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# Service Science: Research and Innovations in the Service Economy

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Editors

# Fundamentals of Service Systems

Foreword by Jim Spohrer

 Springer

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## Foreword

Writing a textbook about the world of service is a daunting task in part because the world of service is truly vast. Where to start? How best to guide students as they begin their journey? To become oriented quickly, students will need a good map.

In *Fundamentals of Service Systems*, Jorge Cardoso, Hansjörg Fromm, Stefan Nickel, Gerhard Satzger, Rudi Studer, and Christof Weinhardt all from the Karlsruhe Service Research Institute (KSRI)—provide a map with multiple entry points for students of service. Students who read this textbook learn that context matters. For example, economists have their definition of service, and computer scientists have a different definition. Compounding the learner's dilemma, service is a commonly used word in everyday conversations! From business to government to technology, every student has undoubtedly been a customer of an enormous range of types of service by the time they enter college, which is just one more type of service system with a focus on education.

Jorge Cardoso and Hansjoerg Fromm—together with their coeditors Rudi Studer, Stefan Nickel, Christof Weinhardt, and Gerhard Satzger,

One of the great strengths of this new college-level textbook is that it provides students with up-to-date examples in context. Of course, the world of service technologies is fast moving, and we can only hope that the excellent and finely tuned examples in this textbook will be refreshed regularly. In fact *textbooks as a service* is an area of service innovation that is evolving rapidly, in the age of MOOCs (Massively Open Online Courses), cognitive assistants, and crowdsourcing.

Scholars of service who are familiar with the daunting challenges posed by explaining service to students may be reminded as I was of Richard Normann's book *Reframing Business: When the Map Changes the Landscape*.<sup>1</sup> In that classic book, value-creating systems are presented as rapidly evolving, increasingly dense, and interconnected configurations of resources that shape us as we shape them. Consistent with Normann's view of service (value-creating systems with us inside), this textbook provides a clear map of the world of service for today's students and practitioners while also providing a sky crane for scholars and entrepreneurs actively engaged in reconstructing this constantly changing landscape.

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<sup>1</sup>Richard Normann. *Reframing Business: When the Map Changes the Landscape*. Wiley, 2001.

In Chap. 1 Foundations, this textbook answers the question of why everyone should consider becoming a student of service. Simply put, we all live in a service-oriented society. The economic significance and technological sophistication of diverse types of service, which make up our service-oriented society, should be understood by students of management and engineering as well as those in the liberal arts and humanities, because together we co-create service systems. By the end of the chapter, students will arrive at a deeper understanding of service as transformation processes involving resources from both provider and customer.

Chapter 2 Electronic Services will appeal especially to students of computer science and information systems (informatics). Service progress is shaped by the desire of people to automate activities and evolve better programming paradigms that augment human intellect unlocking new levels of productivity and creativity. Web service technologies, cloud services, and the Internet of services enable the automation of activities (human labor outsourced to technology) and use of powerful programming paradigms (augmentation and amplification of human intellect with technology).

Chapter 3 Service Innovation is the chapter that entrepreneurial students and those interested in creating the next world-changing service may decide to use as an entry point. Also students of innovation and technology management can find concepts and tools in this chapter to systematically explore a variety of innovation frameworks. Context maps, Janus cones, value curves, business model canvas, and other techniques are introduced and clearly illustrated. This chapter also provides insights regarding servitization as an innovation process that manufacturing firms can use to shift from commodity products to higher-value service offerings and solutions.

Chapter 4 Service Design may be the chapter where liberal arts and humanities students want to begin their journey. Methods such as stakeholder maps, persona, customer journey maps, service blueprinting, and other design tools are introduced and clearly illustrated. Service design as a process that is human-centric, interactive, holistic, and iterative and makes use of prototypes is introduced.

Chapter 5 Service Semantics will resonate with students of computer science and information systems who wish to understand the cutting edge of technologies reshaping the service landscape today. Linked USDL is a service description language built with Semantic Web Technologies. APIs (Application Programming Interfaces) from Twitter, LinkedIn, Google, YouTube, Facebook, Dropbox, Instagram, Wordpress, and Lastfm are introduced as contributing to the rapidly growing API economy. The combinatorial possibilities for creating new service offerings continue to grow.

Chapter 6 Service Analytics may be the chapter where students interested in some of the hottest new jobs want to begin their service journey. Data as a resource is still largely untapped, even though it continues to grow exponentially. ITIL (Information Technology Infrastructure Library) is introduced, and analytics for extracting insights from incidence management reports can be used to improve service delivery. Cluster analysis and text mining techniques are also presented.

Chapter 7 Service Optimization will appeal especially to students of operations research and operations management. This is the most mathematically demanding of all the chapters and introduces students to tools and techniques for quantitatively modeling service systems and solving for optimal solutions. Classic problems such as bin packing (configuration planning) and the traveling salesman (route planning) are also presented, along with an introduction to queuing theory.

Chapter 8 Service Co-creation is a chapter well crafted for those interested in systems thinking and the way multiple entities interact in service ecosystems. Value propositions, service quality, service productivity, customer relationship management (CRM), business-to-business (B2B) engagements, customer lifetime value, and customer equity are key concepts introduced in this chapter.

Chapter 9 Service Markets brings the student almost full circle, back to where the textbook began examining the service-oriented society in which we all live. However, in this chapter, microeconomics and agent-based computational economics and other tools and techniques for market engineering are introduced. Pricing strategy and service network platforms are also covered.

Chapter 10 Service Research will appeal especially to students of social sciences and those interested in network theory, but also to today's social-media-savvy millennial generation as well as business practitioners interested in social network analysis. Service network analysis and service level engineering are introduced. The opening case cites a Nov. 7, 2013, article in *Forbes* that declares a Twitter user is worth \$100, Facebook's \$98, and LinkedIn's \$93. Well-crafted cases like this one draw the students in and set the stage for learning about technical tools and methods.

Scholars can use this textbook to learn about other areas of service outside their core area expertise, and they will also appreciate the carefully selected additional readings and extensive references that accompany each of the chapters. By providing these detailed references, the textbook provides a map of the world of service to both students in college and students of service who may be practitioners in business or governments, as well as scholars who need to grasp fundamentals outside their home academic discipline. Furthermore, each chapter begins with a summary and set of learning objectives, as well as a case, that link clearly to the review section, key terms, exercises, and questions at the end, reinforcing the set of concepts and methods that each chapter covers.

In sum, this comprehensive new college-level textbook provides a clear and concise introduction to service-oriented ways of thinking for undergraduate students across the spectrum of academic disciplines. While appealing perhaps most strongly to computer science and information systems (informatics) students, the textbook makes clear that diverse teams will be needed to build and manage tomorrow's service systems. The cases and projects will likely be most useful when discussed and undertaken by multidisciplinary teams of students that include computer science and information systems (informatics) students, as well as students of management, engineering, operations, liberal arts, design, humanities, social sciences, and other areas of academic study. In this sense, the textbook provides a common ground to engage students across the academic spectrum, encouraging students to become more T-shaped with both depth in their academic major as well as

boundary-spanning breadth to communicate with others, and all the while prepare them well for real-world teamwork in business, government, and society.

This textbook is one that I have been waiting for, and KSRI team is to be congratulated!

IBM Almaden Research Center  
San Jose, CA, USA  
April 6, 2015

Jim Spohrer



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# Preface

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## What Is This Book About?

In the last three decades, the world economic landscape has changed at a fast pace shifting from manufacturing to the provision of services. In fact, the service sector is the strongest economic industry of most modern nations, and it is also rapidly becoming an important sector in developing countries. As a result, the interest on services has grown and has originated an emerging and much needed field coined service science.

But what is service science? In very simple terms it is the study of service systems and services. This new field of science started in 2004 as a movement towards making services a first-class discipline. Service systems are structures configured with people, technology, organizations, and information. Services are instances of service systems which typically cause a transformation of the state of an entity resulting from the contractual agreement between a service provider and a service customer.

The typical example of this progression towards services is the concept and model known as *software as a service* such as Google Mail and Microsoft Office 365. The software (product) does not shift anymore in ownership. The provider has ownership and is responsible for its maintenance, upgrades, and repair. The customer has access to the leased product available as a service and pays a fee for its use. Since the service sector is amazingly varied, many other examples exist from transportation and distribution services, utilities and city planning services, and banking and insurance services to computer, legal, and consulting services.

The study of service systems is multidisciplinary and interdisciplinary and draws on concepts, theories, methods, and tools from a number of existing areas such as innovation, design, computer science, information systems, operations research, marketing and business, and economics with the main objective of creating an integrated, coherent, and consistent body of knowledge.

## Why Is This Textbook Necessary?

One key element of service systems is their nature, focusing not merely on one particular characteristic of a service but rather considering a system of interacting elements (parts) which include:

- People skills and competencies
- Organizational structures encompassing business models
- Technologies supporting mobile and electronic services
- Information, knowledge, and analytics to deliver intelligent services

Studying these basic elements and the principles that interconnect them provides a body of knowledge underlying service systems. Furthermore, understanding how service systems can be created, designed, analyzed, and commercialized is yet another challenge for service experts. Nonetheless, current approaches for studying service systems—at an academic and professional levels—vary from organization to organization. In practice, *informal*, *ad hoc*, and *disconnected* methods are often used. For example, it is not uncommon to find professionals creating their own languages, techniques, architectures, and graphical representations.

Thus, the integrated knowledge provided by this textbook is indispensable to foster a new wave of future professionals to think in a service-focused way with the right balance of competencies in computer science, engineering, and management.

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## Who Should Read This Textbook?

The concepts presented in this textbook are precious for organizations, practitioners, researchers, and students who need to move towards new, innovative business models that rely on services as a source of new opportunities for generating value and driving a higher customer experience. The material explored, while not exhaustive, enables to train T-shaped professionals who must have a deeply developed specialty area (e.g., business management or computer science) as well as a broad set of skills and capabilities in the field of services (e.g., service design and optimization).

The intended audience of this book is twofold. For researchers, teachers, and students who want to learn about this new emerging science, this textbook provides an overview of the core disciplines underlying the study of service systems. It is aimed at students of information systems, information technology, and business and economics. It also targets business and IT practitioners, especially those who are looking for better ways of innovating, designing, modeling, analyzing, and optimizing service systems.

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## Book Content

This textbook is a centerpiece of a course syllabus on service systems. It provides a source of information and insights on a subject that was not properly covered by existing bibliography. It brings together in one place ten relevant subjects.

- Chapter 1. Foundations** What are services? Why are they becoming increasingly important for society? What is a service system? How are they structured? How do they contrast with goods?
- Chapter 2. Electronic Services** Which developments enabled the evolution of services into electronic services? What different types of electronic services exist? Which technologies are available for their implementation?
- Chapter 3. Service Innovation** What is service innovation? Which available methods support projects for new services development?
- Chapter 4. Service Design** How is service design related to service innovation? Which known methods and techniques are available to design services?
- Chapter 5. Service Semantics** How to enrich the description of electronic services with semantic knowledge? What are the benefits for service providers?
- Chapter 6. Service Analytics** How can the wealth of data generated by services be used for analysis? Which main tasks and methods are available?
- Chapter 7. Service Optimization** Which mathematical models can be used to solve planning problems arising in the area of services? Which tools can be used to assist engineers?
- Chapter 8. Service Co-creation** What is value co-creation, service encounters, service quality, and service productivity? Which methods can be used to manage them?
- Chapter 9. Service Markets** How can service systems be commercialized? Which methods enable the creation of competitive service markets? Which frameworks exist to model markets?
- Chapter 10. Service Research** What is the importance of recent research streams, such as service network analysis and service level engineering, for service systems? Why are service networks important for an interconnected world?

Each chapter includes a summary, a list of learning objectives, an opening case, and a review section with questions, a project description, a list of key terms, and a list of further reading bibliography. All these elements enable students to learn at a faster and more comfortable pace.

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## Suggested Course Structure

The guiding principle in writing this textbook was to make its content on service systems suitable for several contexts.

**Service engineering** This textbook is a central reference for a degree on service engineering since it brings under one umbrella several fields which contribute in one way or the other to the development of services with a superior quality.

**Computer science** will benefit from new insights from service innovation, design, semantics, analytics, and optimization to implement superiorly engineered electronic services such as Web or cloud services.

**Industrial engineering** will benefit from principles and methods to design services and approaches to analyze and optimize services.

**Operations management** can explore the fields of service design, service analytics, and service optimization for overseeing, controlling, and improving the process of production and redesign of services.

**Service design** naturally benefit from service innovation and service design but can also benefit from service co-creation and service markets to understand the synergies between all the stakeholders involved in service provisioning.

**Marketing engineering** can capitalize on service markets and co-creation chapters to understand organizational control systems such as sales force management systems and customer relationship management tools.

Table 1 shows how various degrees and courses benefit from the textbook.

**Table 1** Coverage of the chapters (●, full; ◐, partial; ○, optional)

Course	Foundations (Ch 1)	Electronic services (Ch 2)	Innovation (Ch 3)	Design (Ch 4)	Semantics (Ch 5)	Analytics (Ch 6)	Optimization (Ch 7)	Co-creation (Ch 8)	Markets (Ch 9)	Research (Ch 10)
Service engineering	●	●	●	●	●	●	●	●	●	●
Computer science	●	●	◐	◐	●	●	●	○	○	●
Industrial engineering	●	●	◐	◐	○	●	●	◐	◐	●
Operations management	●	●	◐	◐	◐	●	●	●	●	●
Service design	●	●	●	○	○	◐	◐	●	●	○
Marketing engineering	●	●	◐	◐	○	○	○	●	●	○

## Website Companion

This textbook has a companion website. It provides additional material to help lecturers use the text in their teaching and help students to deepen their understanding. The website is accessible at:

- <http://www.fundamentals-of-service-systems.org>

## Acknowledgments

The writing of this manuscript has been an extensive and stimulating expedition and led to a new view on service systems. It was idealized by Jorge Cardoso during his research stay at the Karlsruhe Institute of Technology (KIT) in Germany and driven in close collaboration with Hansjörg Fromm, together with their coeditors Stefan Nickel, Gerhard Satzger, Rudi Studer, and Christof Weinhardt, all affiliated with the Karlsruhe Service Research Institute (KSRI) at KIT.

This textbook has involved an extensive collective effort of a group of professionals and researchers that spread over more than 20 months. Coordination, self-motivation, inspiration, knowledge, meetings, discussions, phone calls, e-mails, and many slides were all indispensable ingredients in its conception. Contributing experts are identified in each chapter.

While listing all the people with whom we had at some point interacted would be an almost impossible task without forgetting someone, we would like to thank the ones that were closer to us and that reviewed and provided valuable feedback for each chapter:

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Rama Akkiraju <i>IBM Almaden Research Center, USA</i>	Chapter 5
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François Habryn <i>IBM Global Technology Services, Switzerland</i>	Chapter 6
Boris Amberg <i>FZI Forschungszentrum Informatik, Germany</i>	Chapter 7
Stephen K. Kwan <i>San José State University, USA</i>	Chapter 8
Steven Kimbrough <i>University of Pennsylvania, USA</i>	Chapter 9
Barbara Pernici <i>Politecnico di Milano, Italy</i>	Chapter 10

## About the Editors



**Prof. Dr. Jorge Cardoso** joined the Information System Group at the University of Coimbra in 2009. Since 2015, he is Lead Architect for Cloud Computing at Huawei's European Research Centre (ERC) in Munich. In 2013 and 2014, he was a Guest Professor at the Karlsruhe Institute of Technology (KIT) and a Fellow at the Technical University of Dresden (TU Dresden), respectively. Previously, he worked for major companies such as SAP Research (Germany) on the Internet of services and the Boeing Company in Seattle (USA) on Enterprise Application Integration. Since 2013, he is the Vice-Chair of the KEYSTONE COST Action, a EU research network bringing together more than 70 researchers from 26 countries. He has a Ph.D. in Computer Science from the University of Georgia (USA).



**Prof. Dr.-Ing. Hansjörg Fromm** studied computer science and mathematics and received his Ph.D. in 1982 from the University of Erlangen-Nürnberg. After a research assignment at the IBM Watson Research Center, Yorktown Heights, New York, he joined IBM Germany, where he had different management positions

in Software Development, Manufacturing Research, and Business Consulting, and received the title of an IBM Distinguished Engineer. From 2006 to 2010 he was the European Director of the IBM Center for Business Optimization (CBO). From 2011 to 2014, Prof. Fromm was a director at the Karlsruhe Service Research Institute (KSRI). After his retirement, he is still active as an honorary professor at the Karlsruhe Institute of Technology and the University of Erlangen-Nürnberg.



**Prof. Dr. Stefan Nickel** obtained his Ph.D. in Mathematics at the Technical University of Kaiserslautern, Germany, in 1995. From 1995 to 2003 he was assistant and then Associate Professor in mathematics at the Technical University of Kaiserslautern. After a Full Professor position at Saarland University (Chair of Operations Research and Logistics) from 2003 to 2009, he became one of the directors of the Institute for Operations Research at the KIT in April 2009. In 2011, he became director at Forschungszentrum Informatik (FZI) and Karlsruhe Service Research Institute (KSRI). His research focuses on location planning, area planning, health care, and online optimization. He has coordinated the Health Care Working Group within the German OR society (GOR) and was president of the GOR.



**Prof. Dr. Gerhard Satzger** leads the research group “Service Innovation and Management” at KSRI focusing on designing novel data-based services and business models. He holds a diploma in Business Engineering from the University of Karlsruhe and an MBA from Oregon State University, as well as a Ph.D. in Information Systems (University of Gießen) and a postdoctoral lecturer qualification in business administration (University of Augsburg). Simultaneously, he has pursued an industry career with IBM since 1989 – among others serving as CFO for IBM’s Global Technology Services business in Central Europe (2002–2007), and as Head of IBM Business Performance Services Europe (2011–2014). He built up the KSRI as an industry-on-campus concept 2008–2011 and returned to KSRI as a director in 2014.



**Prof. Dr. Rudi Studer** is Full Professor in Applied Informatics at the Karlsruhe Institute of Technology (KIT), Institute AIFB. In addition, he is director at the Karlsruhe Service Research Institute (KSRI) as well as at the FZI Research Center for Information Technology. His research interests include knowledge management,



Semantic Web technologies and applications, data and text mining, big data, and service science. He obtained a Diploma in Computer Science at the University of Stuttgart in 1975. In 1982 he was awarded a Doctor's Degree in Informatics at the University of Stuttgart, and in 1985 he obtained his Habilitation in Informatics at the University of Stuttgart. From 1985 to 1989 he was project leader and manager at the Scientific Center of IBM Germany.



**Prof. Dr. Christof Weinhardt** is heading the Institute of Information Management and Systems (IISM) at KIT. He is member of the board of directors at the Research Center for Information Technologies in Karlsruhe (FZI). Since its foundation, Prof. Weinhardt is director at KSRI, heading the research group Information and Market Engineering. Christof Weinhardt received his Diploma in Business Engineering and his Ph.D. in Economics in 1989 at Universität Karlsruhe. Until 1994, he was an Assistant Professor at the University of Giessen. He then was assigned chair of the Department for Quantitative Methods in Business Administration at the University of Bielefeld. In 1995, he became Full Professor and head of the Department for Information Systems, University of Giessen.



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# Contents

<b>Foreword</b> .....	v
<b>Preface</b> .....	ix
<b>1 Foundations</b> .....	1
Hansjörg Fromm and Jorge Cardoso	
<b>2 Electronic Services</b> .....	33
Jorge Cardoso and Hansjörg Fromm	
<b>3 Service Innovation</b> .....	75
Marc Kohler, Björn Schmitz, and Andreas Neus	
<b>4 Service Design</b> .....	105
Niels Feldmann and Jorge Cardoso	
<b>5 Service Semantics</b> .....	137
Steffen Stadtmüller, Jorge Cardoso, and Martin Junghans	
<b>6 Service Analytics</b> .....	179
Jorge Cardoso, Julia Hoxha, and Hansjörg Fromm	
<b>7 Service Optimization</b> .....	217
Melanie Reuter-Oppermann and Anne Zander	
<b>8 Service Co-creation</b> .....	261
Johannes Kunze von Bischoffshausen, Peter Hottum, and Tim Straub	
<b>9 Service Markets</b> .....	297
Simon Caton, Christian Haas, Wibke Michalk, and Christof Weinhardt	
<b>10 Service Research</b> .....	325
Jorge Cardoso, Björn Schmitz, and Axel Kieninger	
<b>Index</b> .....	359