Services Sciences, Management, and Engineering (SSME) and Its Relation to Academic Disciplines

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1 Introduction

The service economy refers both the service sector of industrialized economies as well as services performed in the manufacturing and extractive sectors of the economy. The spectacular growth of the service economy in the past fifty years is reflected both the GDP statistics of nations as well as the annual reports of manufacturing companies that report on growing services revenue. The Fortune 1000 reflects the growth trend of the service economy. Both the increasing number of service firms (e.g. Google) that appear on the list and the increasing percentage of revenue from services for many non-service firms (e.g. John Deere) reflect this new economic reality.

In spite of the significant measurable growth of the service economy, there is no widely accepted definition of service, and furthermore, measurement of service productivity, quality, compliance, and innovation are still in the early stages of development. For example, in healthcare services, an innovation might eliminate a routine medical need and hence allow more resources to be dedicated toward a more complex illness, with the result being an apparent drop in hospital productivity, in spite of real advancement being made!

Perhaps Gallouj (2002) best described the slow progress in understanding innovation and services when he wrote: "… modern economies are both service economies and economies of innovation. Paradoxically, they are not regarded as economies of innovation *in* services, that is as economies in which service firms' innovation efforts are proportionate to their contribution from the major economic aggregates. It is as if service and innovation were two parallel universes that coexist in blissful ignorance of each other."

Seven explanations are often given to explain what appears to be slow progress in understanding the fundamentals of the service economy: (1)

diversity of service industries and service activities in other industries makes discovery of general principles difficult, (2) misconceptions about services as low value jobs has slowed investment, (3) misconceptions about services as unproductive and resistant to productivity gains has slowed investment, (4) inability to patent or otherwise protect service innovations has slowed investment, (5) data about service phenomena that could form the basis of a general theory of service are considered confidential and proprietary and hence difficult to obtain, (6) the multidisciplinary nature of service research has meant each discipline is separately making progress rather than establishing effective collaborations and building off each others' successes, and (7) all of the above, and more!

The good news of course is that progress has been made especially over the last twenty years, and recent activities around the world (including SSME) show signs of accelerating that progress (Tien and Berg, 2006). For example, in business schools, courses in service management, service operations, service marketing, and other aspects of services have well established textbooks, journals, and conferences. In engineering schools, operations research as well as industrial and systems engineering are shifting their focus from factories to service operations and service value chains. Also, computer science departments are beginning to research and teach about web services, service-oriented architectures, data center economics and networked information services techniques. The social sciences, especially economics, are delving deeper into the production, provisioning, and consumption of services. Even the noted economist William Baumol, who studied the unproductive nature of many services in the 1960s and 1970s, has recently begun to devise theories of research and investment in services, concluding that "…innovation activities are fundamentally service activities."

One final bit of good news is the progress that government and advisory agencies are making as they characterize the opportunity to do more. For example, the U.S. National Academy of Engineering's 2003 Report on "The Impact of Academic Research on Industrial Performance" summarized the reality well: "..the studies suggest that services industries represent a significant source of opportunity for university-industry interaction. Services account for more than 80% of the U.S. gross domestic product, employ a large and growing share of the science and engineering workforce, and are the primary users of information technology. In most manufacturing industries, service functions (such as logistics, distribution, and customer service) are now leading areas of competitive advantage. Innovation and increased productivity in the services infrastructure (e.g. finance, transportation, communication, and healthcare) have an enormous

impact on productivity and performance in all other segments of the economy. Nevertheless, the academic research enterprise has not focused on or been organized to meet the needs of service businesses. Major challenges to services industries that could be taken up by universities include: (1) the adaptation and application of systems and industrial engineering concepts, methodologies, and quality-control processes to service functions and businesses, (2) the integration of technological research and social science, management, and policy research, and (3) the education and training of engineering and science graduates prepared to deal with management, policy, and social issues."

Another example of government response to service innovation opportunity is the inclusion of a focus on "Modern Services" in China's 2006-2010 Five Year Plan. In 2006, Germany strengthened its efforts with an "Innovation with Service" program announced at the nation's Sixth Annual Service Engineering Conference, which was followed one week later by the First Annual German Services Science Conference. Australia recently hosted the 15th Annual Frontiers in Service Conference, at the University of Queensland in Brisbane, fittingly in the Colin Clark building, named after the first economist to compile worldwide statistics of the growth of the service sector. In 2006, Japan's National Science & Technology Policy Agency established a Services Science Forum for industry, academic, and government collaboration around the service innovation theme. European Union efforts have been truly pioneering over a decade, with significant results as well. The July 2006 issue of the Communications of the Association of Computing Machinery (ACM) has a special section on Services Science, reporting on these global efforts as well as exploring the interdisciplinary connections needed to advance a science of services.

Nevertheless, perhaps the biggest barrier holding back the next level of government investment (on par with investment in other emerging innovation areas such a nanotechnology, bioinformatics, and cyberinfrastructure) is the lack of a general theory of service with well defined questions, tools, methods, and practical implications for society. On the one hand, there is the view that economics or the science of complex systems is the appropriate starting point for a general theory of service. On the other hand, some hold the view that since service is so broad and pervasive in the economy, investments in specialized areas such as bioinformatics will provide the appropriate foundation for new healthcare services, for example. This view holds that service is primarily many applied or practical sciences, and not a deep scientific area of theoretical inquiry on its own. And yet, some others feel there may be a middle ground somewhere between one large and gen-

eral, complex systems science of service, and many small and specific applied sciences of service.

In the next section, the two leading efforts to create a general theory of service from within the service research community will be presented. After that section, ten academic disciplines and areas of study with great relevance to a general theory of service are presented. In conclusion, a synthesis is attempted around the notion of SSME and service systems.

2 Service Research Approaches

In this section, two approaches toward a general theory of service are described. Both originate from within the service research community. The first, "A Unified Services Theory", derives from a service operations and management discipline perspective. The second, "Evolving a Service Dominant Logic," derives from a service marketing discipline perspective.

In "Foundations and Implications of a Proposed Unified Services Theory", Sampson and Froehle (2006) first introduce the need for a unifying theory of service, and then outline six characteristics of a good inductive theory (from Locke, 2005): (1) it is based on observation and data, (2) it defines concepts in a way that differentiates them from other concepts, (3) it integrates concepts and resolves apparent contradictions, (4) it identifies causal relationships, (5) it typically takes time to develop, and (6) it is open ended, allowing for extensions and re-applications. The starting point for their theory is the observation that "*With service processes, the customer provides significant inputs into the production process*." They argue that the presence of customer input is necessary and sufficient to define a production process as a service process, as distinct from manufacturing and extractive processes. They go on to define inputs, customers, and production processes, and note that customer inputs are the root cause of the unique issues and challenges of service management.

Sampson and Froehle (2006) then work to reconcile their efforts with prior service perspective based on defining characteristics (see Lovelock and Gummesson, 2004): intangibility, heterogeneity, simultaneity (inseparability), perishability, and customer participation. They note that the fifth characteristic, customer participation, is also called "coproduction" by some (Bitner et al, 1997) and is essentially a limited view of their own "customer inputs" concept. However, coproduction is too often associated with customers providing themselves as labor in the production process,

while they can also provide property and/or information – not just customer labor. They also note that Chase's (1981) customer contact theory is very related, though virtual customer input, not just the physical presence of the customer in the system, allows for the front-office service (real customer) and back-office service (virtual customer) distinction of Metters (2006) and Shostack (1984). Exactly what and how customers provision their inputs to the service process is the focus of many other frameworks, including Schmenner's (1986) Service Process Matrix, Wemmerlov's (1990) technologization, degree of customer contact, and object of the service (goods, information, people) framework, Kellogg and Nie's (1995) Service Process/Service Package Matrix, Napolean and Gaimon's (2004) standardized/unpredictable inputs framework, and others. The nature of the customer inputs (tangible or intangible) and bi-directional flows in customer provisioning of inputs has been referred to as a two-level bidirectional service supply chain (Fitzsimmons and Fitzsimmons, 2006). Extensions into business-to-business (B2B) services and supply chain management (Roth and Menor, 2003) are noted as a fertile ground for future contributions.

Next, Sampson and Froehle (2006) present the operational implications of their Unified Services Theory in three areas: (1) capacity and demand management (reservation systems, pricing incentives for off-peak, self-service, time psychology, etc.), (2) quality management (improve customer capabilities including screening and compliance, manage customer expectations, socialize and promote the establishment of objective standards and measures, etc.), and (3) strategy management. For strategy management such as Porter's (1980) cost leadership, focus, and differentiation types, each can be translated into an approach to customer input provisioning. For example, cost leadership may be achieved through a self-service approach, focus by screening and market segmentation to select customer with uniform inputs, and differentiation through more optimal processing of aggregate customer input as in Amazon's book recommendation system.

In their conclusion, Sampson and Froehle (2006) assert that all managerial issues unique to services stem from the fact that service processes involve customer inputs. Furthermore, their Unified Services Theory meet the criteria for a good theory because: (1) it is based on a wide variety of industry observations and research literature, (2) it defines services and service concepts in a way that differentiates them from traditional manufacturing concepts, (3) it integrates prior models of service management under a common basis, (4) it shows the cause of various service phenomena (i.e. the requirement for customer inputs), (5) it is based on time-tested research

of others, and (6) it defines services in a way that is very open-ended in terms of implications and applications.

A second approach being advanced from within the service research community takes a very different tack and has been gaining momentum relatively rapidly. Vargo and Lusch (2004) argue for evolving a service-dominant logic in marketing to replace the goods-dominant logic that has taken hold over the last two centuries. A theory of service may follow, but first a service-dominant logic must be evolved that establishes concepts, world view, and a small set of fundamental propositions, along with their empirical support. To evolve a service-dominant logic, Lusch and Vargo (2004) propose eight fundamental propositions to be tested: (FP1) the application of specialized skills and knowledge is the fundamental unit of exchange, (FP2) indirect exchange masks the fundamental unit of exchange, (FP3) goods are distribution mechanisms for service provision, (FP4) knowledge is the fundamental source of competitive advantage, (FP5) all economies are service economies, (FP6) the customer is always a coproducer, (FP7) the enterprise can only make value propositions, and (FP8) a service-centered view is customer-oriented and relational.

Vargo and Lusch (2004) define the essential concept of "service" as *the application of competences for the benefit of another entity*. They prefer the term "service" (singular), which is a process, as distinct from "services" (plural) which implies "intangible goods." They defend the notion that value is always cocreated. Therefore, they emphasize market with (relational) over market to (transactional). They seek to shift the focus to "operant resources" (value in use, verbs) from "operand resources" (value in property, nouns). They also assert that all economies are service economies, and all businesses are service businesses by this definition.

To relate service-dominant logic to the Sampson and Froehle (2006) view, *customer input is a part of every process* (in the service-dominant logic world view), it just may be very indirect (FP2). Vargo and Lusch (2004) point out that the goods-centered dominant logic implies that the qualities of manufactured goods are normative qualities and (in essence) ideal for self-service – tangibility, separation of production and consumption, standardization, and non-perishability (Parasuraman, Zeithaml, Berry, 1985). The service-centered dominant logic puts competence in provision of service and competence in consumption of service in the spotlight, and more or less on an equal footing. Self-service competes with service from others. However, to consume the most sophisticated services may require a lot of competence, and knowledge of self. For example, consider the challenge of being one's own doctor. Self-service healthcare has its limits (e.g. oper-

ating on oneself while unconscious after an accident). Nevertheless, some may envision robot doctors as an ideal good to support self-service in such circumstances.

Vargo and Lusch (2004) emphasize the evolving nature of this proposed world view, in their article "Service-Dominant Logic: What It Is, What It Is Not, What It Might Be." In the section "what it might be," they see four future research directions for service-dominant logic: (1) the foundation of a paradigm shift in marketing, (2) a theory of the firm, (3) a reorientation for economic theory, and (4) a reorientation for a theory of society. The purpose of the first eight foundational premises aims at a paradigm shift for marketing, while the latter three directions may lead to additional foundational premises. For example, as a theory of the firm, after a discussion of the importance of entrepreneurs in starting new firms, FP9 is proposed to be: organizations exist to integrate and transform microspecialized competences into complex services that are demanded in the marketplace.

For service-dominant logic to become a general theory of service, much work remains to be done. If service is the application of competences to benefit another entity, and all exchange is service for service (with indirections and specialization), then this implies a need to understand entities, competences, exchange, benefit, indirection, and specialization. Such a conceptual foundation is provided in Shelby Hunt's (2000) "A General Theory of Competition: Resources, Competences, Productivity, and Economic Growth." Known as Resource-Advantage Theory, Hunt proposes nine premises that stand in contrast to neo-classical economic theory: (P1) demand is heterogeneous across industries, within industries, and dynamic, (P2) consumer information is imperfect and costly, (P3) human motivation is constrained self-interest seeking, (P4) the firm's objective is superior financial performance, (P5) the firm's information is imperfect and costly, (P6) the firm's resources are financial, physical, legal, human, organizational, informational, and relational, (P7) resource characteristics are heterogeneous and imperfectly mobile, (P8) the role of management is to recognize, understand, create, select, implement, and modify strategy, and (P9) competitive dynamics are disequilibrium-provoking, with innovation endogenous. Basing a general theory of service on what appears to be a general theory of competition between firms has certain advantages. Business and professional services are the fastest growing part of the service economy (based on U.S. job outlook projections), and B2B service research is under-represented in the service research literature. Thus, a resource advantage theory of competition between firms is better aligned with where the service economy is going in the age of globalization and

technology-enabled outsourcing. Furthermore, since the primary competitor for the provisioning of market services is in fact the customer (via self-service), an understanding of comparative advantage in the external provisioning of services between nations, cities, firms, and people – even when one could "do it better oneself" – is instructive.

In the next section, perspectives on a theory of service from other academic disciplines will be presented.

3 Other Academic Disciplines

In this section, academic disciplines relevant to a general theory of service are discussed. Each discipline seeks to create a body of knowledge that professionals from within that discipline can use to explain phenomena, answer questions of theoretical significance, and solve problems of practical value to society. The ten areas with relevance to a general theory of service considered in this section are:

- Economics and Law
- Operations Research
- Industrial Engineering
- Computer Science
- Information Science
- MBA and Management Consulting
- Management Information Systems and Knowledge Management
- Organizational Studies and Organizational Learning
- Urban Planning, Ecosystem Services, and Nature's Services
- Complexity Science and Complex Adaptive Systems for Social Systems Research

To highlight the overlaps in purpose among these disciplines and areas of study, extensive quotes from Wikipedia are used.

Economics and Law: Economics is the social science that studies human activities associated with the production, distribution, and consumption of products and services. Microeconomics is the branch of economics concerned with individual agents, the household or family unit, firms or enterprises (including for-profit businesses, non-profit organizations, non-gov-

ernment agencies (NGOs), and government agencies). Macroeconomics considers entire nations and the global economy. While there are many branches of economics relevant to a general theory of service, econometric which seeks to measure variables of economic interest and understand the relationships between those variables is one important area. For example, measures of service productivity, quality, compliance, and innovation are poorly understood today, but areas of study by economists. Experimental or behavioral economics is a relatively new area that allows laboratory experiments to understand human decision-making processes. Information economics also seeks to understand how information affects economic decisions of households, firms, and nations. In addition, the area of complexity economics (strongly related to evolutionary economics) seeks to unify microeconomics and macroeconomics by simulating economic agents and their decision-making processes from the ground up to obtain emergent macro network effects as observed in real economies. Also, especially relevant to a general theory of service is the study of economic growth and industrial economics, since the role of technological progress or capability improvements is an explicit part of these models. Just as important as improvements in technological capabilities are those in organizational and institutional capabilities, which is the area of study of institutional economics. Finally, spatial relationships are important in many services, so the areas of urban economics, economic geography, and international economics (international trade) have great relevance.

The connection between the law and economics has major implications for service, not just in international trade and service level contracts between firms, but also in the design of new services that are considered fair and sustainable. "Law and economics, or economic analysis of law, is the term usually applied to an approach to legal theory that incorporates methods and ideas borrowed from the discipline of economics. As used by lawyers and legal scholars, the phrase "law and economics" refers to the application of the methods of economics to legal problems. Because of the overlap between legal systems and political systems, some of the issues in law and economics are also raised in political economy and political science. In the United States, economic analysis of law has been extremely influential. Judicial opinions utilize economic analysis and the theories of law and economics with some regularity."[1]

A general theory of service will need to both draw on and align with many areas of economics. One must understand value coproduction between economic entities as they produce and consume services. What are the

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[1] Wikipedia article *law and economics* on 7/16/2006

origins of new services between entities (*inter-entity services*)? If many new services result because of the inadequacy of self- service, then what are the origins of new services within economic entities (*intra-entity services*)? The production and consumption of services between economic entities (family, firm[2], city, and nation) implies win-win value propositions can be cocreated that are superior in some way to self-service, which is the internal provisioning of service. "… the theory of comparative advantage explains why it can be beneficial for two entities to trade services, even though one of them may be able to produce every kind of service more cheaply than the other. What matters is not the absolute cost of production, but rather the ratio between how easily the two economic entities can produce different services. The concept is highly important in modern international trade theory."[3] For a general theory of service, the cost of consumption (Womack and Jones, 2005), not just the cost of production, plays a role in an extended notion of comparative advantage.

Operations Research (OR): "Operations research, operational research, or simply OR is an interdisciplinary science which deploys scientific methods like mathematical modeling, statistics, and algorithms to decision making in complex real world problems which are concerned with coordination and execution of the operations within an organization. The nature of organization is essentially immaterial. The eventual intention behind using this science is to elicit a best possible solution to a problem scientifically, which improves or optimizes the performance of the organization. The terms operations research and management science are often used synonymously. When a distinction is drawn, management science generally implies a closer relationship to the problems of business management. Operations research also closely relates to industrial engineering. Industrial engineering takes more of an engineering point of view, and industrial engineers typically consider OR techniques to be a major part of their toolset. Some of the primary tools used by operations researchers are statistics, optimization, stochastics, queuing theory, game theory, graph theory, and simulation. Because of the computational nature of these fields, OR also has ties to computer science, and operations researchers regularly use custom-written or off-the-shelf software. Operations research is distinguished

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[2] In this paper, the term "firm" refers to: for-profit business, non-profit organization, government agency, and non-government agency, "family" is a multi-person household. Later, we will refer to "service systems" that have both internal and external consumption and production of services. A general theory of service should hold for at least the four key types of services systems observed in the world - family, firm, city, and nation.

[3] Modified Wikipedia article *comparative advantage* on 7/16/2006.

by its ability to look at and improve an entire system, rather than concentrating only on specific elements (though this is often done as well). An operations researcher faced with a new problem is expected to determine which techniques are most appropriate given the nature of the system, the goals for improvement, and constraints on time and computing power. For this and other reasons, the human element of OR is vital. Like any other tools, OR techniques cannot solve problems by themselves."[4]

A general theory of service will have to both draw on and align with operations research. Operations research has been applied to many practical problems relevant to service operation and management: back-office service operations, supply chain management, guaranteeing service quality in network design, scheduling of fleet and field service operations, efficient customer relationship management, optimizing the rate of robotic automation in factories, and workforce management. Extending the range of problems that OR tools and methods can address, especially with respect to the evolution of intra-entity and inter-entity service capabilities, necessitates balancing the shifting costs of both production and consumption of service, and factoring in institutional and regulatory dynamics of service transactions, technological capability dynamics, as well as the relative mobility of people and their microspecializations.

Industrial Engineering (IE): "Industrial engineering is the engineering discipline that concerns the development, improvement, implementation and evaluation of integrated systems of people, knowledge, equipment, energy, material and process. Industrial engineering draws upon the principles and methods of engineering analysis and synthesis, as well as mathematical, physical and social sciences together with the principles and methods of engineering analysis and design to specify, predict and evaluate the results to be obtained from such systems. Industrial engineers work to eliminate wastes of time, money, materials, energy and other resources. Whereas most engineering disciplines apply skills to very specific areas, industrial engineering is applied in virtually every industry. Examples of where industrial engineering might be used include shortening lines (or queues) at a theme park, streamlining an operating room, distributing products worldwide, and manufacturing cheaper and more reliable automobiles. The name "industrial engineer" can be misleading. While the term originally applied to manufacturing, it has grown to encompass services and other industries as well. Similar fields include operations research, systems engineering, ergonomics and quality engineering. There are a number of things industrial engineers do in their work to make processes

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4 Wikipedia article *operations research* on 7/16/2006.

more efficient, to make products more manufacturable and consistent in their quality, and to increase productivity."[5]

Again, a general theory of service would both have to draw on and align with industrial and systems engineering. The shift of industrial engineering toward services is very clear in the quote above. The many elements (people, knowledge, equipment, energy, material and process) that must be considered to improve systems are also highlighted. More could be said about the alignment of the emerging area of service engineering and engineered systems design, and industrial engineering. Also, lean, six sigma, and process improvement methodologies are routinely taught in industrial and systems engineering courses.

Computer Science: Computer science is the study of computer systems. Computer scientists work to understand and improve information technology capabilities. From e-commerce websites that enable self-service in retail to artificial intelligence and robotics, computer science is driving the development of capabilities underlying many practical services. The study of web services, service-oriented architectures, and network services is also on the rise in computer science.

A sphere of computer science that is especially relevant to a general theory of service is the multi-agent systems area. "In computer science, a multi-agent system (MAS) is a system composed of several agents, collectively capable of reaching goals that are difficult to achieve by an individual agent or monolithic system. The exact nature of the agents is a matter of some controversy. They are sometimes claimed to be autonomous. For example a household floor cleaning robot can be autonomous in that it is dependent only on a human operator to start it up. On the other hand, in practice, all agents are under active human supervision. Furthermore, the more important the activities of the agent are to humans, the more supervision they receive. In fact, autonomy is seldom desired. Instead, interdependent systems are needed. MAS can be claimed to include human agents as well. Human organizations and society in general can be considered an example of a multi-agent system. Multi-agent systems can manifest self-organization and complex behaviors even when the individual strategies of all their agents are simple. Topics of research in MAS include: (1) beliefs, desires, and intentions (BDI), (2) cooperation and coordination, (3) organization, (4) communication, (5) negotiation, (6) distributed problem solv-

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5 Wikipedia article *industrial engineering* on 7/16/2006.

ing, (7) multi-agent learning. (8) scientific communities and (9) dependability and fault tolerance."[6]

Like economics, operations research, and industrial engineering, computer science deals with both the modeling of complex real world systems and the creation of new tools and methods that improve the systems' performance. However, in the former three, the notion of social costs or economic costs is more prominent in the models, and an improved system is more productive from a socioeconomic cost standpoint. In computer science, cost is typically associated with "difficulty" or computational complexity, and the space (storage) or time (processing) complexity of an algorithm or a system. Mechanism design theory is one area of research that involves computer scientists where there are clear efforts to bridge the two notions of costs. "Mechanism design is a sub-field of game theory. It is the art of designing rules of a game to achieve a specific outcome. This is done by setting up a structure in which each player has an incentive to behave as the designer intends. The game is then said to implement the desired outcome. The strength of such a result depends on the solution concept used in the game. Most of the results in mechanism design have been established by economists, but some mathematicians, computer scientists and electrical engineers also work in the field. One branch of mechanism design is the creation of markets such as auctions. Another is the design of matching algorithms such as the one used to pair medical school graduates with internships. A third application is the provision of public goods, and the optimal design of taxation schemes by governments."[7]

A general theory of service will draw on concepts from computer science, especially multi-agent systems and mechanism design, for the modeling of service. In addition, service computing, which deals with technical capabilities and standards around web services and service-oriented architectures, is rapidly developing as a special interest group area among computing professionals. Multi-agent systems draw on some of the research that originated in the area of distributed artificial intelligence, which is heavily drawn on in many of the MMORPG (massively multiplayer online role playing games). Guilds within MMORPGs such as World of Warcraft are Petri dishes for future online service exchange.

Information Science: "Information science is an interdisciplinary science primarily concerned with the collection, classification, manipulation, storage, retrieval and dissemination of information. Information science stud-

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6 Wikipedia article *multi-agent systems* on 7/16/2006.

7 Wikipedia article *mechanism design* on 7/16/2006.

ies the application and usage of knowledge in organizations, and the interaction between people, organizations and information systems. It is often, though not exclusively, studied as a branch of computer science and is closely related to the cognitive and social sciences. Information Science focuses on understanding problems from the perspective of the stakeholders involved and then applying information (and other) technology as needed. In other words, it tackles the problem first rather than technology first. Within information science, attention has been given in recent years to human–computer interaction, groupware, the semantic web, value sensitive design, iterative design processes and to the ways people generate, use and find information. Some authors treat informatics as a synonym for information science. Because of the rapidly evolving, interdisciplinary nature of informatics, a precise meaning of the term "informatics" is presently difficult to pin down. Regional differences and international terminology complicate the problem. Some people note that much of what is called "Informatics" today was once called "Information Science" at least in fields such as Medical Informatics. However when library scientists also began to use the phrase "Information Science" to refer to their work, the term informatics emerged in the United States as a response by computer scientists to distinguish their work from that of library science, and in Britain as a term for a science of information that studies natural, as well as artificial or engineered, information-processing systems."[8]

A rapidly growing portion of the service sector deals with information services. All four types of economic entities, family, firm, city, and nation, have two-level bidirectional service supply chains operating within and between entities. A general theory of service will need to borrow from and align with information science.

MBA and Management Consulting: "Master of Business Administration (MBA) is a master's degree in business administration, which attracts people from a wide range of academic disciplines. The MBA designation originated in the United States, emerging as the country industrialized and companies sought out scientific approaches to management. MBA programs expose students to a variety of subjects, including economics, organizational behavior, marketing, accounting (especially activity based costing), finance, strategy, operations management, international business, information technology management, management of innovation, human capital management, risk and insurance management, financial engineer-

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8 Wikipedia article *information science* on 7/16/2006.

ing, e-sourcing, e-commerce, government policy, strategic consulting, and management consulting."[9]

"Management consulting (sometimes also called strategy consulting) refers to both the practice of helping companies to improve performance through analysis of existing business problems and development of future plans, as well as to the firms that specialize in this sort of consulting. Management consulting may involve the identification and cross-fertilization of best practices, analytical techniques, change management and coaching skills, technology implementation, strategy development or even the simple advantage of an outsider's perspective. Management consultants generally bring formal frameworks or methodologies to identify problems or suggest more effective or efficient ways of performing business tasks. Management consulting is becoming more prevalent in non-business related fields as well. As the need for professional and specialized advice grows, other industries such as government, quasi-government and not-for-profit agencies are turning to the same managerial principles that have helped the private sector for years. There is a relatively unclear line between management consulting and other consulting practices, such as information technology consulting."[10]

A general theory of service will need to both draw on and align with the large body of knowledge about the firm that has been compiled in MBA programs and in management consulting practices. The management of technology and the management of innovation are especially relevant to the dynamics of the firm. The tools for formally modeling firms are still in their early stages, but considerable alignment between OR, IE, and management consulting is likely when such tools exist and are in widespread use.

Management Information Systems and Knowledge Management: "Management information systems is a general name for the academic discipline covering the application of information technology to business problems. As an area of study it is also referred to as information technology management. The study of information systems is usually a commerce and business administration discipline, and frequently involves software engineering, but also distinguishes itself by concentrating on the integration of computer systems with the aims of the organization. The area of study should not be confused with computer science, which is more theoretical in nature and deals mainly with software creation, or computer en-

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9 Modified Wikipedia article *Master of Business Administration* on 7/16/2006.

10 Wikipedia article *management consulting* on 7/16/2006.

gineering, which focuses more on the design of computer hardware. IT service management is a practitioner-focused discipline centering on the same general domain. In business, information systems support business processes and operations, decision-making, and competitive strategies."[11]

"Knowledge management (KM) may refer to the ways organizations gather, manage, and use the knowledge that they acquire. The term also designates an approach to improving organizational outcomes and organizational learning by introducing into an organization a range of specific processes and practices for identifying and capturing knowledge, know-how, expertise and other intellectual capital, and for making such knowledge assets available for transfer and reuse across the organization. Knowledge management programs are typically tied to specific organizational objectives and are intended to lead to the achievement of specific targeted results such as improved performance, competitive advantage, or higher levels of innovation. While knowledge transfer (an aspect of KM) has always existed in one form or another, for example through on-the-job discussions with peers, formally through apprenticeship, professional training and mentoring programs, and – since the late twentieth century – technologically through knowledge bases, expert systems, and other knowledge repositories, KM programs seek to consciously evaluate and manage the process of accumulation and application of intellectual capital. KM has therefore brought together various strands of thought and practice relating to: (1) intellectual capital and the knowledge worker in the knowledge economy; (2) the idea of the learning organization; (3) various enabling organizational practices such as Communities of Practice and corporate Yellow Page directories for accessing key personnel and expertise; (4) and various enabling technologies such as knowledge bases and expert systems, help desks, corporate intranets and extranets, content management, wikis, and document management. While knowledge management programs are closely related to organizational learning initiatives, knowledge management may be differentiated from organizational learning by its greater focus on the management of specific knowledge assets. The rise of KM has seen an increasing understanding of the relevance of the distinction between tacit and explicit knowledge, sophisticated perspectives on the management, assessment and use of intellectual capital, and the emergence of new organizational roles and responsibilities such as the position of Chief Knowledge Officer (CKO)."[12]

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11 Wikipedia article *management information systems* on 7/16/2006.

12 Wikipedia article *knowledge management* on 7/16/2006.

The practice side of information economics theory is realized in management of information systems and knowledge management. A general theory of service at the firm level will need to borrow from and align with these areas. The pace of technological change and new methods in these areas can be a major source of competitive advantage and superior financial performance of firms, both intra-entity and inter-entity services production and consumption.

Organizational Studies and Organizational Learning: "Organizational studies, organizational behavior, and organizational theory are related terms for the academic study of organizations, examining them using the methods of economics, sociology, political science, anthropology, and psychology. Related practical disciplines include human resources (HR) and industrial and organizational psychology. Organizational studies are the study of individual and group dynamics in an organizational setting, as well as the nature of the organizations themselves. Whenever people interact in organizations, many factors come into play. Organizational studies attempts to understand and model these factors. Like all social sciences, organizational behavior seeks to control, predict, and explain. But there is some controversy over the ethical ramifications of focusing on controlling workers' behavior. As such, organizational behavior or OB (and its cousin, industrial psychology) have at times been accused of being the scientific tool of the powerful. Those accusations notwithstanding, OB can play a major role in organizational development and success."[13]

"Organizational learning is an area of knowledge within organizational theory that studies models and theories about the way an organization learns and adapts. In organizational development (OD), learning is a characteristic of an adaptive organization, i.e. an organization that is able to sense changes in signals from its environment (both internal and external) and adapt accordingly (see adaptive system). OD specialists endeavor to assist their clients to learn from experience and incorporate the learning as feedback into the planning process."[14]

These areas of academic study are again crucial for any general theory of service at the firm level. Organizational learning theories from Argyris and Schon, March and Olson, Kim, Nonaka and Takeuchi, and Bontis are relevant to making continuous improvement in firms, and not unrelated to the lean and six sigma quality methods that are deployed as parts of OR or IE solutions.

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13 Wikipedia article *organizational studies* on 7/16/2006.

14 Wikipedia article *organizational learning* on 7/16/2006.

Urban Planning, Ecosystem Services, and Nature's Services: "Urban, city, or town planning is the discipline of land use planning which deals with the physical, social, and economic development of metropolitan regions, municipalities and neighborhoods. Other professions deal in more detail with a smaller scale of development, namely architecture, landscape architecture and urban design. Regional planning deals with a still larger environment, at a less detailed level. Historically, urban development was more often a haphazard, incremental event than a deliberate, planned process. In the nineteenth century, urban planning became influenced by the newly formalized disciplines of architecture and civil engineering, which began to codify both rational and stylistic approaches to solving city problems through physical design. However, a number of broad critiques of the rational planning model gained momentum after the 1960s (such as those of Jane Jacobs), helping to expand the domain of urban planning to include economic development planning, community social planning and environmental planning."[15]

"Ecosystem services are processes by which the natural environment produces resources useful to people, akin to economic services. They include: (1) Provision of clean water and air, (2) Pollination of crops, (3) Mitigation of environmental hazards, (4) Pest and disease control. Accounting for the way in which ecosystems provide economic goods is an increasingly popular area of development, catalyzed in particular by Gretchen Daily, a conservation biologist at Stanford University. The concept of ecosystem services is similar to that of natural capital. The Millennium Ecosystem Assessment released in 2005 showed that 60% of ecosystem services are being degraded or used unsustainably."[16]

"Nature's services is an umbrella term for the ways in which nature benefits humans, particularly those benefits that can be measured in economic terms. Robert Costanza and other theorists of natural capital conducted extensive economic analysis of nature's services to humanity in the 1990s. The economic contribution of seventeen of these was found to be approximately US$33 trillion per year, greater than the activities in the inter-human economy, which totaled about US$25 trillion. This was based on estimated costs of replacing the services nature provides, with equivalent services using methods wholly based on human infrastructure."[17]

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15 Wikipedia article *urban planning* on 7/16/2006.

16 Wikipedia article *ecosystem services* on 7/16/2006.

17 Wikipedia article *nature's services* on 7/16/2006.

The practice of the design of service at the city level is part of the urban planning discipline. The geographic and ecosystem aspects of a general theory of service need to borrow from and align with this discipline and area of study.

Complexity Science and Complex Adaptive Systems for Social Systems Research: "Complex adaptive systems are special cases of complex systems. They are complex in that they are diverse and made up of multiple interconnected elements and adaptive in that they have the capacity to change and learn from experience. The term complex adaptive systems was coined at the interdisciplinary Santa Fe Institute (SFI), by John H. Holland, Murray Gell-Mann and others. The term complex adaptive systems (or complexity science) is often used to describe the loosely organized academic field that has grown up around the study of such systems. Complexity science is not a single theory – it encompasses more than one theoretical framework and is highly interdisciplinary, seeking the answers to some fundamental questions about living, adaptable, changeable systems. Examples of complex adaptive systems include the stock market, social insect and ant colonies, the biosphere and the ecosystem, the brain and the immune system, the cell and the developing embryo, manufacturing businesses and any human social group-based endeavor in a cultural and social system such as political parties or communities. What distinguishes a CAS from a pure multi-agent system (MAS) is the focus on top-level properties and features like self-similarity, complexity, emergence and self-organization. A MAS is simply defined as a system composed of multiple, interacting agents. In CASs, the agents as well as the system are adaptive: the system is self-similar. A CAS is a complex, self-similar collectivity of interacting adaptive agents."[18]

To be relevant to a general theory of service, CAS must focus on social systems. For example, CAS or agent based models applied in the following social sciences areas could have great relevance to a general theory of service: sociology, political science, public policy, family, anthropology, economic anthropology, economic history, communication, linguistics, education, cognitive science, and psychology.

In the next section, a synthesis is attempted around the notion of SSME and service systems.

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[18] Wikipedia article *complex adaptive systems* on 7/16/2006.

4 SSME and Service Systems

SSME has been defined as the application of scientific, management, and engineering disciplines to tasks that one organization performs beneficially for or with another ('service'). Today, SSME (Services Sciences, Management, and Engineering) is an urgent call to action for industry, government, and academics to focus on becoming more systematic about service innovation (Spohrer, Maglio, McDavid, Cortada, 2006; Maglio and Spohrer, 2006; Chesbrough and Spohrer, 2006; Maglio, Kreulen, Srinivasan, and Spohrer, 2006; Hidaka, 2006). However, SSME is also a proposed academic discipline and research area, which would complement (not replace) the many academic disciplines that contribute to the body of knowledge about service.

As we've just seen in the previous section, there are numerous existing academic disciplines and areas that study entities that produce and consume service, or exchange service for service. The entities may be social, economic, computational, or human in nature, but one characteristic that unites them all is the production and consumption of service. Often the entities have considerable internal structure that allows for the production and consumption of service, as well as existing within a population or ecosystem of similar entities producing and consuming services, and learning from each other in the process of service production and consumption.

Both Sampson and Froehle's Unified Services Theory as well as Vargo and Lusch's Service-Dominant Logic focus on the service relationship (customer input in the production process, cocreation of value in "service for service exchanges" through the application of competences) as fundamentally important. As Vargo and Lusch point out, the real competitor of service is self-service – if the customer or client has the competences and prefers self-service to service provisioning from another. Both approaches to service also highlight the possibility of indirection (indirect service) or virtual client input (two-level bidirectional service supply chains) developing as other service consumers and providers form networks along which service and service value can travel.

A review of the service-relevant existing academic disciplines shows a similar pattern – a focus on systems of interacting entities, composed of multiple elements. The Industrial Engineering article states: "…concerns the development, improvement, implementation and evaluation of integrated systems of people, knowledge, equipment, energy, material and process… While the term originally applied to manufacturing, it has grown to encompass services and other industries as well." The Operations Re-

search article states: "…an interdisciplinary science which deploys scientific methods like mathematical modeling, statistics, and algorithms to decision making in complex real world problems which are concerned with coordination and execution of the operations within an organization. The nature of organization is essentially immaterial." The Multi-Agent Systems article states: "In computer science, a multi-agent system (MAS) is a system composed of several agents, collectively capable of reaching goals that are difficult to achieve by an individual agent or monolithic system. The exact nature of the agents is a matter of some controversy. ...Furthermore, the more important the activities of the agent are to humans, the more supervision they receive. In fact, autonomy is seldom desired. Instead, interdependent systems are needed."

What emerges is a notion of entities that produce and consume services within populations of other entities. The competences of the entities are critically important, including the competency of custom tuning the service delivery based on input from the customer entity – or else the customer entity may prefer self-service or service from another entity. Also of interest, the importance of humans in the equation is pointed out, even as the autonomous capabilities of the technology components of the system rapidly evolve. The fact is, in the types of services we humans care about most strongly, there are rights of people to be protected. The definition of these rights (or laws) and how they are monitored and enforced (e.g. basic freedoms, property rights, privacy rights, etc.) are important services that evolve over time within the complex entities that produce and consume service.

We term the entities that produce and consume service, *service systems*, highlighting their internal structure and external ecosystem. In everyday life, we frequently encounter four types of entities that might usefully be viewed through the lens of the service system abstraction: family, firms, city, and nations. Firms include for-profit businesses, non-profit organizations, government agencies, and non-government agencies. Perhaps the for-profit business is the canonical entity to be viewed through the service system lens. Businesses exist in a complex ecosystem of service exchange. Businesses have a considerable amount of internal structure, which allows a business to be viewed as a set of components or internal service systems. Thus, the notion of intra-entity services and inter-entity services can be developed. Family or household is a very fundamental service system, in part because it is in all societies the service system that produces people for the future. And hence we see laws emerging related to this service system: "Article 16(3) of the Universal Declaration of Human Rights says: "The family is the natural and fundamental group unit of society and is

entitled to protection by society and the State."[19] Families directly or indirectly (e.g. taxes to schools) contribute to the preparation of the next generation of people to participate in society. Businesses are increasingly concerned with the work/life balance of their employees. Cities and nations are rated on the quality of life they provide families, based on the services offered. Hence, to develop a general theory of service, accounting for the production and consumption of services within and between family, firm, city, and nation entities is an important start.

We can define a service system as a value coproduction configuration of people, technology, other internal and external service systems, and shared information (such as language and laws). Note that this is a recursive definition. This definition highlights that fact that service systems have internal structure (intra-entity services) and external structure (inter-entity services) in which value is coproduced through win-win value propositions, directly or indirectly with other service systems. One should strive not to confuse the abstraction that is termed "service system" with real family, firm, city, and nation entities, or assume the types of service systems are limited to these four canonical types of service systems. The service system abstraction leaves out a lot of detail. However, we will occasionally say "the firm service system" or "the service system of the firm" when what we actually mean is "the firm viewed through the abstraction we term a service system."

The two ends of the service system spectrum are an individual person (who produces and consumes services, with external service systems) and the entire global economy (which contains many internal service systems that produce and consume services). However, a well-formed service system has both internal service structure as well as external service structure. So an individual person and the entire global economy are service systems that require special treatment. A person and all of nature are special types of service systems, since they do not perfectly fit the proposed definition of service systems.

A general theory of service should broadly consist of three bodies of knowledge:

1. Service systems and their services: Understand the origins of new service systems and new services. Understand what is and is not a service system, and what services are produced and consumed by instances and classes of services systems, both externally and internally. The role of people, technology, shared information, as well as the role of customer

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[19] Wikipedia article *family* on 7/17/2006.

input in production processes and the application of competences to benefit others must be defined as well.

2. Service system improvements: Understand the ways a service system improves or can be improved over time through investments, including improving efficiency (improved plans, methods, and techniques for a service system), effectiveness (improved measures, goals, purpose, and key performance indicators for a service system), and sustainability (improved value proposition results, robustness and versatility with more old and new service systems).
3. Service system scaling: Understand the ways improvements (new competences) in one service system can be spread (scaled out and scaled up) to other service systems, both within and between types of service systems (family, firm, city, nation, etc). This leads to the coevolution of intra-entity services and extra-entity services, as service systems obtain greater competences for the production and consumption of more sophisticated services. Because of the nature of customer input (and often customer transformation) in the production process, scaling the distribution of competences is a challenge in service systems. Unless the new competence can be reduced to a simple list of instructions that the receiving service system can implement through self-service, a more complex transformation service is required to spread the competence.

With these three bodies of knowledge as the foundation for a general theory of service, the job of a service scientist is to study service systems, improve service systems, and scale service systems.

From the perspective of the firm, the first body of knowledge relates to the design of new services, the second to continuous improvement of the firm, and the third to the possibility of franchising or in other ways monetizing competences that spread from the innovating firm to the receiving firms. Or more concisely stated: (1) creation (design origins), (2) perfection (improvement), and (3) transformation (scaling).

What are the simplest types of service like? To the degree that the application of competence(s) can be reduced to a list of instructions that one service system can communicate to a second service, and the second service system can use the instructions to gain the benefit of the competence (say through self-service), then the issue of customer input in the production process (Sampson and Frohle, 2006) and the application of competences for the benefit of another (Vargo and Lusch, 2006) – are minimized to "tell me" type service. Thus, a conversation is a building block type of service (in which two service systems exchange self-service executable compe-

tence(s) of satisfactory benefit to both (a win-win value proposition that is not coerced)). More sophisticated service categories include "show me," "help me," and "do it for me."

However, the real world is not that simple. Some competences cannot simply be reduced to a list of easily executed instructions (e.g. riding a bike, transforming the supply chain of a business). Some service systems may not have all the requisite skills to execute the instructions (e.g. a business with a new employee who does not know the corporate culture and IT systems), or it may just be physically impossible at the current technology level for a system to perform the self service (e.g. open heart surgeons operating on themselves). Some services lose their significance when not performed by specific entities (e.g. elevator safety inspection done by a vendor versus appropriate city agency). The execution of some competences may have side-effects and associated risks to other service systems if not executed properly, and so certification may be required as well as proof of responsibility in dealing with unintended consequences (e.g. driver's license and car liability insurance, hospital certification and malpractice insurance). A general theory of service must clarify the characteristics of service systems and service competences that we see in everyday life.

Can a purely technological system be a service system? No, not without including some of the people: the people who design and build it, the people who operate and maintain it, or the people who dismantle or dispose of it. The perspective provided by the Multi-Agent System (MAS) Wikipedia article is helpful: "In fact, autonomy is seldom desired. Instead, interdependent systems are needed. MAS can be claimed to include human agents as well." In fact, whenever an entity can take actions in the world, society prefers to know who is responsible, in case something goes wrong.

What is the role of shared information in a service system? A service system is defined to be a value coproduction configuration of people, technology, internal and external service systems, and shared information. The role of the shared information is especially important in coordination and governance. Three key types of shared information are language, laws, and prices. Without some form of language, signaling, or standard encoding of information, coordination of service systems may be difficult and lead to missed opportunities for innovation or efficiency gains (Gorman, 2004; Paton, 2004). Without laws (as far as we know today), sophisticated service cannot be provisioned, and complex service systems cannot be maintained. Typically, every service system has a governing authority service system that seeks to ensure that all the people in the service system

can communicate in shared languages and abide by shared laws. In families it is the parents, in firms it is the CEO and Board of Directors, in cities it is the mayor and city board, and in nations it is government leaders and agencies, as well as shared legal documents and enforcement agencies. Linguistic evolution, political science, information economics, as well as economics and law are all relevant to a general theory of service, and a deeper understanding of service system design and evolution.

What entities in everyday life can be viewed as types of service systems? So far several types of service systems have been discussed: (1) the first set includes family, firm, city, and nation, (2) firm includes (a) for-profit business, (b) non-profit organization, (c) government agency, and (d) non-government organization (NGO), and (3) and two special cases (a) person and (b) nature, which require special treatment. A service system that is technology centric has also been alluded to, though that service system must include the people who design, operate, or dispose of the technology as part of the service system. In addition, two especially important types of service systems (that fit roughly in the non-profit organization category) are: (1) academic disciplines, and (2) professions. An academic discipline can be viewed as a service system with the faculty and students part of the system, as well as different universities providing services to that service system. A profession may be viewed as a service system that in some cases receives government certification services (e.g. lawyer, doctor, and accountant) as well as services from professional membership associations. Service systems can feed one into the next to create service supply chains. For example, family feeds into academic discipline which in turn feeds into the profession service systems.

Are service systems just another name for organizations? While there is certainly a fair amount of overlap between what qualifies as a service system and what qualifies as an organization, it is worth looking at the standard description of what an organization is: "An organization is a formal group of people with one or more shared goals. The word itself is derived from the Greek word ὄργανον (organon) meaning tool. The term is used in both daily and scientific English in multiple ways. In the social sciences, organizations are studied by researchers from several disciplines. Most commonly in sociology, economics, political science, psychology, and management. The broad area is commonly referred to as organizational studies, organizational behavior or organization analysis. Therefore, a number of different theories and perspectives exist, some of which are compatible, and others that are competing."[20] Where the purpose of a for-

[20] Wikipedia article *organization* on 7/17/2006.

mal group of people is the coproduction of value via the application of competences for the benefit of other organizations, and organizational input is required in the production process, then we begin to see how the notion of organization and service system can begin to be aligned. Furthermore, to the degree that provisioning of the services depends on competences derived from configurations of people, technology, other internal and external organizations, and shared information – and the analysis of these factors is important to understanding (1) the organization and its services, (2) organizational improvements, and (3) organizational scaling – then there is very good alignment between the notions of service systems and organizations. However, the differences in emphasis and focus will require a rethinking of which parts of organization theory contribute most to a general theory of service, and the concept of service system which is one important building block.

What motivates the choice of the four components of a service system (people, technology, internal and external service systems, and shared information)? Hunt (2000) refers to seven types of resources of the firm: financial, physical, legal, human, organizational, informational, and relational. These seven types of resources map well to the four service system components: people (human), technology (physical), internal and external service systems (organizational, relational), shared information (informational, legal, and financial). Nelson and Winter (2000) make the distinction between physical technology and social technology. Physical technology maps to the traditional notion of technology, and social technology maps to people (changing modes of division of labor), other service systems (new ways of organizing and governing work) and shared information (laws and language). The competences or capabilities required to provision a service between service systems are distributed amongst people, technology, other service systems (both internal and external), and shared information. Engelbart (1962, 1980) makes similar distinctions when he talks about basic human capabilities (sensory-motor) coevolving with a human system (social technology – language, methodology, skills and knowledge, attitudes and beliefs) and tool system (physical technology artifacts). The result of the coevolution is a capability infrastructure that can be used to augment knowledge workers and improve the collective IQ of organizations.

What factors influence the evolution of service systems? Baldwin and Clark (2000) provide an in-depth analysis of the coevolution of the tools system (artifacts) and the human system (industry SIC codes) for the computer industry. They identify six modular operators: (1) splitting, (2) substituting, (3) augmenting, (4) excluding, (5) inverting (such as reversing an

automation step), and (6) porting (to a new standard platform). This provides a list of the things that service system designers can do to service systems, or any other type of human-designed artifact or system. Baldwin and Clark examine the short-term economic impact of a modularity decision as well as the long term economic impact (e.g. the effect of module size and visibility on incentive to experiment). March (1991) describes exploration and exploitation in organizational learning, as the key tradeoff a learning organization (evolving service system) must make in an uncertain ecology of other organizations (external service systems competing with value propositions). Sanford (2006) explores the role of the component business model (CBM) for business design and evolution in the context of an ongoing improvement cycle: productivity (exploitation), innovation (exploration), collaboration (internal and external value proposition revisions for sustainability and standardization). Hunt (2000) explores the role of the entrepreneur and innovation in the context of a general theory of competition, and the disequilibrium-provoking impact innovation produces. What emerges is a picture of service systems with complex internal service system structure (CBM) embedded in ecosystems with complex external service system structure. Standardization and modularity emerge at multiple levels and both are disrupted by innovation. When the focus is on a single service system entity, say a particular firm, there appears to be a triple loop learning process at work. The first loop deals with efficiency improvements (plans), the second loop with effectiveness improvements (goals), and the third with sustainability improvements (value propositions, both external and internal). Any action of the firm may of course impact all three simultaneously. For example, when a component of the firm is outsourced, it may improve the efficiency, effectiveness, and sustainability. Alternatively, under different circumstances, in sourcing the same component could lead to improvements across all three.

In sum, this paper suggests that many everyday entities that produce and consume service may usefully be viewed as service systems. Service is defined as the application of competences for the benefit of another, with self-service being one of its main competitors. The degree to which a process is a service process is related to the degree that customer input is essential to realize the mutual benefit. The complex internal structure of service systems includes value coproduction configurations of people, technology, internal and external service systems, and shared information (such as language and laws). The complex external structure of service systems is sustained through the maintenance of win-win value propositions. Competition and innovation act as disequilibrium-provoking forces. The job of a service scientist is to understand and catalog the many types

of service systems and service that exist or might exist someday in the world, and apply that understanding to advancing our collective ability to design, improve, and scale service systems for many practical business and societal purposes (efficiency, effectiveness, and sustainability).

The introduction of the notion of a service system begins the process of aligning research from multiple disciplines to create a general theory of service. A general theory of service can serve as the basis of a new academic discipline (SSME) and a profession (service scientists).

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