research in the Context of Co-located Teams