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The Emergence of Service Science: Toward Systematic Service Innovations to Accelerate Co-Creation of Value

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The current growth of the service sector in global economies is unparalleled in human history—by scale and speed of labor migration. Even large manufacturing firms are seeing dramatic shifts in percent revenue derived from services. The need for service innovations to fuel further economic growth and to raise the quality and productivity levels of services has never been greater. Services are moving to center stage in the global arena, especially knowledge-intensive business services aimed at business performance transformation. One challenge to systematic service innovation is the interdisciplinary nature of service, integrating technology, business, social, and client (demand) innovations. This paper describes the emergence of service science, a new interdisciplinary area of study that aims to address the challenge of becoming more systematic about innovating in service.

Key words: service science; service innovation; coproduction; value co-creation
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1. Introduction: Motivation and Goals

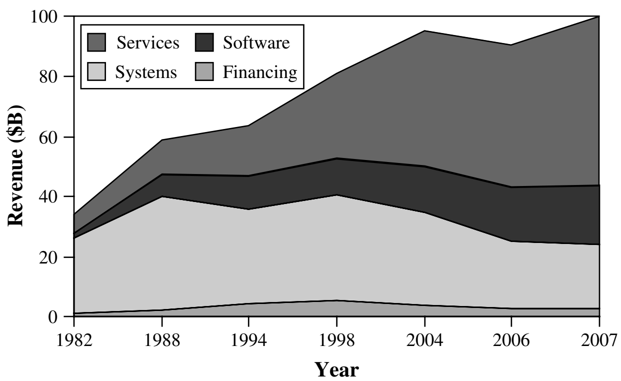
As the service sector of the global economy grows, the study of services and especially the study of service innovation are moving to center stage. This paper shares some first impressions on the study of services from two relatively new students of it. About five years ago, we were given the opportunity to study how we could possibly have an impact on IBM's huge services business, and in this article, we detail what we have been thinking, what we have been doing, and what we have learned in that time.

First, we need to set the stage. IBM is one of the largest information technology (IT) companies in the world. And although IBM is generally thought of as a systems and software company, in the last 20 years the proportion of revenue from services has grown dramatically—in 2007, of $99B in total revenue, $54B came from services (see Figure 1). IBM's services business spans IT services, including consulting and outsourcing, and business services, including consulting and outsourcing. After IBM acquired PriceWaterhouseCoopers Consulting in 2002 and created what became the IBM Global Business Services division, we found ourselves—IBM Research, a world leader in technology and product innovation—with little experience and capability in service innovation, the kind of innovation that seemed to matter more and more to our business. IBM Research needed to change.

What constitutes a service at IBM? To start, we think services require clients and providers to work together to transform some state, such as material goods, information goods, or organizations, that is owned or controlled by the client (Hill 1977, Gadrey 2002). In general, services require the application of competencies, capabilities, or resources by the provider for the benefit of the client (Vargo and Lusch 2004). IBM focuses on Business Performance Transformation Services (see http://www.ibm.com/investor/viewpoint/features/2005/24-08-05-1.phtml)—using knowledge, skills, and resources first to help clients understand their businesses (component by component) and then to help clients transform their businesses.

What constitutes service innovation at IBM? Consider that business service operations at IBM can often be improved through organizational innovations, educational innovations, or technological innovations—or through combinations of these. Innovations often lead to increases in productivity: doing the same work but with less effort. The importance of this can be shown with a simple example. IBM's 2007 Annual Report describes gross profit margins for different parts of the business. Software had gross margins of 85%, whereas services had margins of only 27%. Doubling service productivity would result in margins of more than 60%, and improving productivity by 10 times would result in margins of more than 90%.

Figure 1 Increase in Service Revenue at IBM



Source. IBM Annual Reports.

Change is not easy, but we discovered that this was not the first time IBM Research had to adapt to changes in the business environment. A huge transformation occurred in the 1970s when software systems research was added to an organization that had been composed primarily of physicists, chemists, electrical engineers, and mathematicians. During that transformation, computer science PhDs joined the organization in large numbers. This is only fitting, as IBM had played a major role in helping to establish the discipline of computer science in the 1950s (Asprey and Williams 1994).

So the question arose with services: what new types of PhDs might be needed to build a world-class, corporate services research organization? A quick survey of the PhDs within IBM's services division revealed a three-way split among technology, business-related, and social science PhDs. Also, it was clear that the existing research organization was dominated by technology PhDs. For a research organization focused on technology systems, the shift to services would require a shift toward innovation aimed at improving sociotechnical business systems (Trist 1981). For example, nowadays clients rarely buy an IT system simply because of its technical capabilities (faster, more capacity, etc.) but instead require a business model (return on investment) and an organizational change model (reengineered processes and job roles) that will make the technology an effective solution to their business problems. In a nutshell, this is the reason for IBM's transition from a company specializing in systems and software to a company specializing in combining services with systems and software to co-create the transformation of client businesses.

Some colleagues in IBM and in academia advocated a bold approach—creating a new academic discipline called *service science* (Chesbrough 2004, 2005; Horn 2005), which aims theories and methods from many different disciplines at problems that are unique to the service sector. At the start, the particular disciplines (including some engineering, social science, and management disciplines) and the particular problems (e.g., improving service innovation and service productivity) were not clear. However, this idea of an integrated service science was particularly appealing to us, as we found that the number of separate PhDs required to form a suitable services research organization had grown to nearly a dozen! We had recruited PhDs in anthropology, cognitive psychology, computer science, cognitive science, education, human factors, industrial engineering, and organizational psychology, among others. The communication challenge alone of getting such a diverse population of scientists to speak a common language around "service innovation" required training everyone in each others' disciplines to some extent, as well as injecting new, practical concepts fresh from the front lines of our own services business.

In what follows, we first lay out some background on the service economy and on the growing demand for service innovations. Next, we describe some of the current educational and academic focus on services. Finally, we suggest what we might find if we can coordinate and align business, academic, and government players toward the common objective of understanding and increasing service innovation by developing a service science.

2. Economic Shifts

The macroeconomics are clear. As Figure 2 shows, the economies of the world are shifting from agriculture and manufacturing to services, as measured by the percentage of the workforce employed in each sector. Columns show the percentage of the world's labor force in each country; the percentage of the labor force employed in agriculture, goods production, and services; and the percent change in services in the last 25 years. Put simply, the economies of the world are becoming one large service system. In 1800, approximately 90% of the labor in the United States worked on farms. Today, fewer than 3% work on farms—and that 3% feeds a much larger population than before. This decrease in labor represents a millionfold increase in productivity. The International Labour Organization (2007) reported that for the first time in 2006, more people worked in the service sector worldwide than in either the manufacturing or agricultural sectors.

According to the Clark-Fisher hypothesis (Clark 1957), labor migrates from high-productivity, low-value portions of the economy to low-productivity, high-value portions of the economy. Value is determined largely by supply and demand: low supply and high demand creates economic value. Productivity increases result largely from technology, specialization, and new processes for performing activities. Productivity increases create leisure time in individuals and higher returns for businesses, both of

Figure 2 **World Economies Are Shifting from Agriculture and Manufacturing to Service**

Nation	World labor (%)	Agriculture (%)	Goods (%)	Services (%)	25-year increase in services (%)
China	21	50	15	35	191
India	17	60	17	23	28
United States	4.8	3	27	70	21
Indonesia	3.9	45	16	39	35
Brazil	3.0	23	24	53	20
Russia	2.5	12	23	65	38
Japan	2.4	5	25	70	40
Nigeria	2.2	70	10	20	30
Bangladesh	2.2	63	11	26	30
Germany	1.4	3	33	64	44

Note. Data compiled from national labor statistics and other sources in 2003.

which get invested in new endeavors creating new areas of demand. Although Baumol and Bowen (1968) identified lagging productivity in the service sector, information technology and the Internet have begun to pay off with a surge in service sector productivity (Brynjolfsson and Hitt 2000, Hilsenrath 2003, Triplett and Bosworth 2004). The recent rise in outsourcing services to low-cost geographies has also provided a boost to service sector productivity.

There are many ways of telling the remarkable story of the growth of the service sector. Bryson et al. (2004) may have the beginnings of a deep theory that might underlie a service science in their recent book, *Service Worlds*. However, there are many other perspectives as well. For instance, Fuchs (1968) may have been the first to define services in terms of coproduction. An excellent background can be found in texts by Fitzsimmons and Fitzsimmons (2005) on service management and by Sampson (2001) on service operations. Tien and Berg (2003) demonstrate the need for service systems engineering. From an economic perspective, Clark (1957) notes the rise of the service sector; Porat and Rubin (1977) refer to the rise of the information economy; Herzenberg et al. (1998) characterize the shift to a new economy; Bell (1999) refers to the post-industrial society; Pine and Gilmore (1999) describe the experience economy; Karmarkar (2004) tracks the industrialization of services globally; Paloheimo et al. (2004) describe industrial services; Tanninen-Ahonen (2003) shows the rise of knowledge-intensive business services; and Sen (1999) argues that increases in freedoms will increase value in the service economy.

Earlier, we defined services as clients and providers working together to transform some client-controlled state. However, it turns out that defining services is not easy. Consider just this small sample of definitions available in the literature:

- deed, act, or performance (Berry 1980);
- an activity or series of activities…provided as solution to customer problems (Gronroos 1990);
- all economic activity whose output is not physical product or construction (Baruch et al. 1987);
- intangible and perishable…created and used simultaneously (Sasser et al. 1978);
- a time-perishable, intangible experience performed for a customer acting in the role of coproducer (Fitzsimmons and Fitzsimmons 2005);
- a change in condition or state of an economic entity (or thing) caused by another (Hill 1977);
- characterized by its nature (type of action and recipient), relationship with customer (type of delivery and relationship), decisions (customization and judgment), economics (demand and capacity), mode of delivery (customer location and nature of physical or virtual space) (Lovelock 1983);
- deeds, processes, and performances (Zeithaml and Bitner 1996);
- application of competencies for the benefit of another entity (Vargo and Lusch 2004).

For conciseness, we think *pay for performance* is a reasonable definition of a service—in that this phrase captures the idea that what the provider *does* for the client is essential, as opposed to exchange of an artifact or a good being essential. However, combining Fitzsimmons and Fitzsimmons's definition with Hill's definition, *a time-perishable, intangible experience performed for a client who is acting as a coproducer to transform a state of the client*, reveals some other essential characteristics of services: namely, that the client plays a key role in coproduction activities (the client has responsibilities) and in the co-creation of value (transformed state of the client) (see also Sampson and Froehle 2006). To understand the notion of responsibility in a coproduction activity, consider a teacher telling a student to read a book and work a problem set (exercises) or a doctor instructing a patient to eat certain foods and exercise more. In both cases, the providers perform certain activities, but the clients must also perform activities that transform their own states or else the benefit or value of the service will not be fully attained. In business services, if the client does not install the new IT systems and train the necessary people in the reengineered process, the client will not receive the benefit of the service. Thus, the provider in many cases must negotiate to monitor and assess that the client is performing adequately on the client's responsibilities, and, of course, the client needs to determine that the provider is likewise applying satisfactory effort and quality controls in the performance of the provider's tasks. These issues become of paramount importance in outsourcing services, when a client may outsource a component of its business to a provider that is in a different country with different government regulations and national culture of the employees.

In viewing services as *pay for performance in which value is coproduced by client and provider*, there are at least three types of performance of interest to providers: high talent performance (trained chef), high technology performance (ordering dinner from a website), and routine performance supported by superior environment (service personnel with average abilities, a good cookbook, and a well-equipped kitchen). When thinking about getting more systematic about service innovation, firms can invest in talent, invest in technology, or provide a superior environment for performance. Talent allows for the opportunity to provide the widest range of services for a client with the greatest levels of unique customization. Technology allows for the greatest efficiencies to be achieved for highly standardized or well-scoped alternative configurations. Environmental supports allow for the greatest flexibility on the part of the provider in finding employees who can perform well for clients with some degree of customization. Of course, a service provider may use all these approaches on different client segments.

One misconception about the growth of the service sector is that it is creating more low-skill, low-value jobs than high-skill, high-value jobs. In fact, the evidence is to the contrary. Figure 3 shows the distribution of jobs in the United States by work system (and by sector: all sectors, service sector, and goods manufacturing sector). Tightly constrained jobs, such as those found in call centers, and human labor-intensive jobs, such as child care, account for fewer than a third of service jobs. More autonomous sorts of jobs, such as managers and engineers, account for the vast majority of service jobs. Recently, the U.S. Bureau of Labor Statistics (2005) has begun to project that job growth in the United States will be based entirely on service sector jobs and will grow most for high value professional and business service jobs.

In part because high technology performance and superior environment performance require specialists—not to mention that high talent performance also requires specialists—services tend to create good entry-level jobs (average ability in superior environment) and then provide growth paths that lead to high talent or jobs associated with high technology performance. Moreover, the information services sector is growing dramatically (Apte and Nath 2007). Many studies link the growth of information and communication technologies (ICT) in an economy to the growth of the service sector and the growth of GPD per capita (Colecchia et al. 2002, Pilat 2003, Porat and Rubin 1977). Although speculating about causal relationships is always risky, we think it is safe to say that technology, business, and work innovations coevolve.

Figure 3 Percent Employment by Work System in the United States

	1996 (%)			
	All	Services	Goods	Examples
Tightly constrained	5	4	10	Call center, fast food
Unrationalized labor-intensive	25	26	15	Maid, child care
Semi-autonomous	30	29	34	Admin., manager
High-skill autonomous	41	40	40	Executive, engineer

Note. Adapted from Herzenberg et al. (1998).

3. Academic Shifts

Academic interest in services has been growing slowly and steadily, with more and more disciplines rethinking their curricula and research agendas in light of the growth of services. Nevertheless, most academics and government policy makers are still operating in a manufacturing paradigm rather than in a service paradigm. Change is slow, and this has a negative impact on service innovation rates. At the national level, Germany, Denmark, Finland (Paloheimo et al. 2004), Norway (Hauknes 1996), the United Kingdom (Tidd and Hull 2003), and Canada have made significant efforts over the last decade to rectify this situation. There are many reasons why the shift to a new logic based on services has been slow to happen (Vargo and Lusch 2004), although probably the greatest single cause is simply inertia. Nevertheless, pioneers in service research are showing increasing confidence that the tipping point has been reached, and they are calling for a wider range in service research (Rust 2004).

In addition to economists and specific service professions, business schools have often been the schools in universities to begin offering service-related courses. Marketing departments saw the rise of service marketing, and strategies based on taxonomies of services and deeper understanding of the special characteristics of a service relationship emerged (Lovelock 1983). Operations Management departments have been paying increasing attention to the management of service operations since the seminal work of Chase (1978) and Chase and Tansik (1983). Operations Research departments sometimes associated with Management Science departments in business schools, or Industrial and Systems Engineering departments in science and engineering schools, have recently seen the rise of service operations, service engineering, service systems engineering (Tien and Berg 2003), and enterprise transformation departments (Rouse 2004). Recently, undergraduate majors have also begun to show the shift towards service, such as the recently revised ORMS major at University of California, Berkeley (see http://www.ieor.berkeley.edu/AcademicPrograms/Ugrad/ORMS.pdf) and the Service Systems Engineering program at Michigan Technological University (see http://www.sse.mtu.edu/). In business schools, Finance departments have begun shifting toward more focus on activity-based costing (Roztocki 1998), reflecting the shift towards activity-based economic transactions and the firm operations inherent in services. Also, Professional Science Masters (PSM) programs have begun to appear, mixing science, business, and mathematics (Jones 2004).

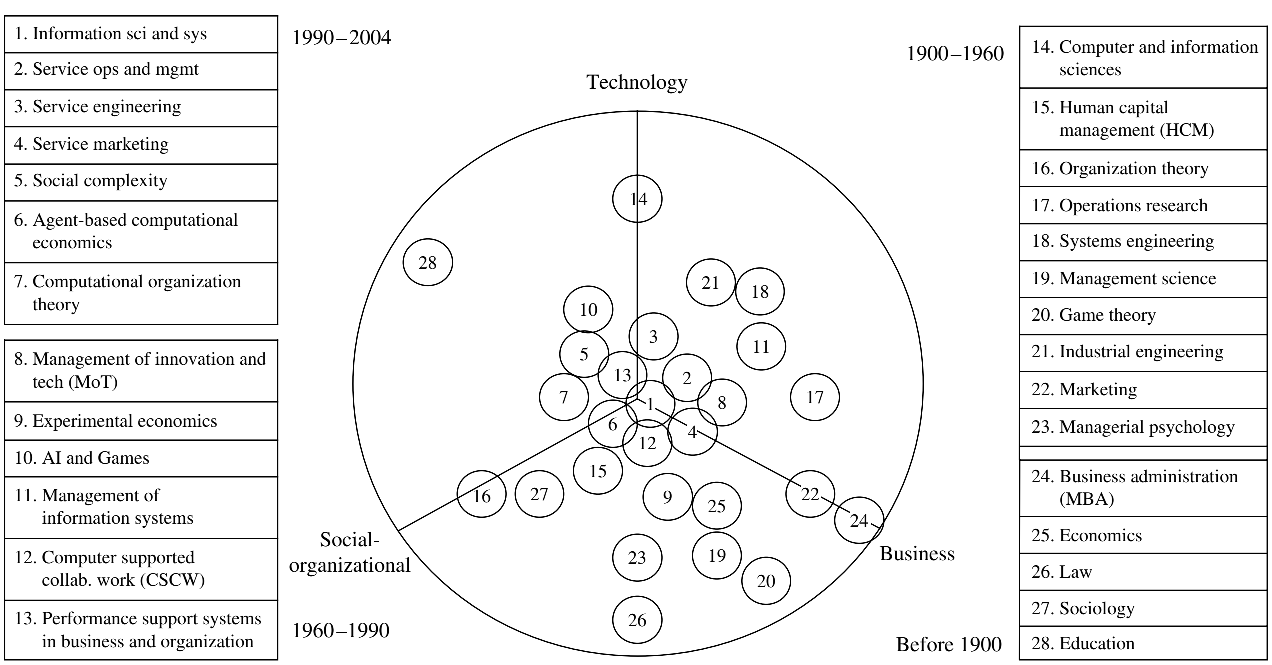
Computer Science departments are seeing the growth of services-related curriculum elements, including service-oriented architectures (SOA), Web services, and service computing (McAfee 2005, Newcomber 2002). Agent-based modeling techniques first developed for artificial intelligence are now being applied in new areas, such as computational organization theory (Carley 2002) and agent-based computational economics (Tesfatsion 2002).

Social science schools are seeing the shift towards services not only in economics but also in areas such as anthropology, in its shift to the study of cultures in business settings rather than in remote jungles (Baba 1995). Organization theory, which is taught both in social science schools and in business schools, and decision science, which is closely aligned with operations research, are seeing similar shifts toward more service content in curricula elements as well as toward more service-oriented research questions. Organization theory and coordination theory are essential for understanding the decisions made in organizations and the evolution of work systems (Malone et al. 2003; Malone 2004; March and Simon 1993; March 1988, 1999).

Overall, we see certain academic disciplines revising content based on the shift to services in the economy. Our own assessment of the content of course shifts over the last 100 years—toward more balance among human, technical, and business concerns—bears this out. Figure 4 shows academic courses and programs over the last 100 years plotted along three axes, roughly by the amount of concern for technology, business, and social-organizational matters. The years associated with these fields are only rough estimates meant to illustrate the point: over time, we see courses converging toward the center—toward a balance among these three concerns. Moreover, this convergence is now being documented by others at information schools (Glushko 2008), business schools (Davis and Berdrow 2008), engineering schools (Larson 2008), and elsewhere (see, for instance, Hefley and Murphy 2008).

At an even higher level, the need for government investment in services is significant, and the few programs that exist need to be greatly expanded. In addition, the government needs to expand its efforts in measurement of services in the economy as well as to consider ways to increase the number of patents in the service innovation area. The benefits of industry, academic, and government collaboration to increase knowledge and competitive advantage are becoming well documented, and the effects can last for decades (Murmann 2003).

Figure 4 Changes in Academic Courses and Programs over the Past 100 Years



4. Research Agenda

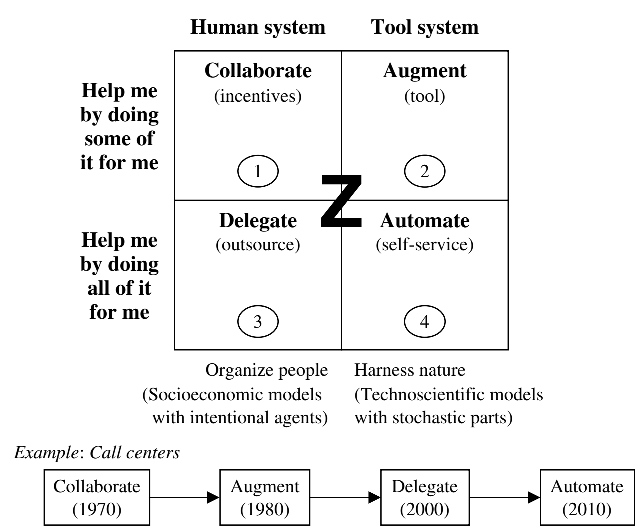
A central problem in service science is likely to be related to understanding service system evolution. After all, service innovation—our ultimate goal—creates changes to a service system, which is made up of clients and providers co-creating value and which has a direct impact on the evolution of the system (Spohrer et al. 2007). One measure of value is as a measure of the differential between supply and demand (low supply plus high demand equals potential for high value). Specialization is one of the key mechanisms for creating value. If two entities have different abilities for achieving a goal (supply diversity), then under certain conditions they can specialize in what they do best and create an overall increase in productivity, which leads to increased profits that are then invested in new goals (demand diversity). From the provider perspective, specialization can lead to high talent, high technology, or superior environment-enabled performances for creating value. Specialization leads to the need for trusting others and coordinating activity across potentially vast networks (with or without central control). As a result, service system evolution is a special case of meaning-creation in sociotechnical system evolution, in which value is one locus of meaning and design (Trist 1981, Engelbart 1963, Simon 1996). The types of service businesses and their capabilities are also evolving (Hofferberth 2004).

By understanding where demand is likely to head (consumer preference knowledge) as well as opportunities and challenges created by the other players and resources on the field (environmental resources and risks knowledge), many service providers seek to maximize returns from profits by investing in innovation and other practical change to grow revenue, cut costs, and improve relationships that co-create more profits and value (production capability knowledge). One thing that makes decision making difficult is anticipating the actions of others (Brandenburger and Nalebuff 1995). In a service system, economic entities lie along a continuum from self-sufficient interactions with the environment to highly specialized production-consumption relationships with others (Hawley 1986, Seabright 2004, Prahalad and Ramaswamy 2004). Improving the productivity of interactions (Butler et al. 1997, McAfee 2005) and labor productivity (Lewis 2004, Patterson 2001, Gilbert 1978) are key targets of service innovation, including innovation in measuring productivity (Triplett and Bosworth 2004, Brynjolfsson and Hitt 2000).

Decisions that clients and providers make in a service system largely determine the way the service system evolves (assuming a stable environment, as well as many other assumptions dealing with complex adaptive system evolution). For example, Oliva (2001) and Oliva and Sterman (2001) examine service systems in which demand increases can lead to a number of alternative provider responses, such as service personnel increasing effort, personnel cutting corners, or management investing in more capacity. Some service system designs allow service personnel to make the decision to invest in increasing capacity. Understanding service system dynamics and service system evolution at the level of the model presented by Oliva and Sterman is still relatively rare. There are tremendous opportunities for service researchers to develop models with high relevance to service operations. For example, understanding an optimal investment strategy between high talent, high technology, and superior environment would be of enormous value to service providers. Other fundamental investment choices are between exploitation and exploration (March 1999) and between generalists and specialists in an organization (Cataldo et al. 2000).

Figure 5 presents a model for understanding work evolution in a service system, a type of sociotechnical system. Under certain conditions work systems can evolve from fully human systems (people working together) to technology augmented systems (people using tools), to delegation across firm boundaries (outsourcing process), to fully automated (technology-only) processes. The trick lies in understanding or predicting when or how each of the transitions may be made. In this model, the choice to change work practices requires answering four key questions: (1) Should we (what is the value)? (2) Can we (do we have the technology)? (3) May we (do we have

Figure 5 Framework for Thinking About Work Evolution in Service Systems



Note. Based on Englebart's 1963 notion of human augmentation or human systems and tools systems' coevolution.

authority or governance)? (4) Will we (is this one of our priorities)? For example, consider the way call centers have evolved over the decades. Early technology call centers in the 1970s were often staffed with the actual developers and key technologists who had developed a technology. This is sometimes still the case when calling a young start-up company for technical support. However, as demand rises, it makes sense to provide average performers with a superior environment (e.g., computers with a Frequently Asked Questions tool). Later, as demand continues to rise and competition increases, it may be possible to outsource or delegate the call center component of the business to a service provider in India. Finally, as technology advances, websites and automated speech recognition systems can provide automated or self-service assistance to clients with questions. A parametric model of work evolution, like the Oliva and Sterman (2001) model of service quality erosion, is another challenge for service scientists to undertake.

One other major area that should not be neglected in this discussion of service science research questions deals with results from historical economics as well as experimental economics related to perceptions of trust and fairness (Seabright 2004). Because service systems can evolve into highly interdependent collections of entities, possibly dependent on global-scale "service value chains," understanding the evolution of trust and mechanisms for supporting and enforcing trust are of great interest (e.g., eBay's reputation system). The importance of trust is another reminder that service systems are a special type of sociotechnical system in which construction of meaning is focused on value, such as that created by imbalances in supply and demand.

The range of research questions with scientific and practical importance for service scientists to tackle is extensive. The literature on service research and service science is now growing (e.g., Hefley and Murphy 2008, Maglio and Spohrer 2008, Spohrer and Riecken 2006). As the community of interest in service science grows, we will expect to begin to see a systematic enumeration of service research questions and answers (Gupta et al. 2006, Smith et al. 2007). But this has only just begun.

5. Concluding Remarks

The growth of the service sector of the economy is truly a wonder of human history, on par with the agriculture revolution and the industrial revolution. But is it too broad and diverse to be a suitable area of scientific study? Or is it possible to understand the evolution of service systems in terms of a few simple principles that provide powerful frameworks to explore core research questions? For example, can service systems be understood in terms of specialization to create value networks and the cost of allocating knowledge among high talent, high technology, and superior environment portions of the system? Or can they be understood in terms of the unequal evolution of know-how in different industry sectors (Nelson 2003)? Will new agent-based simulation tools reveal the secrets of service system evolution, in terms of industry evolution and organizational change? Will greater knowledge of service systems lead to a more disciplined and systematic approach to service innovation?

Now, many people at IBM and elsewhere talk about an even broader approach: service science, management, and engineering (SSME), which is defined as the application of scientific, management, and engineering disciplines to tasks that one person, organization, or system beneficially performs for and with another person, organization, or system (Maglio et al. 2006). This expanded name for service science is useful, as it indicates directly the need for an integrated approach that spans not only existing discipline-based silos within academic organizations (i.e., marketing, operations, and human resource management within a business school) but also across academic organizations (i.e., business, engineering, and liberal arts). An interesting phenomenon occurs when interdisciplinary efforts lead to generalists that after some time become the new specialists (Spohrer et al. 2006). Something like this happened in computer science, which combined software and algorithm complexity theory as well as hardware and logic design into a new specialty that increased our understanding of computation in technological systems. Perhaps service science will combine multiple disciplines to form a new specialty that increases our understanding of value co-creation in sociotechnical systems. Ultimately, this deeper understanding of service system evolution could lead to more systematic approaches to service innovation. Service innovations have the potential to impact service productivity, service quality, and rates of growth and return for service systems.

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