PART I

INTRODUCTION

CHAPTER 1

SERVICE SCIENCE: TOWARD A SMARTER PLANET

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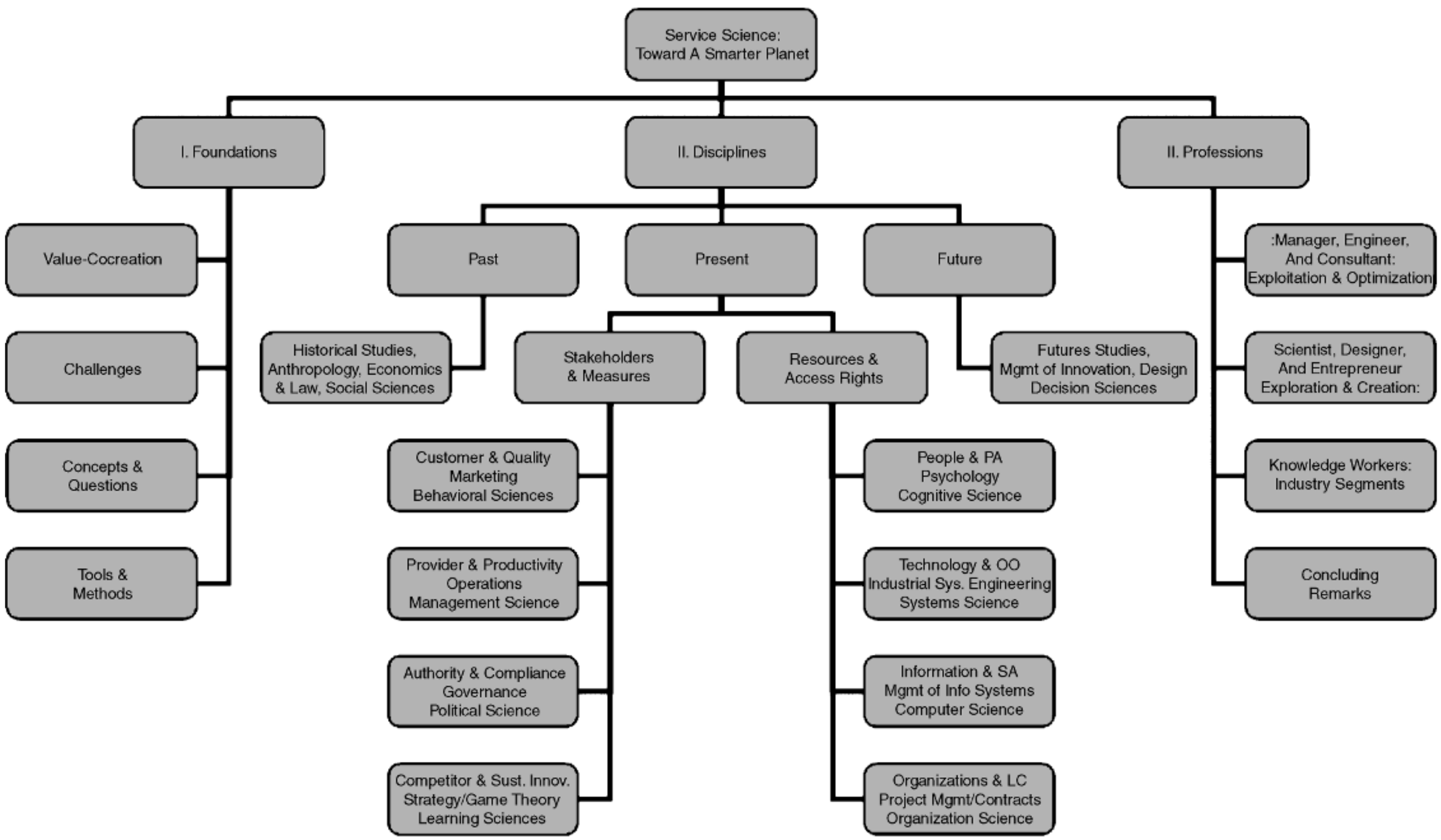
Foundations

Service science is short for *service science, management, engineering, and design*, also known as SSMED. It began as a "call to action," focusing academics, businesses, and governments on the need for research and education in areas related to service (Chesbrough, 2004; IBM, 2005). After all, the service sector (as traditionally measured) has grown to be the largest share of gross domestic product and employment for all major industrialized countries (Spohrer and Maglio, 2008). Service science has grown into a global initiative involving hundreds of organizations and thousands of people who have begun to create service innovation roadmaps and to invest in expanding the body of knowledge about service systems and networks (IfM and IBM, 2008).[1]

But exactly what counts as *service science*? Simply put, service science aims to explain and improve interactions in which multiple entities work together to achieve win–win outcomes or mutual benefits (Spohrer and Maglio, 2008). More precisely, we define service as *value cocreation*, value as change that people prefer, and value cocreation as a change or set of related changes that people prefer and realize as a result of their communication, planning, or other purposeful and knowledge-intensive interactions. Science is the agreed upon methods and standards of rigor used by a community to develop a body of knowledge that accounts for observable phenomenon with conceptual frameworks, theories, models, and laws that can be both empirically tested and applied (Kuhn, 1962). So service science seeks to create a body of knowledge that accounts for value cocreation between entities as they interact—to describe, explain, and (perhaps someday) better predict, control, and guide the evolution of value-cocreation phenomena.

Previously, we described many problems and concepts related to service science (e.g., Maglio et al., 2006; Chesbrough and Spohrer, 2006; Spohrer et al., 2007). Here, we start to put together a more comprehensive picture. Figure 1.1 illustrates the organization of this

FIGURE 1.1 ORGANIZATION OF THIS PAPER.

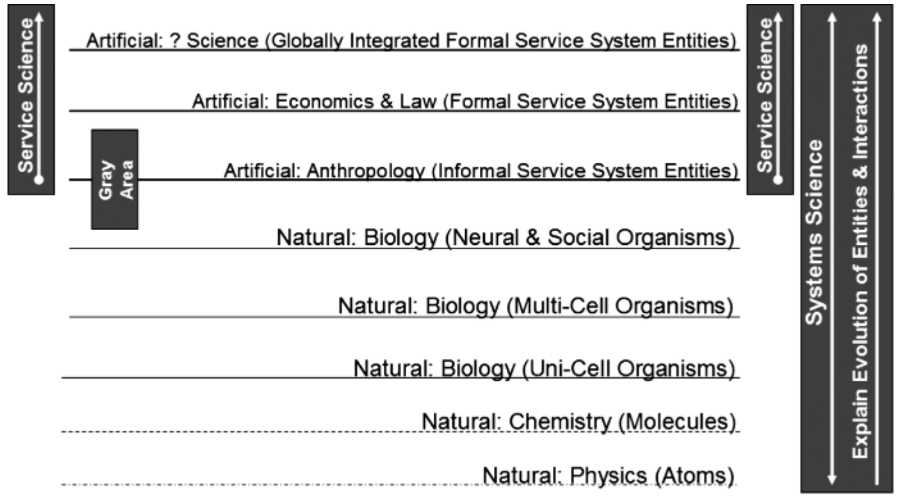


paper. This first section introduces the challenges faced by the service-science initiative, as well as the foundational concepts, questions, tools, and methods of service science. The second section provides an overview of the many existing academic disciplines that service science both draws on (without replacing!) and contributes to. These disciplines can be organized around the coevolution of entities and their interactions; past, present, and future possibilities are all relevant. The final section discusses existing professions and the ways a service scientist can both integrate and contribute to job roles across industries. Service science is on a path to become a new scientific degree area as well as a new liberal arts or professional science degree in conjunction with other degree programs. Someday service science will be a useful scientific foundation for management, engineering, design, arts, and other types of degrees, and it will also be useful to entrepreneurs and business consultants.

Value Cocreation

Service science is a specialization of systems science (see Figure 1.2). Systems scientists seek to explain the evolution of hierarchically complex systems (systems of systems) through time. Systems science addresses both the natural world and the artificial world. Service science deals primarily with the relatively recent artificial world—the human-made world—that results directly or indirectly from conscious, purposeful, knowledge-intensive activities (Simon, 1996).[2] Both the natural world and the artificial world can be physically real, for example, the Great Lakes are part of the natural world, and Lake Mead, which was created by the Hoover Dam, is part of the artificial world. The last ice age was part of the natural world, and global warming is part of the artificial world.

FIGURE 1.2 SERVICE SCIENCE IS A SPECIALIZATION OF SYSTEMS SCIENCE THAT STUDIES VALUE COCREATION IN THE ARTIFICIAL (HUMAN-MADE) WORLD.



For our purposes, the human-made world can be thought of through three stages of evolution: from informal service-system entities (local clan, hundreds to thousands interacting) to formal service-system entities (written national laws, thousands to millions interacting) to the globally integrated formal service-system entities of today (global technology, millions to billions interacting). In a nutshell, the increasing sophistication of systems in the artificial world, including the amount of knowledge they use and the sophistication of their technological and organizational augmentations, creates the need for service science to better understand the value-cocreation phenomena that sustains and catalyzes more service-system developments. Though it may be viewed as a specialization of systems science, service science must integrate across many disciplines that already study aspects of the artificial world of interacting service-system entities. Service interactions are increasingly mediated by markets governed by written laws and global technology systems (Friedman, 2008; Cortada, 2006).

Value-cocreation phenomena are both a mundane and a profound aspect of our artificial world. A simple act of collaboration, such as an exchange of favors or the keeping of a promise, can be an example of mundane value cocreation. A simple act of competition, such as playing a game of chess, can be an example of mundane value cocreation, benefiting the junior player to learn and benefiting the senior player to validate a performance ranking. However, the concepts of collaboration, competition, and coordination do not do justice to standardized or societal-scale patterns of value-cocreation phenomena. Money (universal medium of exchange), rights (universal rule of law), and literacy (universal education) are three of the most profound service-enabling innovations ever made. And each tremendously expanded opportunities for value-cocreation interactions. Biologists, computer scientists, economists, anthropologists, and others have written about the evolution of collaboration, competition, and coordination in social systems (Seabright, 2005; Beinhocker, 2006; Buchanan, 2007). The full range of value-cocreation phenomena, which include diverse innovations such as lotteries, installment-payment plans (see Appendix Two), insurance, taxation, tithing, advertising, leasing, and others, has not been fully mapped or well understood. One especially important branch of value-cocreation phenomena deals with dispute-resolution or governance mechanisms, such as auctions, elections, periodic tournaments, pecking orders, competitive rankings, and reputation systems. Value-cocreation phenomena may be the most powerful force shaping the evolution of the human-made world in which we live. The wealth of examples of value-cocreation phenomena that surrounds us provides a solid base for an empirical science of our artificial world.

Challenges

Attempts at large-scale value cocreation (service) can fail catastrophically for many reasons. Two recent reminders of service failure are hurricane Katrina (emergency response services) and the subprime mortgage meltdown (global finance services). As the people, businesses, and nations of the world become more interconnected and interdependent (globally integrated), the ecology of interacting service systems and networks has become increasingly complex and difficult to manage. Understanding service phenomena and associated risks and rewards of different types systems and networks, as well as their modes of interaction, is becoming increasingly critical. The need to understand, manage, engineer, and design/imagine better service systems and networks requires that a more rigorous scientific foundation be established.

Computer-aided design (CAD) is routine practice in building bridges, buildings, airplanes, cars, and computers, but everyday businesses and governments invest billions to transform existing service systems without the benefit of such tools and methods.

For the first time in human history more than 50 percent (and growing) of the world's population lives in urban regions or cities (United Nations, 2007), creating complex webs of daily service interactions. Less than 40 percent (and shrinking) is involved in agriculture or living directly off the land (International Labour Organization, 2008), with its different intensity, types of relationships, and timescales of service interactions. Today, most people work in and depend on businesses and governments to provide jobs and provision service for their survival as customers and citizens. In this world of complex service systems and networks, new concerns arise. For example, in *Supercapitalism*, Robert Reich (2007) writes about the transformation of business, democracy, and everyday life, and an emerging conflict of interest between people as citizens and people as employees and customers: "Companies are not citizens. They are bundles of contracts. The purpose of companies is to play the economic game as aggressively as possible. The challenge for us as citizens is to stop them from setting the rules" (page 14). The social, technological, economic, environmental, and political systems that people are part of and within which they play multiple overlapping roles have become increasingly interconnected and interdependent. As a result, the potential for value cocreation and the risk of catastrophic service failure have never been higher.

As an emerging academic discipline, service science faces at least three major challenges, which can be summarized as "too much, too little, too soon." First, service science is not a merger of two disciplines, but a quest for a holistic integrative discipline. What could possibly integrate diverse disciplines such as economics and law, marketing, operations research, management sciences, industrial and systems engineering, computer science, management of information systems, social sciences, management of technology and innovation, financial engineering, and more? Therefore, some will say that there is too much here for a single coherent discipline. The first section of this paper attempts to show that there is in fact a coherent integration by using a systems approach and identifying ten foundational concepts. Service science is less general than systems science, but borrows heavily from it. Second, service science seeks to add value to many existing disciplines through a focus on value cocreation (i.e., service) and on the dynamic configurations of resources (what we call *service-system entities*) that create value when arranged into systems with other such configurations of resources (*service systems*). Therefore, some will say that there is too little here to warrant a separate discipline; service science is just a shift in focus or case examples in many existing disciplines. The second section of this paper attempts to connect service science with more than a dozen existing disciplines, and to demonstrate that it is more than just a shift in focus—that it is a reconceptualization of disciplines as service-system entities and networks evolving. Service science begins the process of rationalizing discipline structure and interconnections. Third, the emerging profession associated with service science will critically depend on a tool that probably cannot be built for at least another decade. Therefore, some will say that both the emerging discipline and profession are simply premature—too soon to become established. The first section provides some background to understand this tool, and the third section describes six existing professions that will communicate better based on development of this tool. As we will see, these three challenges—too much, too little, too soon—are exactly the challenges one would expect in an emerging 21st-century discipline. It is our view that the evolution and design of our globally integrated (interconnected) enterprises and institutions have been shaped to favor or enhance value-cocreation interactions, which are the essence of service phenomena, and to limit other types of nonservice interactions, which destroy value, create waste and instabilities, and damage the environment.

Concepts and Questions

A systems approach models the world in terms of entities, interactions, and outcomes (Weinberg, 1975). In the context of service, *service-system entities* are dynamic configurations of resources, which include people, businesses, hospitals, universities, nations, online communities, and the like. In fact, the four primary types of resources are people, organizations, shared information, and technology (Spohrer, Maglio, Bailey, and Gruhl, 2007), and there are many ways to put these parts together. For example, an individual person can function as a service-system entity in the context of other people and organizations (e.g., my wife and children, my employer, my nation), shared information (e.g., my native language), and technology (e.g., my personal property, and shared access to a physical environment). As a service-system entity, a person is not just the flesh-and-blood part, but the whole constellation of resources that can be mobilized to create value in the context of others. Complexity arises in part from the fact that a service-system entity can fill multiple roles in multiple service systems simultaneously. The combinatorial possibilities for value cocreation (e.g., multi-tasking in multiple roles) and for hazards (e.g., cascade failures in service networks) can skyrocket quickly.

Imagine two entities interacting and the set of possible outcomes that might result. Two people might be talking, trying to decide what movie to see. Or two companies might be negotiating, trying to come to an agreement about how to work together. Of all the possibilities, both entities might prefer certain outcomes. There might be one movie two people can agree on. There might be a set of joint projects that are in the mutual interests of two companies. We call these preferred outcomes the *value-cocreation subset*. Service science is the study of value cocreation, of entities seeking value cocreation outcomes from interactions among entities that cocreate value, and so on. There are two basic perspectives we can take: (1) evolution—describe and explain the specific types of entities, interactions, and outcomes that have arisen over time; and (2) design—predict and control the continuous improvement of entities, interactions, and outcomes over time.

Marketing was one of the first business disciplines to examine service from a positive perspective (Berry, 1980). Recently, Vargo and Lusch (2004) proposed a service-dominant logic for marketing, which considers service—rather than goods production—as primary economic activity. We think this new worldview is an important foundation for service science (Maglio and Spohrer, 2008; see also Appendix One). Its first fundamental premise is that service is the fundamental basis of exchange. Because people (and other economic and social actors) specialize in particular knowledge and particular skills, exchange is required. And the more a society depends on specialization, the more exchange is required. For example, one individual may specialize in farming and another in fishing, so when vegetables are exchanged for fish, what is really being exchanged is application of farming knowledge and skills for the application of fishing knowledge and skills. When a person buys a car or a computer, he or she is really buying specialized knowledge and capabilities that went into the creation of the car or the computer. Simply defined, service is the application of competences (knowledge and skill) for the benefit of another entity. This is the heart of value cocreation.

Concepts. To begin to understand the diversity and complexity of value cocreation, we formulated ten foundational concepts: ecology, entities, interactions (networks), outcomes, value proposition-based interactions, governance mechanism-based interactions, stakeholders, measures, resources, and access rights (see also Spohrer and Kwan, 2009). We describe each in turn.

- *Ecology*: At the highest level, service-system ecology is the population of all types of service-system entities that interact over time to create outcomes. Types of service-system entities include individuals (people) and collectives (organizations). History is the trace of all outcomes over time for all entities that interact.
- *Entities*: Service-system entities are dynamic configurations of resources. As described below, resources include people, organizations, shared information, and technology (Spohrer et al., 2007). These four types of resources can be combined in many ways. In all service-system entities, at least one of the resources (the *focal resource*) has access, either directly or indirectly, to all the other resources in its configuration. Formal service-system entities are named entities, often with legal rights (such as a corporation), and ultimately the focal resource must be a person or group of people in some authoritative or formal role relative to the other resources (such as the chief executive officer and board of directors). Informal service systems may not have legal rights, and the focal resource may simply be a person or group of people with an idea (shared information), such as the tentative name and purpose of a new company. The journey from idea to informal service system to formal service system is an important one in business.
- *Interactions (networks)*: Patterns of interaction give rise to service-system networks. The interactions occur between and among a set of service-system entities over time. Recognizable patterns of interactions (networks) are commonly known as *business models*. The simplest service-system network is a customer and a provider connected by a single value proposition. More complex service-system networks include multiple stakeholders, comprising a provider, and one or more customers, competitors, and authorities, as well as all the value propositions that connect these entities and other satellite stakeholders (criminals, victims, etc.).
- *Outcomes*: From game theory, two player games have four possible outcomes: win–win, lose–lose, win–lose, and lose–win. Win–win, or, more correctly, benefit–benefit, is the desired outcome of service-system interactions. Taking a broader service-science perspective, we proposed ten possible outcomes via the Interact-Service-Propose-Agree-Realize (ISPAR) model, based in part on the four-stakeholder view: customer, provider, authority, and competitor (Maglio, Vargo, Caswell and Spohrer, 2009).
- *Value proposition-based interactions (individuals)*: Individual entities try to interact with other entities via value propositions. Normatively, service-system entities interact to maximize short-term and long-term value cocreation. They do this by communicating and agreeing to value propositions, which they reason about and refine through trial-and-error and other mechanisms. For example, informal promises between people, contracts between businesses, and treaties or trade agreements between nations are all examples of value

proposition-based interactions. Value determination is entity-dependent, history-dependent, and context-dependent. A good value proposition connects the key performance indicator (KPI) measures of two service-system entities in a mutually reinforcing manner, creating measurable value cocreation as interactions occur over time. Borrowing and repaying with interest, installment payment plans, compound interest on deposits, and leasing are all examples of value proposition based interactions, and one type of value-cocreation phenomena.

- *Governance mechanism-based interactions (collective)*: This is a type of value-cocreation interaction, often invoked by authorities or by an injured party as a remedy when value is not being created as mutually agreed, or when service-system entities interact in non-normative ways. Authorities are one of the few types of service-system entities that can use coercion in a value-proposition-based interaction (“Pay your taxes or go to jail”). Criminal entities may use coercion (“Your money or your life”), but they do not have the authority to do so (by definition). Auctions, voting, binding arbitration, and courts are all also examples of dispute-resolution interactions or governance mechanisms.
- *Stakeholders*: All service-system entities can view themselves and be viewed by others from multiple stakeholder perspectives. There are four main types of stakeholder perspectives: customer, provider, authority, and competitor. From a provider’s perspective, a good value proposition is one that is in demand (customers need or want it, and do not prefer self service), unique (only the provider can perform it), legal (no disputes with authority, and will pass all audits), and superior (once competitors know about it, they cannot propose anything better, but may try to copy it, given enough time). Other stakeholder perspectives include criminal, victim, and many others.
- *Measures*: The four types of measures include quality (customer determines), productivity (provider determines), compliance (authority determines), and sustainable innovation (competitor determines). Service-system entities often have associated KPIs that must be improved to create value. So value cocreation can occur when the KPIs of two or more service-system entities become linked in ways that improve the KPIs together. Estimating the quantitative or qualitative values of KPIs and communicating these measures to others are fundamental competences of service-system entities.
- *Resources*: Every named thing is a resource. For our purposes, there are four types of resources: physical-with-rights (people), physical-with-no-rights (technology, environment), nonphysical-with-rights (businesses, nations, universities), nonphysical-with-no-rights (information). All resources have a lifecycle: a beginning, middle, and end. All nonphysical resources exist as localized or distributed patterns in the physical states of physical resources, and are subject to coding errors (imperfect patterns or interpretations). The *variety* of a resource describes all possible states of that resource. When two resources interact, variety can either increase or decrease depending on the nature of the interaction.
- *Access rights*: Resources have associated access rights. A resource can be owned outright (such as a car that is paid for), be leased or contracted (such as limousine and driver), have shared access (such as the language we speak), or have privileged access (such as one’s own thoughts).

Questions. The two fundamental questions that service science must address are the fundamental questions of any science: How did we get here (describe and explain) and where are we going (predict and control)? Science tries to understand the essence of things, including how they change over time. From a service-science perspective, the diversity of resources, service-system entities that configure resources, and value propositions that interconnect with others are all of fundamental importance. How did the observed diversity of value-cocreation phenomena come into being and where might each instance evolve over time?

As in structuration theory (Giddens, 1986), service science adopts an evolutionary perspective, that structure (resources and service-system entities) and action (interactions, both value cocreation and governance) constrain each other in a coevolving way. The world begins via simple resource interactions and over time more complex resources and interactions result, ultimately leading to physical symbol system (Newell, 1980) interactions (entities with symbol manipulation and communication abilities), leading to informal service-system interactions (behavioral norms), and then to formal service-system interactions (institutional laws). Structures and actions that enhance value cocreation become self-reinforcing (Wright, 2000). Service density increases as structures and actions create and use more resources and maintain high degrees of adaptive resource liquidity (Normann, 2001). Resources that are not fully utilized provide opportunities. Potential resources—those that have not yet been created—also provide opportunities.

The two fundamental questions (how did we get here and where are we going) lead to a practical question for individuals, businesses, and nations, and for service-system entities in general: How can we best invest locally to improve things globally? In practice, this quickly becomes how best to invest to cocreate the future with others. History reveals a mostly tacit or reactive investment strategy by individual entities, as well as unpredictable consequences of those investments (Sterman, 2000). In contrast, consider the explicit investment in semiconductors to achieve the promise of Moore's law (transistors on a chip doubling roughly every two years). For almost half a century, the semiconductor industry has invested to improve capabilities according to this investment roadmap. For example, if the number of transistors on a chip were a KPI for the semiconductor industry, that industry has made good progress investing to improve that KPI year over year (Cortada, 2006). What would an investment law for service-system improvement and service network improvement be like? Is such a law even possible?

The practical service-science question is about investment to improve KPIs of service-system entities. Often this question becomes how to invest to improve KPIs continuously year over year, as with Moore's law. This leads to additional practical questions: How well do we know the most important KPIs of customers and providers? How does one invest in KPIs in a way that does not simply boost up local performance while dragging down global performance? How can one invest while minimizing unintended consequences on other KPIs? How can we effectively evolve new KPIs over time? For example, "carbon footprint of a business process" has recently become a KPI, as global warming and sustainable business practices have become important societal issues (Diamond, 2005). Most KPIs derive from capacity constraints on some resource within a service-system entity. Complexities occur when a constraint is not an internal constraint, but either an external or interface constraint (Ricketts, 2008). When the constraint is external or an interface constraint, then the investment requires relationships and coordinated investment (interdependence): How does one entity invest time, money, reputation, and other resources to achieve the best balance between healthy and productive short-term and long-term relationships with other entities?

Nearly all KPI improvements (e.g., business goals) can be reformulated as investing in creating, sustaining, transforming, and ending a relationship with another entity (Vickers, 1995). For example, if revenue growth or market-share growth is a high-level goal, then mergers and acquisitions may be a component of the improvement process. If profit margin growth is a high-level KPI of a large conglomerate, then divestitures and spin-offs may be a component of the improvement process. Value cocreation can result from investment in organizational fusion (mergers and acquisitions) and fission (divestitures and spin-outs), which usually change the identities and relationships between entities.

Tools and Methods

Tools and methods to create and improve service systems fall into two generations of approaches so far: process-based approach and stakeholder-network-based approach. A third-generation approach, an ecology-based approach, is under development, but will take time to develop and mature.

The first-generation or process-based approach to service creation and improvement includes variants of service blueprinting (Bitner, Ostrom, and Morgan, 2008). In service blueprinting, customer and provider interactions are mapped out over time. Service blueprinting is related to use-case methods used by software engineers (Jacobson, 1992), business process modeling used by business consultants (McKenna, 2006), and document engineering used by information architects (Glushko and McGrath, 2005). These approaches have been developed and refined over the years to be compatible with lean and six sigma methods as well (Womack and Jones, 2005). The tools often help the designer understand what is front stage (visible to the customer) and backstage (invisible to the customer), and the different types of optimizations available to both (Glushko and Tabas, 2009). In addition, a number of tools for modeling and simulating processes are available, some with capabilities that allow queues to be visualized and design variations to be compared based on various experience measures and key performance indicators (see Rockwell Automation's Arena tool for strategic maintenance solutions, etc.). Process-based approaches for creating new service offerings or businesses use adjacent activity methods (Slywotzsky et al., 2003).

The second-generation or stakeholder-network-based approach to service creation and improvement includes variants of network mapping. Network mapping or service-system network analysis begins by enumerating all stakeholders, possibly many customer–provider pairs in extended networks, and then identifies as-is problems and to-be benefits for each stakeholder (Svendsen and Laberge, 2007). Another variation is service responsibility tables (SRT) used in work system and service-system design (Alter, 2007). Systems engineering begins by creating a mission and requirements analysis for all stakeholder systems, and then performing back-chaining and dependency analysis to create an optimal project plan to create or transform the interconnected service systems (Grady, 2006). Value nets, another stakeholder-network-based approach, are used by consultants to map and then to transform complex organizations or industry networks (Allee, 2002). Stakeholder-network-based approaches often use systems dynamic modeling and simulations to evaluate alternative designs (Sterman, 2000). Stakeholder-network-based approaches for creating new service offerings or businesses use ''blue ocean'' and complementor methods (Kim and Mauborgne, 2005).

The third-generation or ecology-based approach is the most ambitious, and is still under development. As the world becomes more interconnected and interdependent, the density of service (and nonservice) interactions among all stakeholders is increasing. When everything affects everything (within a few degrees of separation), an ecology-based approach becomes necessary to look for and understand unintended consequences of local optimizations that do not translate to global improvement (Ricketts, 2008). Component business modeling of all industries, mapping out all functions and associated KPIs, with service oriented architecture views (technology systems) and process views (that include types of workers and their work practices) is an ambitious undertaking, but one that is underway (Sanz et al., 2006).

Ultimately, the ecology-based approach must model nations, businesses, online platforms, cities, families, and people—all the major types of service-system entities. Though this is a massive undertaking, it is important to realize that about two thirds of the world's population resides in just the twenty largest nations (according to statistics available at NationMaster.com, the top twenty nations by total population size include over four billion people), an estimated one quarter of all goods and services are provisioned in just the 150 cities with the largest GDPs (over 16 trillion dollars GDP in the top 150 cities)[3], and over half of the worldwide gross domestic product (GDP) is concentrated in just 2000 publicly traded companies (see Forbes Global 2000 list). Add to this list the largest privately held firms, largest online Web communities, and venture-backed companies, and a quite comprehensive service-system ecology model can be approximated. Existing weather simulations and resource depletion simulations are already being used by insurance companies (HPC Wire, 2007). Though it is impossible to predict the future, these ecology-based approaches focus on world model fidelity and year-over-year variance reduction. Many events are not predictable, but can be anticipated (e.g., earthquakes in California, hurricanes in Florida, business cycles, investment bubbles, recessions, depressions, wars, resource depletions, pandemics, commoditization, and certain technological capability improvements).

Disciplines

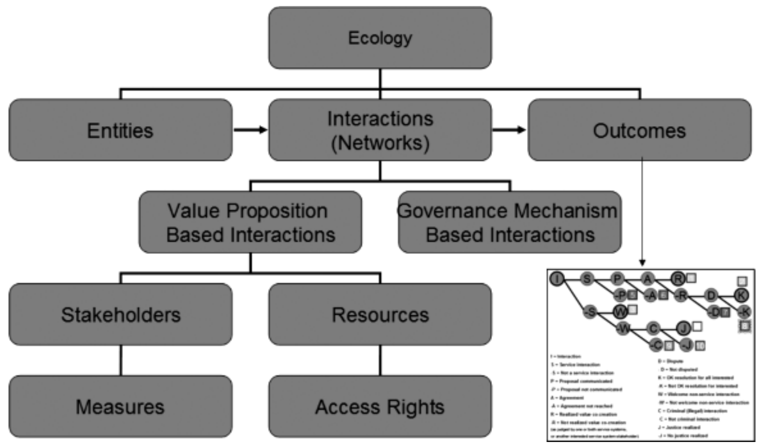
In this section, we relate our ten foundational service-science concepts (summarized in Figure 1.3) to concepts in existing academic disciplines. Three main discipline clusters examine the history, present, and possible futures of our human-made service-system ecology.

Past

Table 1.1 provides an overview of the discipline cluster relevant to understanding the history of economic, social, technological, political, and legal evolution. These disciplines, or the historical specializations of these disciplines, seek to understand the types of entities and interactions that existed in the past and how they evolved into what we see today.

From an economic perspective, rational entities should seek value-cocreation outcomes. Economics explains why value cocreation is so frequently a possibility when service-system entities interact. In contrast, law exists in part because value cocreation is not the only possible outcome when entities interact. The law spells out both the non-value-cocreation

FIGURE 1.3 TEN FOUNDATIONAL CONCEPTS OF SERVICE SCIENCE.



interactions and their consequences (sanctions or punishments). A successful society creates abundant shared-access resources, but society members must promise to obey the laws to have access to those resources. Members must also strive to keep their promises to each other, and societies have informal and formal dispute-resolution mechanisms to enforce civility and contracts. But law and associated judiciary and enforcement systems are costly. A major contribution of law to service science is that law explains how the productive capacity of a service-system network can sometimes be improved more by adopting the right law (shared information in a high compliance society) rather than even the invention of a breakthrough technology. In short, law can be very economical.

Do all human interactions create value? No. Some actions might make us better off, but others worse off; some actions that make us better off in some ways, but worse off in others; some actions might make us better off in the short term, but worse off in the long term. Sometimes we cannot know all the consequences of our actions; sometimes actions are taken based on assumptions about ourselves, others, or the world that are not valid or just uncertain;

TABLE 1.1 DISCIPLINES RELATED TO HISTORICAL PATTERNS OF SERVICE-SYSTEM EVOLUTION.

History	Learning to Balance	Informal	Formal	Disruptive Innovation
1a. Economics/social sciences	Individual value propositions based	Gift giving	Markets	Money
1b. Law and political science	Collective governance mechanisms based	Norms and sanctions	Courts	Written law

sometimes actions we indirectly cause through technologies or other arrangements are not directly under our control. Some interactions begin as service interactions, but over time become routine and abbreviated, continuing as habits or rituals though their original reasons (value cocreation) are no longer valid.

Specialization has the advantage of positively reinforcing comparative advantage. Today, people, businesses, and nations have created enormous interdependencies as division of labor, specialization, and scale economics have driven wealth creation. Just two hundred years ago, the majority of people on the planet were engaged in agriculture or other extractive activities, depending on their local environmental resources for survival (personal independence), rather than global trade, supply chains, and risk hedging (social interdependence). Technological and organizational advances have taken service interactions and interdependencies to a whole new level in the last two hundred years.

Today the most complex type of service-system entities that work to balance independence and interdependence are nations. The risk of being too independent is the risk of falling behind those nations that have worked out better scale economics (and learning rates) through cooperation, focused competition, and interdependence. The risk of being too interdependent is the risk of being negatively affected by relationship problems or other problems associated with the partners' fluctuating productive capacity and developmental path. Businesses, which are another type of service-system entity, face the independence and interdependence challenge when they make outsourcing or insourcing decisions, and decide which is more strategically important—to tightly control or to see a commodity become potentially available to their competitors as well. Individuals, a third type of service-system entity, must also balance independence and interdependence in their decision making. So balancing dependence happens between nations, businesses, and individual people, all engaged in service or value-cocreation activities.

Friedman (2008) places the challenge of balancing independence and interdependence in the contexts of evolving methods of collaboration that work for higher and higher density human populations. Before human populations existed on all continents as they do today, people could seek more independence by moving to a new region of unpopulated land. Regional migration effectively insulated a group from unwanted interactions or interdependencies. When moving away was no longer an option, new mechanisms for high-density living evolved. The nature of routine interactions was changed by increasingly formal moral systems (written laws in a standard language) and market mechanisms (impersonal markets with standard prices). The evolving nature of technology also plays a major role in allowing higher-density human populations and changing the nature of interactions between individuals, businesses, nations, and other types of service-system entities.

Present

Table 1.2 provides an overview of the discipline clusters relevant to modeling the present-day service-system ecology. These disciplines, or the analytic specializations of these disciplines, seek to understand both the types of stakeholders and measures, as well as the types of resources and access rights that matter (see Spohrer and Kwan, 2009, for detailed descriptions of the disciplines in this cluster).

TABLE 1.2 DISCIPLINES RELATED TO PRESENT ANALYSIS OF SERVICE-SYSTEM ECOLOGY.

	Stakeholders			
Present	**Perspective**	**Question**	**Pricing**	**Measures**
2. Marketing and behavioral science	Customer	Should we offer it?	Value-based	Quality
3. Operations and management science	Provider	Can we deliver it?	Cost-plus	Productivity
4. Governance and political science	Authority	May we offer and deliver it?	Regulated	Compliance
5. Strategy and learning science	Competitor	Will we invest to make it so?	Strategic	Sustainable innovation
	Resources Type	**Is physical?**	**Has rights?**	**Access Rights**
6. Psychology and cognitive science	People	Yes	Yes	Privileged access (PA)
7. Industrial and systems engineering	Technology	Yes	No	Owned outright (OO)
8. Computer and information sciences	Shared Information	No	No	Shared access (SA)
9. Organizational management and design	Organizations	No	Yes	Leased/contract (LC)

Future

Table 1.3 provides an overview of the discipline cluster relevant to future studies—to planning, designing, and investing to create the future service-system ecology. These disciplines seek to understand the types of service-system entities and interactions that might possibly exist.

TABLE 1.3 DISCIPLINES RELATED TO FUTURE POSSIBILITIES OF SERVICE-SYSTEM ECOLOGY.

Future	Learning to Balance	Identify	Focus	Invest to Improve
10a. Project management	Exploitation (network)	Constraining resource	Challenges and knowns	Present entities and interaction
10b. Innovation management	Exploration (ecology)	Environmental change	Opportunities and unknowns	Future entities and interactions

March (1991) identifies the main decision that all systems capable of learning, including service systems, must make: how much to invest in exploitation of existing knowledge and how much to invest in exploration to discover new knowledge. If the environment is stable, then exploitation can achieve high returns, but if the environment is changing rapidly, then it is unlikely that existing knowledge will yield high returns without constant exploration.

Professions

Like academic disciplines, the dynamics of professions are part of the artificial world, of our service-system ecology. In fact, division of labor is a primary mechanism for value cocreation in the system of professions (Abbott, 1988). Two aspects of profession formation are (1) what the profession owns, typically some core body of knowledge or technology that allows an important problem or set of problems to be solved, and (2) how the profession establishes and maintains boundaries with related professions.

As our service-system ecology evolves over time, people specialize in a great variety of professions. Some professions are primarily concerned with exploiting (optimally using) the stores of accumulated knowledge (managers, engineers, consultants), others are more focused on creating new knowledge, experience, or businesses (scientists, designers, entrepreneurs), and both these groups and others exist within an evolving structure of industries where capabilities and standards change over time. Every person in a profession can be viewed as part of a service system, whether an informal service system or a formal service system (e.g., a member of a professional association).

Service scientists lay claim to the body of knowledge associated with the human-made or artificial world, and with how entities and interactions evolve over time. Many social scientists, including historical economists, political scientists, and anthropologists, also lay claim to this same area. Service scientists differ because they focus mainly on value-cocreation interactions. Service scientists can draw on decades of research into service from multiple disciplinary perspectives: marketing, operations, management, computing, and more. Service scientists need methods and tools to understand and design service systems and service-system ecologies. As mentioned, a kind of service ecology CAD tool will very likely be essential to service scientists. We can imagine such a CAD tool being used to model the history and evolution of entities and interactions over time, and to represent existing service systems and mechanisms for transforming and developing them over time. Not unlike the way software technology has provided a touchstone for computer scientists, the service-system ecology CAD tool will be a touchstone for service scientists.

In the remainder of this section, we consider the three clusters of professions and their relationships to service scientists. The first cluster includes managers, engineers, and consultants; the second includes scientists, designers, and entrepreneurs; and the third comprises knowledge workers across all industries that make up a modern national economy.

Managers, Engineers, Consultants

The job of improving or scaling (either up or down) service-system entities, especially businesses and other types of enterprises, often falls to managers, engineers, and consultants.

The rise of the managerial profession is well documented by Chandler (1977). Professional managers improve succession planning when no qualified family member or relative of the owner can be found to work in the business. Professional managers also allow businesses to grow much larger than would be possible within a family owned and operated enterprise. However, most importantly, professional managers are able to lower the transaction costs for many types of value-cocreation interactions. Professional managers can not only oversee processes, but they can improve them and adapt them as business conditions change. Managers in many industries have become increasingly technical and specialized, and their modeling and planning tools have begun to look more and more like the tools of engineers.

Like professional managers, professional engineers have expanded rapidly as a percentage of the professional population over the last two hundred years. Table 1.4 provides a summary of the rise of engineering, notably about one new engineering discipline per decade. We indicate a specific year based on the formation of professional associations.

Table 1.5 shows the conceptual relationship of these emerging disciplines to some fields of science and mathematics.

As engineering disciplines have become more diverse and complex, the scientific fields on which they draw are increasingly those integrated by service science, including complexity and system dynamics. Again, the tools of managers and engineers can be seen to be aligning around the entities and interactions that are part of a globally integrated service-system

TABLE 1.4 ENGINEERING DISCIPLINES AND ASSOCIATED PROFESSIONAL ASSOCIATIONS.

Year	Engineering Discipline	Association	Artifacts and Industries
Antiquity	Military	DoD	Cannons, tactics, supply chain
1852	Civil	ASCE	Roads, bridges, buildings
1880	Mechanical	ASME	Steam engines, machinery
1884	Electrical	AIEE/IEEE	Generators, grid, appliances
1907	Agricultural and biology	ASAE/ASABE	Crops, orchards
1908	Chemical	AICE	Fertilizers, fuels, compounds
1948	Industrial and systems	ASIE/IIE	Factories, conveyors
1948	Computing machinery	ACM	Computers, info tech (IT)
1954	Nuclear	ANS	Reactors
1955	Environmental	AAEE	Sustainable construction
1963	Aerospace	AIAA	Jets, rockets
1968	Biomedical	BMES	Medical instruments
1985	Genetic technology	AGT	Bacteria, plants, animals
1992	Financial	IAFE	Derivatives, options
1993	Software	JCESEP	Applications, web sites
2007	Service systems	SRII/SSMED	Healthcare, B2B IT Consulting

TABLE 1.5 ENGINEERING DISCIPLINES AND ASSOCIATED AREAS OF SCIENCE.

Year	Engineering Discipline	Science	Fields + Mathematics
Antiquity	Military	All	Ballistics, metallurgy
1852	Civil	Physics	Mechanics, materials
1880	Mechanical	Physics	Mechanics, materials
1884	Electrical	Physics	Electromagnetism (EM)
1907	Agricultural and bio	Biology	Cellular mechanisms
1908	Chemical	Chemistry	Thermodynamics (TD)
1948	Industrial and systems	Systems	Operations Research (OR), CSD
1948	Computing machinery	Physics/logic	EM, OR, CSD, algorithms
1954	Nuclear	Physics	Nuclear
1955	Environmental	Systems	Complexity/System Dynamics (CSD)
1963	Aerospace	Physics	Fluid dynamics
1968	Biomedical	Systems	Sensors, EM, TD
1985	Genetic technology	Biology/chemistry	Genetics
1992	Financial	Economics	Algorithms, Econ, OR, CSD
1993	Software	Logic	Psych, Social, Econ, OR, CSD
2007	Service systems	Systems	Psych, Social, Econ, OR, CSD

ecology. This is not true for all areas of engineering, but it is true for a growing number, especially those associated more with the artificial world and less with the natural world.

The rise of the consulting profession is well documented by McKenna (2006). What is striking in the rise of consulting is the growing use of technical knowledge and tools. The business and technology gap is closing as managers, engineers, and consultants converge on better modeling and planning tools and methods.

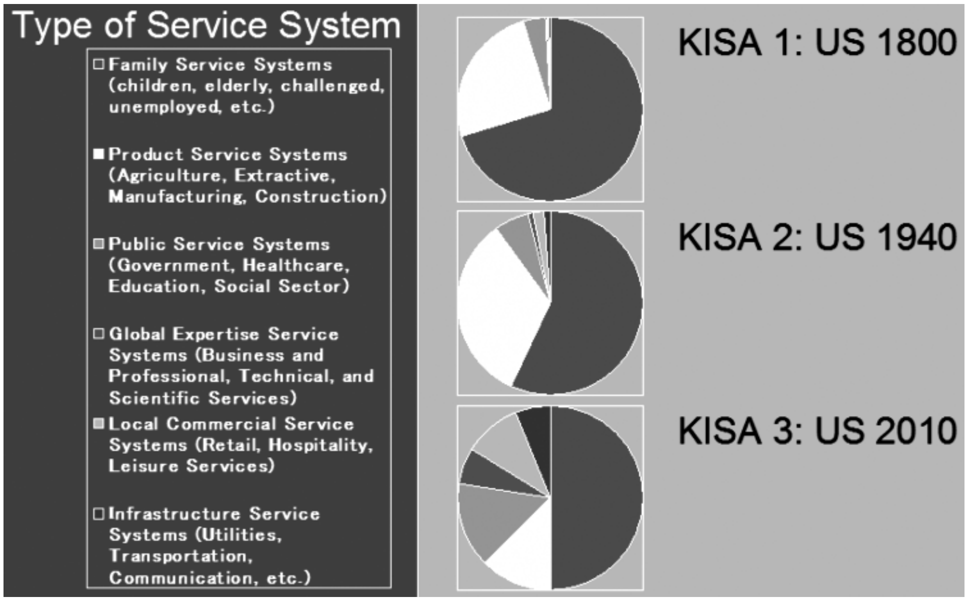
Scientists, Designers, and Entrepreneurs

Scientists, designers, and entrepreneurs are often responsible for technical and business innovations. They work with managers, engineers, and consultants to create new service-system entities and new modes of interactions, both value-proposition-based and governance-mechanism-based. Scientists, designers, and entrepreneurs must remain open-minded to the possibilities of the future, for if they are successful, they will create new knowledge, experience, or businesses that change the course of service-system ecology evolution.

Knowledge Workers

Figure 1.4 shows the growth of knowledge-intensive service activities (KISA) in the U.S. economy over the last two hundred years (based on U.S. Bureau of Labor Statistics Historical Employment data)[4]. First, the shrinking family service segment—those not employed—indicates

FIGURE 1.4 PERCENTAGE GROWTH OF POPULATION INVOLVED IN KNOWLEDGE-INTENSIVE SERVICE ACTIVITIES (KISA) BY SEGMENT (TYPE OF SERVICE SYSTEM) IN THE UNITED STATES FROM 1800 TO 2010.



that more of the population has jobs in formal service systems. Legal and educational reforms have allowed more people to be included in formal service-system activities of business, government, and the social sector. Second, the growth of two segments—infrastructure and business services—indicates how these have contributed to the rise of globally integrated formal service-system entities. Third, the decrease agriculture, extractive, manufacturing, and construction services, sometimes called product service systems, indicates order of magnitude improvements in productivity capacity—no other segment has seen such consistent productivity increases over time (Bell, 1973; Cohen and Zysman, 1988; Lewis, 2004).

Concluding Remarks

Service science faces many challenges. It may seem to some that service science is at once too much, too little, and too early. Maybe. But it also seems to us necessary. The human-made world is based on value cocreation. As interconnections among people, organizations, businesses, cities, nations, and whole geographies increase and become more technology dependent, it is critical that we understand how to predict, manage, and control the system effects of this kind of interdependence. On a small scale, service science aims to help design better and more effective value-cocreation interactions, such as individual and business interactions. On a large scale, the rapid growth of knowledge-intensive service activities defines our artificial world, and globally integrated formal service systems are already beginning to create a smarter planet, one that can be improved year over year according to a continuously improving investment roadmap that achieves more with less. To achieve more with less will require better modeling and planning, and a deeper understanding of our service-system ecology, of our artificial world.

Appendix One. Service-Dominant Logic

The service-dominant (S-D) logic for marketing is a worldview (or mindset) relevant in the service-science community (Vargo and Lusch, 2004). The ten foundational premises (FP1-FP10) of S-D Logic are reviewed below in terms of service-science concepts.

(FP1) Service Is the Fundamental Basis of Exchange

Exchange is a type of interaction among entities. People (and other economic and social actors) specialize in particular skills. Specialization means not doing everything needed to live a quality life, and thus exchange is required. The more a society depends on specialization, the more exchange is also required, and thus interdependence grows. For example, one individual may specialize in farming knowledge and another in fishing knowledge, so when vegetables are exchanged for fish, what is really being exchanged is farming knowledge for fishing knowledge. When customers buy cars or computers, they are really buying specialized knowledge (without which the products would not exist). S-D logic defines service as the application of competences (knowledge and skill) for benefit of a party. Thus, service is the fundamental basis of exchange.

(FP2) Indirect Exchange Masks the Fundamental Basis of Exchange

Exchange is a type of interactions among entities. Exchange can be made more efficient, but often efficiency gains come at a cost. For example, over time the exchange process has become increasingly monetized. Barter of thing for thing, or action for action, has been replaced by jobs (actions for money) and purchasing (money for things and actions). Money and goods as well as organizations and networks are vehicles to enhance the efficiency of exchange, but they mask the fundamental service-for-service basis of exchange. Direct service-for-service exchange facilitates shared knowledge and mutual adaptation via direct contact, while indirect exchange can be more efficient, but creates lags or time delays in mutual adaptation. Service-for-service exchange is about direct service-system entity interactions, in which each entity is both a customer and a provider, and mutual adaptation can happen through direct contact. It is easier to update the value propositions in direct exchange than in indirect exchange because of the number of entities and jurisdictions (governing authorities for dispute resolution) that may be involved.

(FP3) Goods Are Distribution Mechanisms for Service Provision

Goods are a type of resource. Well-designed goods incorporate a great deal of knowledge that may be the accumulation of the skills of many service providers over many years. Goods help solve the efficient knowledge-transfer problem. Goods improve the efficiency of service provision (not all the people have to be present as would be the case for direct service-for-service exchange), but again at the cost of (often) creating a time lag between customer and service provider when mutual adaptation or change is required.

(FP4) Operant Resources Are the Fundamental Source of Competitive Advantage

Resources that can be easily transferred or copied cannot be the source of competitive advantage. One type of operant resource, which is a resource that can take action and make a change in the world, is the service-system entity (e.g., people, businesses, government agencies, nonprofit organizations). Service-system entities always include at least one person, and so cannot be easily transferred or copied. Knowledge embedded in people is the most fundamental type of operant resource. However, knowledge encoded as information or technology is more easily copied and transferred. Knowledge embedded in people or distributed in organizations is more difficult to copy, transfer, and combine (e.g., the fact that many mergers and acquisitions fail to create the expected synergy value). Resources that have rights are difficult to copy, transfer, split apart, and combine, while resources that do not have rights are more easily copied, transferred, split apart, and combined. Establishing relationships and value propositions between service-system entities (access rights) is also a type of resource that is not easy to copy or transfer, and thus service-system networks offer competitive advantage, as well.

(FP5) All Economies Are Service Economies

All economies, be they hunter–gatherer, agricultural, manufacturing, or "services," depend on human knowledge application to create benefit—that is, *service*. Because economics, as a science, arose during the transition from agricultural knowledge to manufacturing knowledge, the focus on tangible output, or goods-dominant logic (G-D logic) is understandable, as the service-for-service nature of exchange was masked by indirect exchange, goods, jobs, and money. Manufacturing knowledge certainly existed during the agricultural era, but it was largely custom and more clearly a service, or specialized application of knowledge for the benefit of a party (the customer). Some prefer to call the current era the information economy or the knowledge economy instead of the service economy. However, all economic eras have been service, knowledge, and information economies. The fallacy becomes even more apparent when a manufacturing business spins off a division and contracts back again for that specialized service using the same employees. At the level of national accounts, economists may now count the same employees, doing the same work, as part of the service economy instead of as part of the manufacturing economy. All economies are service economies. Economists from the time of Colin Clark (1957) have also noted that service-for-service exchanges in the home and local community create significant value, but are not counted in national economic statistics.

(FP6) The Customer Is Always a Cocreator of Value

Customers are entities, which are service-system entities. Providers are also entities, which are service-system entities. Every service-system entity is interdependent with some other service-system entities, because of specialization and exchange. Therefore, every service-system entity is both a customer and provider. Together, customer and provider service-system entities interact to cocreate value. G-D logic sees value creation stopping with manufacturing, and value consumption starting when the customer receives the product. Excellent service design places a value on both customer actions and provider actions in order to innovate. Manufacturers who ignore the total cost of ownership of products, such as the customer's costs of acquisition, setup, maintenance, and disposal, do so at their own peril. These manufacturers may lose to competitors who can provide better design and better service, based on their understanding of the customer as a partner in value cocreation (Womack and Jones, 2005).

(FP7) The Enterprise Cannot Deliver Value, but Only Offer Value Propositions

Value propositions are at the heart of value-cocreation interactions. Both the customer and the provider must agree to the value proposition (noncoercive interactions, which is why no customer trusts a monopoly), and see the mutual benefit as well as the mutual responsibility. Even when an emergency response team is trying to rescue a person in peril, if that person does not want to be rescued, and does not comply or cooperate in the rescue, then it is more likely that the emergency response team will fail. Because the enterprise, as the service provider, can perform only some of the actions (costs), but not all of the actions (customers actions and cost), the enterprise cannot deliver value, but only offer value propositions. Only together can the customer and the provider cocreate value. For example, many educational institutions screen candidates very carefully to determine whether or not the students are likely to be successful at their institutions. Education institutions cannot deliver value, but only offer a value proposition to their students.

(FP8) A Service-centered View Is Inherently Customer Oriented and Relational

Less customer knowledge and lower quality relationships often translate into inferior value propositions, especially for high-value service offerings. A service provider's knowledge of a customer, and the quality of the relationship (level of trust) required to gain shared access to that customer's privileged access resources, directly relates to the quality of the value propositions that the service provider can offer. It would be very unlikely for a service provider to say, "Because I know next to nothing about my customers, and because they do not trust me, I am able to put my competitors to shame in creating value with my customers."

(FP9) All Economic and Social Actors Are Resource Integrators

Service-system entities are economic and social actors, which configure (or integrate) resources, in order to cocreate value with other service-system entities. S-D logic pays particular attention to classifications of resources. For example, resources can be divided into three categories: market-facing resources (available for purchase to own-outright or for lease/contract), private non-market-facing resources (privileged access), and public non-market-facing resources (shared access). In creating or realizing value propositions with others, service-system entities will reconfigure or integrate resources.

(FP10) Value Is Always Uniquely and Phenomenologically Determined by the Beneficiary

Value is more than a decision. Value determination is contextual, history dependent, and unique to an entity. Providers have something to learn from each and every customer. Nevertheless, to oversimplify value determination as a decision, if even just for a moment, does create some interesting thought experiments. Imagine a service-system entity that can accurately predict the judgment of value of another—flawlessly, without error. Next imagine a service-system entity that can control the judgment of value of another. Clearly, prediction and control can make crafting successful value propositions much easier (Ariely, 2008). While perfect prediction and control are not possible, service providers that take advantage of customers and manipulate their decision-making judgments are not cocreating value. Governance mechanisms are one remedy for these situations. However, service providers that take advantage of mass customization technology to allow customers to have it their way can make crafting successful value propositions both more likely and more in the control of the customer. They are also more likely to learn something unique about each of their customers.

Appendix Two. Evolution Examples

Creating evolution examples is a good exercise for students of service science. There are many types of value-proposition-based and governance-mechanism-based interactions between service-system entities that need to be mapped and understood. In an evolution example, a student creates a series of "just-so stories" or scenarios that provide a simplified, hypothetical account of the way specific types of value-cocreation interactions might have arisen. Two evolution examples, lottery and installment payment plans, are provided below.

Lottery

Imagine: There exists a population of 101 service-system entities. The entities have a specific amount of money. One entity, the most wealthy, has $20M dollars, and this is more than twice the amount of the next wealthiest entity, which has only $9M dollars. The wealthiest entity has no heirs, and the expected lifespan of an entity is 100 years. There is a fixed amount of money among the entities in the population, and interactions redistribute the money, thus changing the relative wealth of the entities.

Scenario 1: The wealthiest entity hordes its wealth, provoking both envy and disdain among the other entities, and so the wealthiest entity has a negative reputation.

Scenario 2: The wealthiest entity realizes it could give away $100,000 a year for the rest of its life, and it would still be the wealthiest entity. Instead of randomly giving the money away, the entity decides to run a lottery for 50 of the 52 weeks in a year (taking 2 weeks off for vacation!). This amounts to giving out $2000 a week to the winner of the lottery ($2000 \times 50 = 100{,}000$ per year). The cost of entering the lottery is $6 per entity per week. The chances of winning are 1 in 100, and the payout for the $6 weekly lottery ticket (limited to one per entity) is potentially $2000. Six dollars a week is considered by all entities to be within their disposable income range, and so all entities participate in the lottery, reasoning that if they enter the lottery and win they will enjoy a nontrivial increase in their wealth, and if they lose they have merely used a portion of their disposal income in an enjoyable diversion.

Scenario 3: Exactly like scenario 2, but now the wealthiest entity makes an annual $30,000 donation to the schools. The donation offsets its income from running the lottery, and negates any taxes, but also increases the reputation of the wealthiest entity among the population. In addition, the schools put the money to good use, and the population as a whole benefits from the increased education.

Scenario 4: Exactly like scenario 3, but now the winner, as part of a cultural ritual, decides to donate 10 percent of the winnings or $200 to the schools, uses $800 to stage a weekly celebration for all entities, and pockets $1000 as a nontrivial augment to his or her wealth. This ritual helps lessen envy among the population, and again leads to better schools, which again benefits all of society.

Now assume that this is in fact a historical progression. Each scenario represents a kind of "progress" that is increasing the level of value cocreation (win–win or benefit–benefit interactions). In each step as the scenarios build, entities create new value propositions they offer to others, in order to cocreate value.

Service-science analysis: Service is value cocreation between entities interacting via win–win or benefit–benefit value propositions. Money is only one of many measures of value. Other measures of value include better opportunities for using disposal income, increased chances for augmenting one's wealth, improved reputation, and improved schools. Friedman (2008) in *Morals and Markets* talks about social emotions as the progenitors of moral systems, as well as modern legal and market systems. Envy is one social emotion. Because of envy, the wealthiest person's reputation suffered, and lose–lose interactions could easily have escalated in scenario 1. Anthropologists have studied the approaches different cultures evolve to address extreme wealth disparities, including "potlatch" societies. For example, some entities might have been tempted to engage in illegal activity, violating property rights, in order to take money away from a perceived greedy, wealthy entity. The illegal property rights activity might have even been justified in the guise of a "communist revolution" if the proper ideological foundations were in place. Under slightly different circumstances, the banner might have been "no taxation without representation"—if the wealthiest entity had been an authoritarian oppressor.

Installment Payment Plans

Imagine: There exists a population of service-system entities. All the entities use clothing, which they make for themselves, and the clothing sometimes needs repair so they sew their clothes as a routine part of life. In fact, entities spend about one day a week working on clothing. Because of the excellent schools, one day one of the entities, who truly disliked sewing, invented a machine to help it spend less time making and repairing its clothing. With the sewing machine, the entity is able to spend just one day a month working on clothing and the resulting clothing is of a finer fit as well as more durable—superior quality clothing on two dimensions.

Scenario 1: The entity with the sewing machine keeps the technology a secret, and is able to perfect the art of clothes making. The entity creates clothes of a far superior quality to those of any other entity. Despite the other entities attempts, they cannot duplicate the fine stitching which results in a finer fit and greater durability. The entity with the fine clothes also refuses to share or sell any clothes to the others. Over time, the well-clothed entity becomes the target of envy and disdain, and its reputation suffers.

Scenario 2: With the new technology, the entity finds working on clothes to be quite enjoyable, and now has more time at its disposal—in fact, three days a month are now free for other activities. With the free time, the entity offers to make and repair clothes for three other entities, in exchange for a standard days wage from each of them. The three others can now use their three free days to trade clothes with others in the population. Over time the entity that makes high-quality clothes and the three entities that trade high-quality clothes become wealthier. Furthermore, the reputations of the four increase as they are perceived to be contributing great value to all the entities over time.

Scenario 3: As the wealth of the entity with the sewing machine increases, it decides to sell sewing machines to the three other entities acting as clothing distributors, and make enough money to retire. Because the three others are also quite wealthy, they can easily afford to buy the rather complex and expensive to build sewing machines. One of the three specializes in higher-cost and higher-quality clothing, a second in lower-cost and lower-quality clothing, and the third in novel clothing for special events. All three prosper in their niches.

Scenario 4: The entity that made the sewing machines became bored with retirement, and decided to make more sewing machines and sell them. However, the cost of making sewing machines was quite high, and the average entity would spend twelve days of wages to afford a sewing machine. The average entity would have to save for about a year before it could afford a sewing machine. Furthermore, owning a sewing machine, at a time when most entities did not own one, could allow the entities with sewing machines to earn money faster. Payback from owning a sewing machine could happen in just one-third of the time. For these reasons, the maker of sewing machines decided to sell sewing machines on an installment payment plan of twelve equal payments. The risk, of course, was the cost of repossession of sewing machines, if an entity was to skip or otherwise miss repayment. The entity that made the sewing machines developed a good reputation both for inventing sewing machines and for creating the installment payment plan.

Again, assume that this is, in fact, a historical progression. Each scenario represents a kind of "progress" that is increasing the level of value cocreation (win–win or benefit–benefit interactions). In each step as the scenarios build, entities create new value propositions they offer to others.

Service-science analysis: Three new activity patterns emerged in the population and resulted in opportunities to create new value: the invention of a sewing machine, the emergence of clothes trade and repair (three differentiated niches), and the invention of the installment payment plan. Technological capability, organizational capability, and a new type of value proposition do not arise at random or in isolation. The nature of service-system entities is to interact in such a way that a progression of increasing value cocreation is the result. This is not a monotonic progression, as scenario 1 illustrates, but wherever value destruction occurs when value creation is possible, forces come into play to shift toward the value-creation mode of interaction. This is not mandatory, but is a possibility with autocatalytic properties. The patterns of value cocreation can form a positive feedback loop within a population of service-system entities, leading to new opportunities for value cocreation to occur.

Endnotes

1. For example, more than 200 universities in 50 countries have begun SSMED-related education programs (Murphy & Hefley, 2008); SSMED books have begun to appear (e.g., Hefley and Murphy, 2008); and there are many related activities, including a nascent professional organization (Service Research and Innovation Initiative), integration into an established annual conference (Frontiers in Service), and integration into an established top-rated journal (*Journal of Service Research*), and existing academic and professional organizations have established special interest groups in service (e.g., American Marketing Association, Institute for Operations Research and Management Science, Association for Information Systems).
2. In *The Sciences of the Artificial*, Simon (1996) provides a great deal of the conceptual foundations for what we now call service science. The outline of Simon's book is an overview of the relevant topics: 1. Understanding the Natural and Artificial World, 2. Economic Rationality: Adaptive Artifice, 3. The Psychology of Thinking: Embedding Artifice in Nature, 4. Remembering and Learning: Memory as an Environment for Thought, 5. The Science of Design: Creating the Artificial, 6. Social Planning: Designing the Evolving Artifact, 6. Alternative Views of Complexity, 7. The Architecture of Complexity: Hierarchic Systems).
3. Based on information available at www.citymayors.com/statistics/richest-cities-2005.html.
4. Available at ftp://ftp.bls.gov/pub/suppl/empsit.ceseeb1.txt

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