SERVICE SYSTEMS MANAGEMENT AND ENGINEERING

Creating Strategic Differentiation and Operational Excellence

C. M. CHANG

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Service Systems Management and Engineering

Dedicated to my loving family, wife Birdie Shiao-Ching,
son Andrew Liang Ping, son Nelson Liang An,
daughter-in-law Michele Ming Xiu, and grandson Spencer Bo-Jun.

Preface

INTRODUCTION

The U.S. government is forecasting significant growth rates for the U.S. service sectors over the next few decades. According to the U.S. Bureau of Labor Statistics, in 2008 service-providing industries made up 77.2 percent of total employment in the United States. This percentage is projected to increase to 78.96 percent by 2018, including the impact of the general economic recession of 2007 to 2009. It asserts that the overall growth of the service sectors is to continue its upward trend going forward.

Service systems engineering, which employs scientific and engineering principles to add value to service sectors, is a relatively new field, A specific case of service systems engineering is the efficient application of computer-IT-related technologies and the proper management of teams, projects, and processes involved in achieving productivity, time-to-market, convenience, and value-added benefits to customers.

Services require a higher degree of customization and are less amendable to mass production than products. NSF has initiated a large-scale research program to support new research activities in the emerging field of service systems engineering. It is quite likely that, in view of the significant manpower demand projected for the service sectors, schools will also start to participate in training future systems engineers for the service sectors.

The service company objectives, systems view of service enterprises, T-professionals, SSME-12 skills, and unique strategy of text design will be discussed next.

SERVICE COMPANY OBJECTIVES

Companies in the service sector need to pursue both strategic differentiation and operational excellence in order to enlarge and sustain long-term profitability.

Strategic differentiation is essential for companies to create and maintain market competitiveness in the form of differentiable service packages. Market competitiveness must be built on service innovations as well as on customer orientation. Service systems engineers need to become well versed in creating innovations that are both desired and required by customers. Specific thinking strategies are discussed in Chapter 12, "Innovations in Services," to promote the generation of new ideas and concepts in service environments. Besides training in creative thinking, students need to be exposed to marketing management, financial analysis, and cost accounting so that they can make strategic choices in order to realize long-term competitive advantages in the marketplace and attain sustainable profitability for their employers.

Operational excellence is also important, as service-providing employers need to develop, produce, distribute, and support their service packages at low cost, high efficiency, and competitive speed. Systems engineers need to learn methods to cut waste,

streamline operations, and invigorate productivity of their operations. They need to be exposed to engineering management principles related to planning, organizing, leading, and controlling. Tools advanced in industrial engineering, such as Lean Six Sigma, value stream mapping, DMAIC methodology, 5 S, optimization, and others can be readily applied to add value to service organizations. In addition, service companies can also achieve cost savings and productivity enhancement by using software modules based on Service-Oriented Architecture (SOA) to perform its noncore activities, as well as utilizing Web-based enabler programs.

For systems engineers to contribute effectively to the important corporate goals of achieving strategic differentiation and operation excellence, they need to exercise their leadership skills in envisioning the future. They would benefit greatly from being exposed to the current "best practices" in the service industries. Many of these "best practices" will be introduced throughout the text. The motto to be instilled in graduates is "constantly searching out best practices and then superseding them." Successful systems engineers and leaders must also be able to "think globally and act locally."

THE SYSTEM-INTEGRATIVE VIEW

When educating future service leaders, we agree with Gosling and Mintzberg (2004) that we need to focus on wisdom, as well as knowledge, in order to emphasize the capacity to combine knowledge from different sources and apply this knowledge judiciously. Educators need to emphasize the systems view, including thoughtful reflection and exposure to alternative ways of thinking in order to augment their students' understanding of the world.

Systems approach—the study of and reactions to the interconnectivity and interactions between functionally related components of a complex enterprise system—applies well to today's service systems. According to Norton (2000), systems engineering should be a required course in every business school and executive program as today's business needs are met through a management framework.

By taking a system-integrative view, knowledge workers would be able to see a panoramic view of the forest; mountains beyond and blue sky above, instead of only the individual trees. These workers would recognize the components in a system, the roles played by them, the interactions between them, and the synergy produced that adds value above and beyond the sum of the individual parts.

This conceptual framework is supported by Section 1106 of the National Competitiveness Investment Act, which Congress passed on August 2, 2007 (U.S. Congress HR 2272-2007). In this section, *service science* is defined as:

> Curricula, training, and research programs that are designed to teach individuals to apply scientific, engineering, and management disciplines that integrate elements of computer science, operations research, industrial engineering, business strategy, management sciences, and social and legal sciences, in order to encourage innovation in how organizations create value for customers and shareholders that could not be achieved through such disciplines working in isolation.

Clearly embodied in this definition are the concepts of (1) systems engineering perspectives, (2) application orientation, instead of only focusing on academic research, (3) integrating multiple knowledge domains to bring about innovations, and (4) value creation emphasis to benefit customers and stakeholders.

From the perspective of the service enterprises, it is evident that they are indeed complex business systems, composed of a number of discrete and multidisciplinary components that interact with one another. Systems thinking is of critical importance (Boardman and Sauser 2008). Service leaders of tomorrow need to adopt a systems view about their enterprises, so that attention is paid to all functional units in order to assure success in the marketplace. Figure 1.7 illustrates some typical functional units in a service enterprise.

Science is a very important component in this business system. Science enables great contributions in the form of new types of services, new ways of delivering services, and new ways of supporting customers. Spohrer and Maglio (2010) offer a comprehensive discussion on several aspects of service science. However, science is just one of many contributors to the success of a service enterprise. Thus, we prefer to call SSME *Service Systems, Management and Engineering* (as opposed to Service Science, Management and Engineering) to recognize the important roles that a variety of other disciplines contribute to the success of this business system.

It is known that certain academic programs are said to have failed to impart useful skills, prepare effective leaders, instill norms of ethical behaviors, and lead graduates to good corporate jobs, because of their misplaced emphasis on academic rigor of scientific research (Schoemaker 2008), instead of focusing on the graduates' competency and understanding of the important drivers of business performance (Bennis and O'Toole 2005). We believe that educating future service leaders with a systems view, which is valid from both academic and relevance standpoints, would avoid falling into the same trap.

According to Chesbrough and Spohrer (2006), universities should develop curricula and advocate research that is focused on (1) business models, (2) productivity, (3) quality of life, and (4) competition and innovations through services. Universities should adopt a multidisciplinary approach involving disciplines such as business, engineering, information technology, computer science, and the social sciences. The research required to meet these goals must be mission oriented and application focused.

The rapidly changing environment of today's global economy calls for people capable of holistic thinking, balancing analysis and intuition, living with ambiguity, and practicing strategic flexibility. The skills and capabilities the students of today acquire need to be practical and relevant.

For SSME graduates, relevance is far more important than scientific rigor, so that they are prepared to deal with the messy ambiguities of the real world. This text emphasizes this practical relevance.

T-PROFESSIONALS

As suggested by Maglio et al. (2006), knowledge workers in services should have an in-depth understanding of a particular field (e.g., business, engineering, computer science, psychology, or anthropology), the vertical part of the T. They also need to have a fundamental understanding of service economy issues, core disciplines that interact

with their core knowledge to solve world problems, and the ability to see applications across industries for their knowledge (the horizontal part of the T). In addition, they need to possess broad perspectives and collaborative skills to manage teams, projects, programs, and interact with other professionals. The specific objective of this text is to prepare service engineers to acquire the horizontal part of the T-personality.

The aim of this text is to enable service systems engineers to become much more valuable to service industries by emphasizing broadened perspectives and the knowledge and skills required to strengthen the horizontal part of the T. This text has the potential for educating service systems engineers of any technical background (e.g., industrial engineering, business consulting, information/computation, health science, and other fields). Furthermore, the proposed text could be used by professionals with technological specialty trainings to intensify their marketability and potential value to service enterprises.

Knowledge workers in service sectors must be ready to contribute in two specific ways: strategic differentiation and operational excellence. Both are important, as indicated by Chang (2007):

> *T-shaped professionals need to be capable of creating strategic differentiation and operational excellence for their service employers. Strategic differentiation emphasizes the creation of novel service packages that lead to increased sales revenues. It involves strategy formulation, marketing, design, innovation and supply chains management. Operational excellence, on the other hand, focuses on achieving short-term improvements in processes that leads to lowered cost of services sold. It emphasizes productivity, measurements, quality, operations, human resource management, engineering and computing. T-shape professionals are thus required to become familiar with the principles and methodologies of visioning the future and leading cross-functional teams to bring about breakthrough innovations needed in the marketplace, as well as, applying proven engineering technologies and other tools to achieve gains in productivity, efficiency, quality and cost.*

This text, along with a number of engineering/technological courses, provides the preparation needed to accomplish these goals.

SSME-12 SKILLS

A key strategy of this text is to address the skills and capabilities deemed essential to service system engineers. SSME-12 skills are composed of two groups of skills and capabilities. The first group was suggested by Sorby et al. (2006), comprising twenty-four specific skills important to B.S. engineers in the service industry. These twenty-four skills may be organized into the following six categories:

1. Management of service systems
2. Operations of service systems
3. Service processes
4. Business management

5. Analytical skills
6. Interpersonal skills

In a 2009 report, the Carnegie Foundation for the Advancement of Teaching emphasized critical thinking, problem solving, teamwork, and a multidisciplinary approach. Choudaha (2008) suggested a list of required skills and attitudes for master's degree graduates, based on an online Delphi study. This list includes integration, collaboration, adaptability, critical thinking, interpersonal competence, problem solving, system conceptualization, and diversity orientation. Some of these skills are similar to those identified by Sorby et al. (2006).

For service systems engineers at the master's degree level, I have added the following six groups of skills and capabilities to round out the twelve skill sets:

7. Knowledge management
8. Creativity and innovations in services
9. Financial and cost analysis and management
10. Marketing management
11. Ethics and integrity
12. Global orientation (thinking globally and acting locally)

These twelve categories of skills and capabilities constitute the SSME-12 skills, which, in turn, fully encompass the eleven attributes specified by National Academy of Engineering to be important for Engineers of 2020:

1. Strong analytical skills
2. Practical Ingenuity
3. Creativity
4. Communication
5. Business and management
6. Leadership
7. High ethical standards
8. Professionalism
9. Dynamism
10. Agility, resilience, and flexibility
11. Life-long learning

This text is focused on training students in the SSME-12 skills by using a set of systematically assembled and properly designed class examples, class problems, application notes, specific assignments, and supplemental readings. Many of these skills and capabilities will be illustrated in the text. Business cases and best practices are used throughout to further promote the intellectual exchanges between instructors and students. The objective is to make sure that the students will not only be able to think strategically, make decisions rationally, and execute effectively, but also keep up with innovations in learning. This new text is expected to be of general use to all service systems engineers, regardless of the specific service sectors they elect to enter.

UNIQUE STRATEGY OF TEXT DESIGN

The primary objective of this text is to ready readers to contribute toward the needs of service sector companies in strategic differentiation and operational excellence. The text is designed to prepare students to lead service systems teams, projects, technologies, or programs in a knowledge economy within competitive global environments.

The preparation of this text follows the proven *Three-Decker Leadership-Building Architecture* of our awarding winning text: C. M. Chang, *Engineering Management: Challenges in the New Millennium* (Upper Saddle River, NJ: Prentice Hall, 2005), which has been adopted by more than twenty U.S. universities and numerous international schools, as well as being translated into the Korean language.

The new chapters in this text include: "Introduction to SSME," "Innovations in Services," "Knowledge Management," and "Operational Excellence." Other chapters such as "Globalization," "Service Systems Engineers as Leader," "Ethics," and "Marketing Management" have been significantly revised to include service-based examples, problems, and business cases.

A large number of service-related business cases are contained in the text-end Appendix. These cases cover various service sectors and address diversified SSME issues. They represent a useful extension of the exercise problems listed at the end of each chapter.

By using a set of systematically assembled and properly designed class examples, class problems, application notes, specific assignments, and supplemental readings, selected skills and capabilities are incorporated in the relevant chapters.

This book is organized in three parts. Part I reviews the functions of engineering management. Chapters 2 through 5 are entitled "Planning," "Organizing," "Leading," and "Controlling." Part II covers the business management fundamentals, Chapters 6 through 8, which include "Cost Accounting and Control," "Financial Accounting and Management," and "Marketing Management." Part III addresses the service leadership in the new millennium and contains Chapters 9 through 14: "Service Systems Engineers as Managers and Leaders," "Ethics," "Knowledge Management," "Innovations in Services," "Operational Excellence," and "Globalization." The text-end Appendix includes more than thirty selected business cases. Figure 1.11 illustrates the current Three-Decker Leadership-Building Architecture, which forms the basis of this text design.

This book is suitable for use as a text for two 3-credit graduate courses in 15-week semesters, when selected business cases are added. It may also be used as text for one 3-credit graduate course in a 15-week semester in the absence of case studies, as well as for an elective course at the senior undergraduate level. It could be part of the required core courses in a typical master's degree program centered on service systems management and engineering (SSME), which needs to be effective yet flexible, as the service industry is composed of numerous divergent sectors, such as professional and business consulting, transportation, distribution and logistics, healthcare, IT services, financial services, entertainment, education, government, and others. A sample curriculum for such a master's degree program might include the following three-credit courses:

1. Required courses: SSME-1 and SSME-2 (based on this text).
2. Four more required courses form the core, and are selected from the following: (a) Six Sigma Quality in Services, (b) Supply Chain Management and Global Operations, (c) Services-Oriented Architecture and Web Services,

(d) Data Mining in Services, (e) Innovations in Services, (f) Project Management, (g) E-commerce Technology, (h) Technical Communications, and (i) others.

3. Three elective courses are to be selected from a broader list of service sector–specific courses in order to better customize the degree program to the needs of individual students: (a) Critical Issues in Healthcare, (b) Linear Programming and Optimization, (c) Process Simulation and Control, (d) Advanced Marketing, (e) Consumer Behavior, (f) Knowledge Management, (g) Operations Management, (h) Logistics, (i) Stochastic Methods, and (j) others.
4. One capstone project, which is to emphasize the application of SSME course knowledge and skills to add measurable value to a service organization.

This curriculum, designed in the spirit of the T-personality, not only enables graduates to understand the requirements necessary to be successful within any given service enterprise but also imparts the necessary technological background for the actual implementation of this learning.

In summary, this text aims to equip the future service systems engineers and leaders of tomorrow with the necessary knowledge and skills to achieve strategic differentiation and operational excellence in the growing service sector market.

REFERENCES

Bennis, Warren G., and James O'Toole. 2005. "How Business Schools Lost Their Way." *Harvard Business Review* (May).

Boardman, John and Brian Sauser. 2008. *Systems Thinking: Coping with 21st Century Problems.* Boca Raton, FL: CRC Press.

Choudaha, Rahul. 2008. "Competency-based Curriculum for a Master's Program in Service Science Management and Engineering: An Online Delphi Study." Doctoral Dissertation, University of Denver, Denver, Colorado.

Chesbrough H., and Jim Spohrer. 2006. "A Research Manifesto for Service Science." *Communications of the ACM* 49 (7): 35–41.

Chang, C. M. 2007. "Contributed Comments to IBM-Cambridge Symposium entitled "Succeeding through Service Innovation."" July 2007, University of Cambridge, Cambridge, England. URL: /www.ifm.eng.cam.ac.uk/ssme/comments/business.html#carl-chang

Gosling, Jonathan, and Henry Mintzberg. 2004. "The Education of Practicing Managers," *MIT Sloan Management Review* 45 (4): (Summer).

Heftly, Bill, and Wendy Murphy, eds. 2008. "Systems Engineering." In *Service Science Management and Engineering—Education for the 21st Century.* New York: Springer.

Maglio, P. P., S. Srnivasan, J. T. Kreulin, and J. Spohrer. 2006. "Service Systems, Service Scientists, SSME and Innovation." *Communications of the ACM* 49 (7): 81–85.

Norton, David P. 2000. "Is Management Finally Ready for the Systems Approach?" Harvard Business School Balance Scorecard Report, Article Reprint No. B0009E.

Schoemaker, Paul J. H. 2008. "The Future Challenges of Business: Rethinking Management Education." *California Management Review* 50 (3): (Spring).

Sorby, Sheryl A., Leonard J. Bohmann, Tom Drummer, Jim Frendewey, Dana Johnson, Kris Mattlia, John Sutherland, and Robert Warrington. 2008. *Defining a Curriculum for Service.* Houghton: Michigan Technological University.

Spohrer, Jim and P. P. Maglio. 2010. "Service Science: Toward a Smarter Planet," Chapter 1 in Salvendy, Gavriel and Waldemar Karwowski (Eds), *Introduction to Service Engineering*. John Wiley (January).

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I want also to express my appreciation for an excellent opportunity to serve as a member of a departmental committee, which was charged to design a new master's degree program in service systems engineering (SSE) during the period of November 2006 to August 2007. For a short period of time in 2007, I also served as the director of this new master's degree program. Because of these activities, I was highly motivated to scan, collect, and study a vast amount of service, engineering, and business literature, which subsequently enabled me to modify quite a few sections in the first two parts and new service-centered chapters to the third part of this Three-Decker Leadership-Building Architecture. These new chapters include Chapter 9, "Service Systems Engineers as Managers and Leaders," Chapter 11, "Knowledge Management," Chapter 12, "Innovations in Services," and Chapter 13, "Operational Excellence." During the ensuring semesters, I was able to test-teach all these new and modified chapters.

Various example problems in the current text came from the test problems and business cases used in two graduate courses I taught on engineering management for SSE. The *combinatorial, heuristic and normatively guided* method of producing innovative ideas was tested in about twenty team projects, each of which was conducted in multiple rounds with graduate students as team participants. During the same period of time, I directed all capstone projects of all students enrolled in this master's degree program in SSE. Many of these capstone projects, which were sponsored by industrial firms, contributed to the discussions contained in the current text. I appreciate the valuable inputs many of the SSE graduate students have made, which have enhanced the usefulness of this text enormously.

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