The Emergence of Service Science:

Toward systematic service innovations to accelerate co-creation of value

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Abstract

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 quality and productivity levels of services has never been greater. Services are moving 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 services, integrating across technology, business, social, and client (demand) innovations. This paper argues for the emergence of service science -- a new interdisciplinary area of study -- to address the challenge of becoming more systematic about innovating in services.

Keywords: Service science, service innovation, co-production.

I. Introduction: Motivation & Goals

As the service sector of the global economy grows, the study of services and especially the study of service innovation are moving center stage. This paper shares some first impressions on the study of services from two relatively new students of it. About three years ago, we had the opportunity to begin to study and to try to have an impact on IBM's huge services business, and in this short article, we're going to tell you something about what we've been thinking, what we've been doing, and what we've learned in that time.

But first, we need to set the stage. IBM is the largest IT company in the world. And though 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 2004, of $96B in total revenue, $42B came from services (see Figure 1). IBM's services business spans IT services, including consulting and outsourcing, and business services, including consulting and outsourcing as well. After IBM acquired PriceWaterhouseCoopers Consulting in 2002 and created its Business Consulting Services group, 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 define services as clients and providers working together to transform some state, such as material goods, information goods, organizations, which bears some ownership relation to the client (Hill, 1977; Gadrey, 2002). IBM focuses on Business Performance Transformation Services (see http://www.ibm.com/investor/viewpoint/features/2005/24-08-05-1.phtml) -- helping clients first to understand their businesses (component by component) and then helping clients transform their businesses to become more *On Demand* (see http://www-1.ibm.com/services/ondemand/).

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 2004 Annual Report describes gross profit margins for different parts of the business. Software had gross margins of nearly 90%, whereas services had margins of only 25%. In this case, doubling service productivity would result in margins of 60%, and improving productivity by ten times would result in margins of over 90%.

Change isn't easy, but we learned 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).

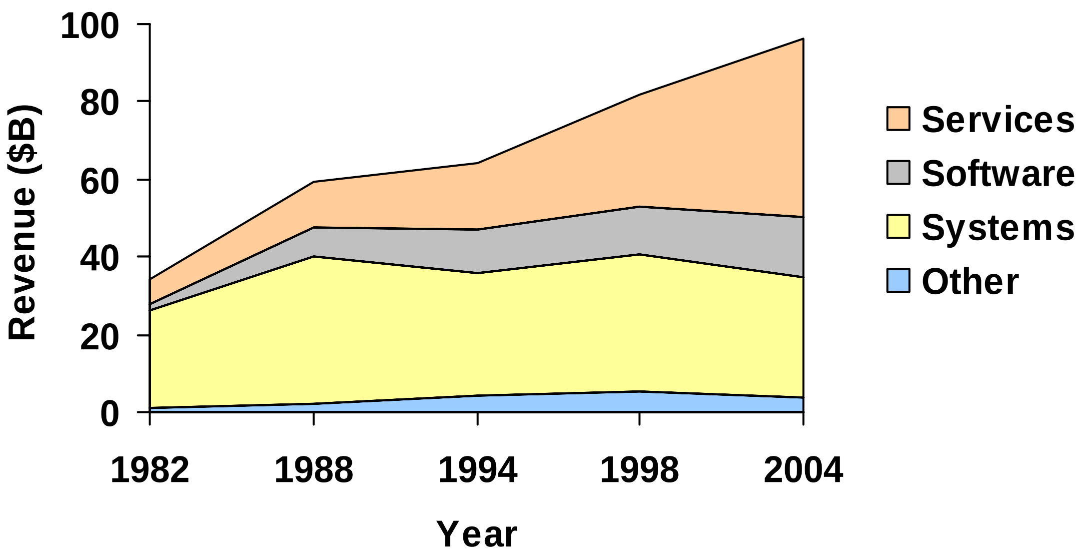

Figure 1: Increase in services revenue at IBM (Source: IBM Annual Reports).

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 between technology, business-related, and social sciences PhDs. And 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 information technology (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 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 *services 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. Yet 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 the injection of new, practical concepts fresh from the front lines of our own services business.

In what follows, first we lay out some background on the services 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 or understanding and increasing service innovation through development of a science of services.

II. 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 percentage of labor force employed in each sector. Columns show the percentage of world's labor force in each country, percentage of 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, about 90% of the labor in the US worked on farms. Today, less than three percent work on farms---and that three percent feeds a much larger population than before. This decrease in labor represents a million-fold increase in productivity. According to the Clark-Fisher hypothesis, labor migrates from high productivity, low value portions of the economy to low productivity, high value portions of the economy. Value is largely determined by supply and demand: low supply and high demand creates economic value. Productivity increases largely result from technology, specialization, and new processes for performing activities. Productivity increases create leisure time in individuals and higher returns for businesses, both of which get invested in new endeavors creating new areas of demand in the economy. Baumol identified lagging productivity in the services sector, though information technology and the internet have begun to payoff with a surge in service sector productivity (Hilsenrath, 2003; Brynjolfsson and Hitt, 2000). 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, Daniels, and Warf (2005) may have the beginnings of a deep theory that might underlie a service science in their recent book, *Service Worlds*. Of course, there are many other perspectives on this story as well. For instance, Fuchs (1968) may have been the first to define services effectively as coproduction. Excellent background can be found in texts by Fitzsimmons and Fitzsimmons (2001) 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, Alic, and Wial, (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, Miettinen, and Brax (2004) describe industrial services; Tanninen-Ahonen (2003) shows the rise of knowledge-intensive business services (KIBS); and Sen (1999) argues that increases in freedoms will increase value in the service economy.

Nation	**World Labor**	**Agriculture**	**Goods**	**Services**	**25-year increase in services**
China	21 %	50 %	15 %	35 %	191 %
India	17 %	60 %	17 %	23 %	28 %
U.S.	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 %

Figure 2: Economies are shifting from agriculture and manufacturing to services. (Data were compiled from national labor statistics in 2003).

We defined services earlier in terms of clients and providers working together to transform some state (usually client-owned stated). But 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 (Brian 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 co-producer (Fitzsimmons, 2001)

- 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, performances (Zeithaml & Bitner, 1996)

For conciseness, we think *pay for performance* is a reasonable definition of a service---in that this phrase captures the idea that it is what the provider does for the client that is essential, as opposed to the exchange of an artifact or a good being essential. However, a combination of Fitzsimmons and Hill's definitions, *a time-perishable, intangible experience performed for a client who is also acting in the role of the coproducer that transforms a state of the client* reveals some other essential characteristics of services: namely, that the client plays a key role in the coproduction of the value (the client has responsibilities) and often the value is a transformed state of the client or some possession of the client. 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 firm 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 (order dinner from a website), and routine performance supported by superior environment (service personnel with average abilities, a good cook book, and a well equipped kitchen). When thinking about getting more systematic about service innovation, firms can invest in talent, 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 degrees of customizations. 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 US by work system (and by sector: all sectors, service sector, goods manufacturing sector). Tightly constrained jobs, such as those found in call centers, and human labor-intensive jobs, such as child care, account for less than a third of service jobs. More autonomous sorts of jobs, such as managers and engineers, account for the vast majority of service jobs.

		1996		**Examples**
	All	**Services**	**Goods**	
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

Figure 3: Percent employment by work system in the US. (From Hertzenbeg, Alic, and Wial, 1998).

In part because high technology performance and superior environment performance require specialists, not to mention high talent performance 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 & Nath, 2005). 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, Guellec, Pilat, Schreyer, and Wyckoff, 2002; Pilat 2003; Porat and Runin, 1977). Though speculating about causal relationships is always risky, we think it is safe to say that technology, business, and work innovations coevolve.

III. 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 production paradigm rather than in a services paradigm. Change is slow. And this has a negative impact on service innovation rates. At the national level, Germany, Denmark, Finland (Paloheimo, Miettinen, Brax, 2004), Norway (Hauknes, 1996), 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 & Lusch, 2004), though 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 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 services-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 operations in services since the seminal work of Chase (1978; Chase and Tansik, 1983). Operations Research departments sometimes associated with Management Science departments in business schools, or Industrial & Systems Engineering departments in science and engineering schools, have recently seen the rise of service operations, service engineering, service systems engineering (Tien & Berg, 2003), and enterprise transformation departments (Rouse, 2004). Recently, undergraduate majors have also begun to show the shift towards services, such as the recently revised ORMS major at University of California, Berkeley (see http://www.ieor.berkeley.edu/AcademicPrograms/Ugrad/ORMS.pdf). 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. And 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, 2004), and agent-based computational economics (Tesfatsion, 2004).

Social science schools are not only seeing the shift in economics towards services, but also in areas such as anthropology shifting 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 and 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, Laubacher, Morton, 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 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. Some universities have established multidisciplinary centers for the study and teaching of services (e.g., Arizona State University’s Center for Services leadership, and the University of Maryland’s

Center for Excellence in Service). But as of now, we know of no university that has integrated or unified curricula and research agendas across academic silos and toward a separate service science.

At an even higher level, the need for government investment in services is significant, and the few programs that exist (Sen, 2004) need to be greatly expanded. In addition, government needs to expand its efforts in measurement of services in the economy, as well as 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).

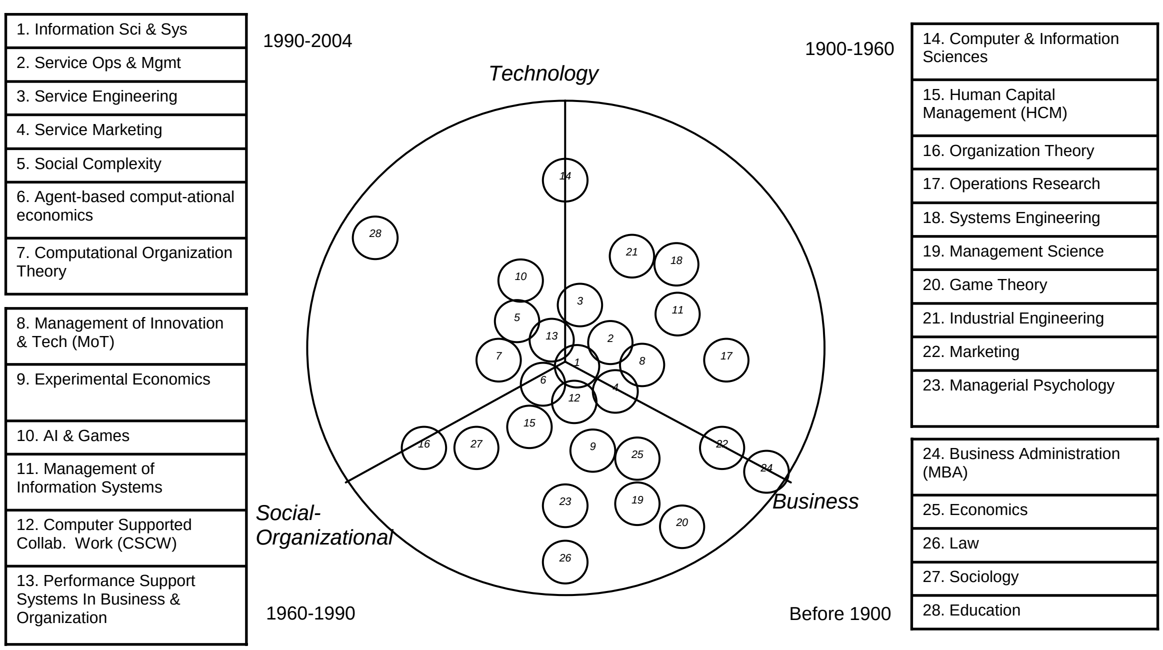

Figure 4. Change in academic courses and programs over the past 100 years.

IV. 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-producing value, and which has direct impact on the evolution of the system. 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 on what they do best, and create an overall increase in productivity that 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 and Sahay, 1997; McAfee, 2004) and labor productivity (Lewis, 2004; Patterson, 2001; Gilbert, 1978) are key targets of service innovation, including innovation in measuring productivity (Bosworth and Triplett, 2003; Brynjolfsson and Hitt, 2000).

Decisions that clients and providers make in a service system largely determine the way the service system evolves (assuming 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 systems 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, Carley, Argote, 2004).

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 authority or governance? (4) Will we – is this one of our priorities? For example, consider the way call centers have evolved over decades. Early technology call centers in the 1970's 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 make sense to provide average performers with a superior environment (e.g., computers with FAQ (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 model of service quality erosion, is another challenge for service scientists to undertake.

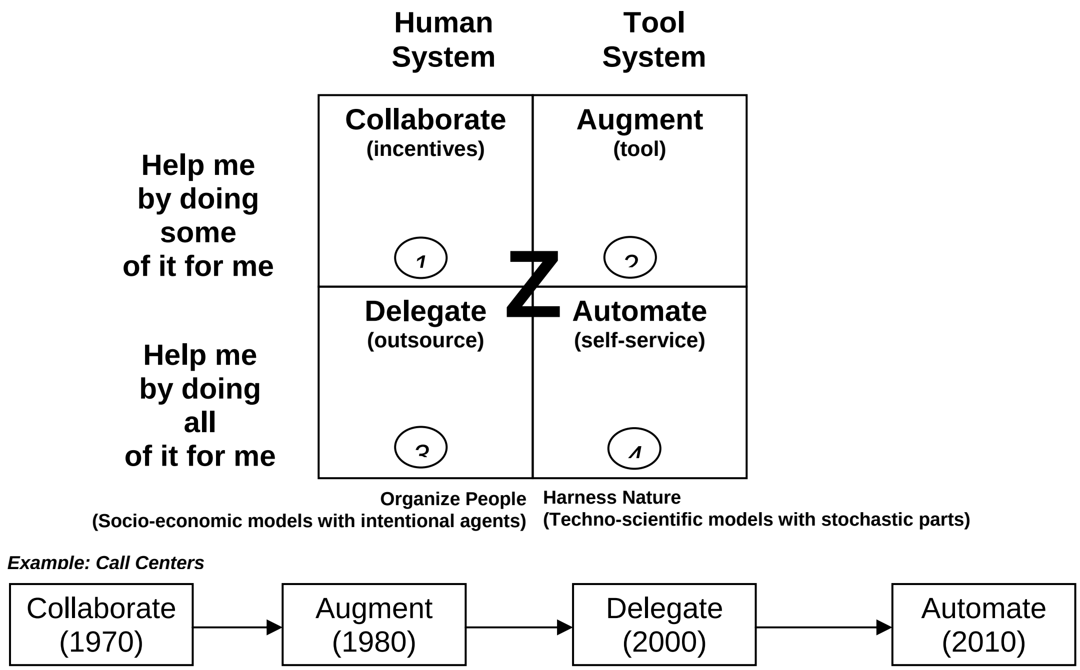

Figure 5: Framework for thinking about work evolution in service systems. (Based on Engelbart's, 1963, notion of augmentation, or human system and tools system coevolution).

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 where 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 scientist to tackle is extensive.   As the community of interest in service science grows, a key need is a systematic enumeration of service research questions.

V. 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, 2001, 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 services systems lead to a more disciplined and systematic approach to service innovation.

Recently, a number of people at IBM and elsewhere have begun to talk about an even broader approach: Service Sciences, 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 ("services"). 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 with 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, Maglio, McDavid, and Cortada, 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 increases 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 coproduction 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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