

Amaresh Chakrabarti · Udo Lindemann
Editors

Impact of Design Research on Industrial Practice

Tools, Technology, and Training

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Preface

This book grew out of a single question: what is the impact of design research on practice? The question was sparked off by the persistent belief that design research has little impact on practice.

The question led to a collaboration between the two editors in the summer of 2013, when Amaresh Chakrabarti took his sabbatical at Technical University of Munich to visit Udo Lindemann. An international workshop was organised by the editors at the Institute of Product Development, Technical University of Munich, Germany in 2013 called “International Workshop on Impact of Design Research on Practice” (IDRP 2013).

Most of the authors of the book participated in the workshop and deliberated on two major questions:

- What guidelines can be formulated for successful transition of outcomes of design research into practice?
- What kinds of platform are needed for supporting ongoing interactions between academia and practice for carrying out academically worthwhile yet practically relevant design research?

These questions were further discussed in breakout sessions, and summarised by Rapporteurs; the goal of the workshop was to learn from each other as to what contributed to the success of cases where research were transferred to practice, so as to achieve the following: to formulate guidelines for other researchers, especially young researchers, to support transition to practice; and, to help evolve common platforms on which transition of design research to practice could be discussed and supported as an ongoing process.

This book is intended to provide an anthology of work that together showcases exemplars of how various aspects of design research were successfully transitioned into, and influenced, design practice. The chapters are written by both academics and practitioners. It also contains surveys: of organisations engaged in design practice; of views of researchers and practitioners of design; and of publications and research outcomes from the academic community. Further, it documents learnings as to what worked in the successful cases of transfer, and what did not in some

failed cases. Through the surveys, several of these chapters encapsulate experience of a much wider community than the one that participated in the IDRP 2013 workshop.

The work and the success stories shared in the chapters in this book show, emphatically, that design research has indeed made a significant impact on design practice. People trained in academia play a key role in impacting practice; therefore, education plays a key role in this process. Further, the impact of design research is not only via design research being transferred to existing practice; it is also about how design research helps create new practice, new jobs, new philosophies of practice, and so on.

This book is meant to instill confidence in the community that the work being carried out in its research and education are indeed important and impactful. It is also meant to provide areas in which the community needs to improve so as to further enhance its impacts on practice and education of design.

The editors wish to thank Technical University of Munich and its Institute of Product Development for their generous support in organising the IDRP 2013 workshop. In particular, the volunteers who worked hard to make the workshop a success, without which this book would not be possible, are gratefully acknowledged. Christopher Münzberg and Srinivasan Venkataraman have been the main support for the workshop. Thanks are also to them and to Hugo d'Albert for editorial and secretarial support for the book.

The editors thank Springer Verlag, in particular Anthony Doyle and Gabriella Anderson for their contributed editorial support.

Finally, Amaresh Chakrabarti wishes to thank Anuradha and Apala for their support and encouragement during the long gestation period for the book, as does Udo Lindemann to Edeltraut.

March 2015

Amaresh Chakrabarti
Udo Lindemann

IDRP Editorial: How Design Research Impacts Practice

Introduction

Design research (DR) is a relatively young discipline with about 50 years of clearly identifiable work as a research community. However, like all progressive research communities with application as a goal, an often-asked question in design research is: what is the impact of design research on practice?

According to Blessing and Chakrabarti (2009), the term ‘Design Research’ refers to the development of understanding of and support for phenomena associated with design in order to make design more effective and efficient, so as to help practice of design and its education to become more successful. Similarly, Telenko et al. (“[Changing Conversations and Perceptions: The Research and Practice of Design Science](#)”, *ibid*) define ‘design research’ as the scholarly inquiry that seeks to advance design by studying and improving it in systematic and scientific ways. More specifically, they see design research as the means to expand, test and operationalise the findings of design science.

Telenko et al. (“[Changing Conversations and Perceptions: The Research and Practice of Design Science](#)”, *ibid*) define impact and influence as transfer of knowledge between design researchers and practicing designers. Knowledge transfer is not necessarily measurable and direct; it may take many forms, involving people, products and partnerships.

There is a persistent belief that design research has made little impact on practice. However, as observed in “[Changing Conversations and Perceptions: The Research and Practice of Design Science](#)” (*ibid*), it is “largely a matter of perspective based on limited assumptions, narrow definitions, and stereotypical views.”

Many issues of transferring knowledge from design research to practice are not unique to design research. For instance, as quoted by Telenko et al. (“[Changing Conversations and Perceptions: The Research and Practice of Design Science](#)”, *ibid*), some of the major challenges in medicine include difficulties faced by health practitioners in approaching scientific literature, assessing validity and practical relevance of new knowledge, and incorporating results into their practice

(Greenhalgh 2010); studies also show that research that should change medical practice is often ignored for years.

This book is intended to provide an anthology of chapters that showcase exemplars of how various outcomes of design research successfully transitioned into and influenced design practice. The chapters written by researchers primarily showcase examples of findings, products and curricular programmes that grew out of design research conducted in academia and influenced the practice of design. The chapters from practitioners primarily showcase experiences from practice as to how design research or training in design methodology influenced design practice.

The evidence from several surveys undertaken in the broader literature, and the surveys undertaken by Telenko et al. ([“Changing Conversations and Perceptions: The Research and Practice of Design Science”](#), *ibid*) and Graner ([“Are Methods the Key to Product Development Success? An Empirical Analysis of Method Application in New Product Development”](#), *ibid*) in this book, as well as the success stories shared across the chapters in this book bust several myths. “Researchers do engage with industry. Industry professionals do participate in academic venues, and many design researchers do have experience in practice as consultants, industry employees or both” ([“Changing Conversations and Perceptions: The Research and Practice of Design Science”](#), *ibid*).

People trained in academia play a key role in impacting practice; therefore, education plays a key role in this process. It is not only about how design research is transferred to existing practice, it is also about how design research creates new practice, new jobs, new philosophies of practice and so on.

As a background, the topic of the book was discussed in a workshop organised at the Institute of Product Development, Technical University of Munich, Germany in the Summer of 2013 called the “International Workshop on Impact of Design Research on Practice” (IDRP 2013). Most of the authors of the book participated in the workshop and deliberated on two major questions: *What guidelines can be formulated for successful transition of outcomes of design research into practice? What kinds of platform are needed for supporting ongoing interactions between academia and practice for carrying out academically worthwhile yet practically relevant design research?* These questions were discussed in breakout sessions, and summarised by Rapporteurs.

The goal of the workshop was to learn from each other as to what contributed to the success of the cases where outcomes of design research were transferred to practice, so as to help achieve the following: to provide guidelines to other researchers, especially new researchers, to support transition to practice; and to help evolve common platforms on which transition of design research to practice could be discussed and supported as an ongoing process.

This editorial provides a summary of the chapters and the breakout sessions from the workshop to highlight some of the examples of successful transfer of design research into practice. It also looks across the chapters and the breakout session summaries to obtain a broad brush picture of the overall impact of design research on practice. The chapters are written by academics and practitioners from twelve countries spanning three continents: Asia (Japan, India, Singapore), Europe

(Finland, France, Germany, Italy, Luxembourg, Spain, Sweden and the UK), and North America (USA). Further, several of these chapters provide surveys of experience from a much larger array of academic researchers and practitioners, and therefore encapsulates experience of a much wider community beyond the one that participated in the workshop.

The book is divided into three parts. The first part “Surveys and Summaries” comprises five chapters: three of these are surveys of impacts of design research on practice; the remaining two are summaries of the breakout sessions from the IDRP 2013 Workshop. The second part “Experience from Academia” contains fifteen chapters. The third part “Experience from Practice” comprises ten chapters. Even though the authors of “[Verification Upstream Process, a Quality Assurance Method for Product Development in ODM Mode](#)” and “[Adoption and Refusal of Design Strategies, Methods and Tools in Automotive Industry](#)” are now in academia, the chapters are written based on the experience of their authors in industry. Except for the summaries from breakout sessions that are placed at the end of the first part, all chapters within each part are organised using an alphabetical order, based on surname of the first authors.

Beyond the two major questions asked at the workshop, this editorial asks some more questions that are related to the two major questions; it then gleans possible answers to these questions from the chapters. In order to assess success of transition of design research outcomes to practice, one needs to understand what metrics could be used for assessing success, and the possible routes through which success could be achieved. The first two questions below explore these aspects. The editorial then seeks possible answers to the two major questions asked in the book. The expanded list of questions explored thus is given as follows:

- What are the metrics with which to assess success of transition of DR results on practice?
- What are the routes through which DR impacts practice?
- What guidelines can be formulated for successful transition of design research results into practice?
- What kinds of platforms are needed for supporting ongoing interactions between academia and practice for carrying out academically worthwhile yet practically relevant design research?

Summary of Chapters and Key Points

In this part, we provide a brief summary of, and the key points made, in our view, in each chapter. “[Preparing for the Transfer of Research Results to Practice: Best Practice Heuristics](#)”–“[Results From the Breakout Sessions of Group B](#)” is on Surveys and Summaries.

In “[Preparing for the Transfer of Research Results to Practice: Best Practice Heuristics](#)”, based on a study of transfer of research results to practice, Blessing and

Seering have identified a number of heuristics for successful transfer. The key points from the chapter are:

- A large concentration of successful applications of research results are in the area of support for a specific design task that is applicable in multiple settings.
- The three heuristics that were considered applicable in most cases are: The question being addressed will be of substantial interest to practitioners; Research results will be evaluated by practitioners; Tools will improve process effectiveness and/or efficiency measurably.
- Industry and academia must be in continuous engagement. The authors suggest the following routes: Academia: findings (practice as sample or data source) → development (practice as sounding board) → verification (practice as test bed).

Graner in “[Are Methods the Key to Product Development Success? An Empirical Analysis of Method Application in New Product Development](#)” reports on a major study on application of design methods in the context of new product development. Based on a study of 410 new product development projects conducted with feedback from experienced product development managers and project managers in 209 manufacturing companies that operate their own new product development from bases in Germany, Austria and Switzerland, it was found that applying methods in new product development led directly to superior financial performance of the developed product, and indirectly to a greater degree of innovativeness, better cross-functional collaboration and shorter time to market. The key points from the chapter are:

- Use of design methods increase chances of product success in New Product Development projects via time to market, cross-functional collaboration and innovativeness—all factors influencing product success. Product development teams should foster adoption of methods in their design process. Companies that use a combination of methods to consider the aspects of customer demand and willingness to pay, technical feasibility, product cost and project management together, will meet with an overall higher product success.
- Companies that have formally defined the new product development process, which split this process into individual process steps that evaluate the status of development at the end of each step and that decide whether to continue the development project at defined gates in the process tend to use more methods in new product development.
- Product development teams that receive greater support from the management adopt substantially more methods. Rigorous project management is also needed if new products are to be developed quickly and with efficient use of resources.

In “[Patterns and Paths for Realising Design-Led Impact: A Study of UK REF Cases Studies](#)”, Hicks examines 22 case studies taken from two of UK’s leading

Mechanical Engineering Departments. The case studies were prepared in 2013 for the purposes of the UK's Research Excellence Framework assessment. The cases are categorised and grouped according to the dimensions of impact, sector, time-scale and core mechanisms employed, with the aim of eliciting common routes to influencing practice, product design and policy. The key points from the chapter are:

- There is a greater focus on research into new/improved products rather than process improvement. Product-led research gave rise to greater international impact and hence reach. Process-led research was generally restricted to more national/local impact. Product-led impact and research generally had a more significant measured economic impact in the timescale considered than process-led research.
- The most common mechanisms for achieving impact were Technology Strategy Board (TSB) funding, Knowledge Transfer Partnerships and consultancy activities. Spin-outs were the key mechanism for product-led impact while consultancy was the key mechanism for tool/method-led impact.
- General insights for realising impact from design process research revealed seven challenges concerning: the limitations of studying what is rather than what should be; the general lack of verification of practice-led research; the difficulty of balancing generality and specificity; the proliferation of tools/approaches; the need to directly support practice and training; the need for integrated funding; and the need for benchmarking and performance measurement.

[“Results From the Breakout Sessions of Group A”](#) and [“Results From the Breakout Sessions of Group B”](#), rapporteured by Lucienne Blessing and Chris McMahon respectively, are not further summarised here, since these are already summaries of breakout sessions from the IDRP 2013 Workshop. Both chapters contain a series of recommendations as to which guidelines should be followed to support successful transfer of research results to practice, and as to which platforms between academia and practice should be helpful for identification, development and transition of research outcomes to practice.

[“Impacts of Function-Related Research on Education and Industry”](#) by Arlitt et al. speaks about the function-based paradigm, which focuses on abstracting what a system does separately from what it is. Within this paradigm, it is important to communicate abstract functions in a consistent manner, without binding them to their embodiments. This chapter discusses two recent outcomes in function-based design research, their impacts on education and industry, and the authors' observations regarding their adoption into practice. The first of these outcomes is an information schema for capturing design artefact knowledge, which includes a standardised function taxonomy. The second research outcome is a conceptual linking between functions and failure modes, enabling new types of failure analysis techniques in early design. The key points from the chapter are:

- Education and training activities provide direct bottom-up influence, though tracing the impacts caused by newly trained engineers is challenging; cultural inertia within established organisations can present barriers to acceptance of new design techniques.
- Direct collaboration with industry provides top-down influence, but requires buy-in from key people in the organisation. Small start-ups represent a compromise between receptiveness to new ideas and capacity to impact practice; a combination of top-down and bottom-up techniques is needed to produce noticeable change in practice.
- Research outcomes must possess demonstrable utility by providing direct solutions to practical problems in an easy-to-use manner. Simplicity and flexibility of core research contributions are critical to facilitate transition into practice, such that interested stakeholders can adopt and adapt the research outcomes with low effort.

“A Framework for the Dissemination of Design Research Focused on Innovation”

by Becattini et al. presents a framework for transferring results of design research into practice, specifically addressing the need to create a circle of players from companies interested in being part of the mass dissemination process of already tested methodologies as well as in pilot experiences and preliminary dissemination activities with latest design research developments. Moreover, the chapter focuses attention on existing metrics for evaluating impact and viability of adoption of design methodologies in practical contexts, showing their lack in covering aspects related to the dissemination of design research concepts. A new metric is then proposed and applied to six case studies of industrial interest. The results highlight the potential benefits from adoption of a shared metric for measurement of knowledge transmission of this kind from design research to practice. The key points from the chapter are:

- It is recommended to rely on a structure that links together academia and industry, such as a centre of competence, with mutual exchanges on research objectives, best practices on design methods and punctual assessment of the related impact; a structure is proposed where students, innovators and early adopters work in collaboration with a design research-centre of competence combination to generate interesting research results, develop new methods and apply on practical case studies, and generate a culture of design research respectively.
- It is recommended to assess the goodness of the outcomes of design research through intensive tests before their dissemination to a bigger audience. A reliable assessment should consider the effectiveness of the proposed methods and tools by validating them with statistical significance (e.g.: by involving students in academia as testers, if needed) and on the field with companies to evaluate their industrial impact;
- It is recommended to measure the outcomes of the transfer by means of appropriate metrics that also allow the identification of issues and troubles of the applied methods and tools, as well as the need of new ones addressing emerging situations.

“[Impact of Design Research on Practice: The IISc Experience](#)” by Chakrabarti analyses the broad development of design practice, research and education in India, and uses some of the major developments at the Indian Institute of Science (IISc.) as exemplars to illustrate the impact of design research on design practice, research and education. The outcomes of design research can influence practice through multiple routes: the chapter illustrates each route with exemplars from work carried out at IISc. The key points from the chapter are:

- A variety of platforms are possible through which design research can impact practice: the most direct is via products. The next is via methods and tools, which can be used on multiple products. The third is via people who move to, or change practice. The fourth is via organisations created around research results. The fifth is via platforms for training.
- A matchmaking of the needs of industry and offerings from academia should happen, where scientific needs of the academia and practical needs of the industry must meet on a platform. The platform should encourage exchange of problems, and the timescale associated with them. It should also encourage ‘tweeting’ on the emerging solutions being developed in academia.
- A more direct platform is not necessarily more impactful. For instance, a specific product may lead to a certain income for an organisation, whereas a person can initiate a variety of products and organisations. However, the more indirect the platform is, the harder it is to assess its impacts. Appropriate metrics need to be developed to support assessment at different levels.

In “[Industrial, and Innovation Design Engineering](#)”, Childs and Pennington describe a 34 year old, highly successful, double-masters programme called Innovation Design Engineering (IDE), run jointly by the Royal College of Art and the Imperial College London. IDE’s teaching philosophy is trans-disciplinary, where students are competent across several disciplines as represented by an ‘m’ shaped profile of multiple discipline competence. While traditionally graduates gained employment in corporations and design consultancies, the past 5 years has seen a shift with the greater proportion of graduates setting up their own businesses and consultancies on completion of the programme. A characteristic of many IDE alumni is that they do not tend to be designer names per se but are transdisciplinary team players. The key points from the chapter are:

- Educational programmes in design have a major impact on practice, and the IDE course is an example case. They impact as resources for fresh inputs to existing industry, its knowledge, its effectiveness and its efficiency in innovation, as well as providing people who will create new practice altogether.
- The course is based on three key principles: diversity, design and engineering mix, and making it real. The programme embraces a wide range of disciplinary entrants, and guides them on a journey through experiences in design, technology and engineering towards a destination of innovation enabled by their diverse skills and experience.

- A highlight of the course is the industrial embedding of some of its student projects. This provides both a contextual exposure to students to industrial problems, and demonstrates to practice the value of what is learnt in design courses.

In “[Clemson Engineering Design—Applications and Research \(CEDAR\) Group—Clemson University, Clemson, SC, USA](#)”, Fadel et al. summarise design research at Clemson University and its impact on industrial practice, particularly in the evolution and transition of disparate ideas into cohesive concepts that were eventually transitioned to industry. In design research, a broad area of endeavour, design theories take the longest to develop and are the slowest to transition to industry. The development of methods, practices and their applications to industrial problems are much quicker to transfer, however, since industry professionals see the immediate potential benefits or shortcomings of the methods and issues of interest to them. The training of students at all levels in design practice also affects industry as many assume positions in and affect the practices of their companies. The key points from the chapter are:

- Transfer of research results directly to practice are enabled by: close collaboration with industry, where Principal Investigators and students remain intimately involved with industry—often through interns or extended work periods; research is both demonstrated and validated with real problems; projects have a clear value proposition for industry.
- Both undergraduate and graduate teaching impact and are impacted by research and together make the biggest impact on practice. Industry sponsored, undergraduate, capstone, design-build-test projects solving industry-provided problems using design methodology with graduate advisors who coach the students as well as use the data from the projects for research have been useful in training students in practical problem solving using design methodology, testing design methods and tools, and demonstrating to industry the power of design methodology.
- A route to industry is industry-sponsored research developing new methods and tools, leading to training programmes for transition to practice (practice → methods → training → practice).

“[Evaluating Tactual Experience with Products](#)” by Georgiev et al. focuses on design research that analyses users’ tactual experience with product interfaces, especially the analysis of users’ impressions of such experiences. The method was developed in a case to evaluate users’ tactual interactions with product interfaces in the context of the car industry, particularly for research and development of interfaces of vehicles. The method was applied in a trial evaluation for vehicle interfaces of navigation systems, audio systems, and air conditioning systems. The key points from the chapter are: