

# Integrated Series in Information Systems

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Alan Hevner · Samir Chatterjee

# Design Research in Information Systems

Theory and Practice

Forewords by Paul Gray and Carliss Y. Baldwin

 Springer

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# Critical Praise for Design Science Research Book

Well designed systems enable productivity and successful adoption. Poor design is the greatest barrier to both. I highly recommend this book as a guideline to understanding where we have come from and where we are headed in design science.

*Kristin M. Tolle, Ph.D., Microsoft External  
Research, Director, Health and Wellness Team*

This enlightening book wonderfully captures the vibrant energy in design science research that Hevner and Chatterjee have been able to mobilize in the information systems design community in the past five years through their work and the successful DESRIST annual conferences. It brings together the contributions of some of the best academic minds from Europe and North America in this growing area, and is the only book of its kind. It is both a foundation and a springboard for enabling the further advancement of design research in information systems.

*Omar A. El Sawy, Professor of Information Systems,  
Marshall School of Business, University of Southern  
California*

This important book provides valuable guidance for design-oriented IS researchers. With an increased demand for more relevant design-oriented research on real-world business problems, this new book on design research in IS has been waited for by many.

*Prof. Dr. Robert Winter, Director, Institute  
of Information Management, University of  
St. Gallen, Switzerland*

Creating and using information systems in business, organizational and consumer settings are both essential and complicated. Most people involved with these information systems initiatives deal with the enormous breadth and depth of complexity by selectively focusing on either the technology aspects, or the managerial, organizational and people impacts. This book on Design Research in Information Systems by Hevner and Chatterjee is an important effort to build bridges across the technology perspective and the managerial and behavioral perspectives of information systems. This important book will help anyone appreciate how those who are building IT systems can contribute to IS research.

*Steven Miller, Professor of Information  
Systems Practice, Dean, School of Information  
Systems, Singapore Management University*

This work is timely, crisp, and comprehensive. Hevner and Chatterjee skillfully lead their readers through the central ideas of information systems design science in a way that is not only authoritative and methodical, but also clear and readable. It provides us with a work that serves design researchers both as a complete tutorial and an excellent desk reference.

*Richard Baskerville, Professor of CIS  
Department, J Mack Robinson College of  
Business, Georgia State University*

*I dedicate this book to all my Georgia State University design colleagues who started the important dialogue when no one else understood our research method. I also dedicate this book to my family, my loving wife Madhumita, and my son Mickey for their support. Finally my gratitude is to my parents for always believing in me. Dad and Mom, you are the greatest generation!*

*– Samir*

*I dedicate this book to my fabulous wife, Cindy.*

*– Alan*



# Foreword

It is 5 years since the publication of the seminal paper on “Design Science in Information Systems Research” by Hevner, March, Park, and Ram in *MIS Quarterly* and the initiation of the *Information Technology and Systems* department of the *Communications of AIS*. These events in 2004 are markers in the move of design science to the forefront of information systems research. A sufficient interval has elapsed since then to allow assessment of from where the field has come and where it should go.

Design science research and behavioral science research started as dual tracks when IS was a young field. By the 1990s, the influx of behavioral scientists started to dominate the number of design scientists and the field moved in that direction. By the early 2000s, design people were having difficulty publishing in mainline IS journals and in being tenured in many universities. Yes, an annual Workshop on Information Technology and Systems (WITS) was established in 1991 in conjunction with the International Conference on Information Systems (ICIS) and grew each year. But that was the extent of design science recognition. Fortunately, a revival is underway. By 2009, when this foreword was written, the fourth DESRIST conference has been held and plans are afoot for the 2010 meeting. Design scientists regained respect and recognition in many venues where they previously had little. Some behavioral scientists now understand, as this book points out (in Fig. 2.1), that the two disciplinary approaches are tied to one another. Design scientists create IS artifacts that create utility and behavioral scientists create IS theories based on these research results that provide truth. We are not there yet in getting the relationships between the designers and behavioralists completely right. But we can be confident that the link between design science and behavioral science will become complimentary and ever stronger in the years ahead.

Design science is a relatively new field. It traces its roots to the 1969 book “Science of the Artificial” by the late, great Herbert Simon. The artificial refers to the idea that phenomena and entities can depend on choices by the designer rather than being true only because they occur in nature. Much of the world of computing is the result of human design choices. Physical phenomena, such as the speed of light or visual acuity, act as constraints on the design choice. Design science focuses on the relevance of IT artifacts in applications. It involves problems characterized by unstable requirements and constraints and complex interactions among problem

components solved by using malleable processes and artifacts, creativity, and teamwork. That's quite an order to fulfill for problems that are at heart wicked. Yet it is being done and being done well.

Design science researchers work on understanding, explaining, and improving information systems. They study artifacts such as algorithms, human/computer interfaces, languages, and system design methodologies. Understanding leads to knowledge for predicting how some aspect of a phenomenon behaves. Design uses that knowledge plus innovation to create new improved artifacts that surpass what was available previously. In practice, design itself involves considerations of the internal, the external, and the interface between the internal and the external. That is, design is the know-how for implementing an artifact that satisfies a set of functional requirements. I could go on to explain design research at ever deeper levels. But that would defeat the purpose of your reading this excellent book.

This volume is the first major book on design science I know of. It is authored by two people, Alan Hevner and Samir Chatterjee, who are experienced leaders and experts in the field. They organize and distill its current extent. You will find the book is a much needed contribution for practitioners, students, and faculty in a rapidly evolving area. I found that it broadened my understanding of design science research and believe it will also broaden yours.

Paul Gray  
Professor Emeritus, Information Science  
Founding Editor, *Communications of AIS*  
Irvine, CA

# Foreword

In his pathbreaking book, *The Sciences of the Artificial*, Herbert Simon observed that the natural sciences enjoyed a privileged position among academic disciplines. By the opposite token, man-made things were not seen as worthy of true scientific inquiry. Simon disagreed. He argued for the establishment of a set of sciences focused on man-made things and unified by an overarching science of design.

One reason, Simon believed, the sciences of the artificial lagged behind the natural sciences was that interesting man-made systems quickly become very complex. Science prizes simplicity and so is preferentially aimed at simple phenomena and broad generalizations.

Researchers in information technology and information systems (IT/IS) of necessity study complex, man-made systems. Moreover, as computers and communication become cheaper, people are inevitably building new IT/IS systems that push the limits of what is possible. Such systems confront us with “wicked problems” where social, technical, economic, and political constraints interact, and solutions cannot be deduced from scientific principles alone. This is the world of IT/IS research. To quote the fearful words of early scientific cartographers: “Here be dragons.”

In domains characterized by complexity, natural science methods can only carry us so far. Such methods leave out the important element of design: the construction of new ways to solve a problem or address a need. Natural science methods take the world as given and do not allow for novelty.

As researchers, how can we allow novel solutions to appear, and then study them in a systematic way? How can we build up scientific knowledge about new designs, in particular, what works and what fails and why? Without such knowledge, we will not be able to understand the large-scale systems we are creating today. The wicked problems will grow evermore wicked. The dragons will win.

Leaving hard-won knowledge about novel solutions scattered about, uncorrelated and unanalyzed, will not make us masters of our own designs. Thus there is a need to build knowledge about designs systematically, to test it rigorously, to share it openly, and to pass it on. Only in this way can we take advantage of what Karl Popper called the “ratchet” of the scientific method: the iterative process by which erroneous conjectures are eliminated through a process of hypothesis formulation, testing and reformulation. (Simon called this the “generate-test cycle,” and placed it

at the center of his science of design.) It is through this scientific method of learning, Popper argued, that knowledge becomes cumulative. Designs get better. Progress is real.

As Newell and Simon said, every artifact asks a question of the world. Put another way, every new design embodies a set of hypotheses about how the world works. The artifact based on the design tests those hypotheses, confirming some and contradicting others. How can we leverage this innate property of artifacts and designs to build up our stores of scientific knowledge?

Hevner and Chatterjee and the other contributors to this volume explain in a practical and systematic way how to do this. They provide a roadmap that will allow *you* to do first-rate design science research. They explain how to pose good research questions, how to frame your questions in relation to prior work, and how and why you must rigorously evaluate and report your results. They do not tell you how to design, but they will help you to situate your designs in the broader discipline of design science.

Designing will never be made entirely systematic, but the knowledge gleaned in the process can be systematized and tested until it reaches the standard of science. This book explains how. By following its precepts, the knowledge gained from your own design experience can become part of the great body of scientific knowledge that enriches us all.

Carliss Y. Baldwin  
Harvard Business School  
Baker Library 355  
Boston, Massachusetts

# Preface

*“The proper study of mankind is the science of design.”*

Herbert Simon

*“Engineering, medicine, business, architecture and painting are concerned not with the necessary but with the contingent – not with how things are but with how they might be – in short, with design.”*

Herbert Simon

## Purpose and Motivation of This Book

The creative human activity of design changes the world in which we live for the better. As academic researchers in the field of information systems (IS), the co-authors have observed, studied, and taught design in the development of software-intensive systems for business. We have experienced the difficulties and wicked nature of designing useful systems. More importantly, we have faced classrooms of students with the challenges of how teach the underlying theories and everyday practices of software system design. These experiences and challenges have motivated us to perform research in the science of design, or design science research (DSR), and to write this book.

We believe that the study of information systems design, both its theory and practice, has become an essential part of the education of IS students and professionals. More and more IS graduate and doctoral programs are beginning to offer graduate-level seminars on design science research. The purpose of this book is to fill a void: the lack of a good reference book on design science research. Most current seminars study a collection of research papers from many sources. Often, these papers are written with differing terminology and research perspectives leading to confusion and misunderstandings for students. Here we provide a consistent approach for performing and understanding design science research while maintaining a diversity of opinions from many thought leaders in the IS design community.

Having worked in the information technology and software design fields as academics and industry consultants, the authors of this book have written from their

extensive experience as educators of design science research. Many chapters of this book are based on a series of seminars that Dr. Chatterjee has taught at Claremont Graduate University. Dr. Hevner's seminal 2004 article in *Management Information Systems Quarterly* journal has had huge impact in the IS field. (Appendix A is a reprint of the Hevner et al. 2004 article in *MISQ*.) It has raised consciousness toward design science as a rigorous and relevant research paradigm and his evangelistic efforts to promote DSR throughout the world has resulted in a heightened awareness of the urgent need for good design research to improve business processes and systems.

In 2006, Drs. Chatterjee and Hevner founded the Design Science Research in Information Systems and Technology (DESRIST) conference which has become a platform for all leading design IS researchers to present their work and a forum to debate the important issues facing the community. We have selected a handful of the best papers that have appeared in this conference over the past 4 years to be included as chapters of the book. In Appendix B, we have provided a list of exemplar research papers in design science as an aid to students for further reading.

It has been our goal to make this book easy-to-read, easy-to-understand, and easy-to-apply. From frameworks to theory to application design, this book provides a comprehensive coverage of the most salient design science research knowledge that is available at the time of this book's publication.

## **Intended Audience**

The material is suitable for graduate courses in information systems, computer science, software engineering, engineering design, and other design-oriented fields. The book is intended to be used as a core text or reference book for doctoral seminars in design science research. The book does not require an extensive background in design and can be appreciated by any practitioner as well who is working in the field of information systems and technology design. IS faculty and industrial researchers who want to further develop their knowledge and skills in the design science research methodology will find it valuable. Each chapter is self-contained with references.

Alan Hevner  
Tampa, Florida

Samir Chatterjee  
Claremont, California

# Acknowledgments

Writing a book is no small task. It is with great pleasure that we acknowledge the efforts of many people who have contributed either directly or indirectly to the development of this book. The ideas presented in this book have been shaped and influenced by the students who have taken the design science research seminars at Claremont and all those doctoral students that we have graduated. In particular we would like to thank the contributors who despite busy schedules have worked hard to write chapters in this book:

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