



Challenges for Service Science

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Abstract:

Service science is still in a formative stage, with many basic ideas still in flux and significant disagreements about definitions and implications of basic concepts. This paper suggests directions for progress in relation to eight problematic areas within service science. It uses five typical medical services to question typical definitions of service and service system. It suggests that service science should not privilege servitizing over productizing; that a series of design dimensions whose endpoints are often associated with products or with services are more useful than yes/no distinctions between products and services; that the concept of "the customer" should be replaced with clearer identification of different groups and types of customers; that value co-production by customers and co-creation by providers are optional characteristics of services; that assumptions about the importance of the intentions and variability of service system participants should be clarified; and that better balance between analytical rigor and the spirit of service is often needed. As a starting point for addressing these challenges, the concluding section identifies premises underlying an integrated view of service marketing, service operations, and service computing.

Keywords: service science, definition of service, service system, dimensions of service, productization, servitization, co-production of value, co-creation of value

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WHAT SHOULD SERVICE SCIENCE TALK ABOUT?

Although it is less than ten years old, service science has already become the focus of substantial research and attention. The research and attention is deserved because of the continually increasing economic significance of services. In its current state, however, there is little clarity about what service science is about. Consider, for example, the joint sense of the following three quotations, and their joint implications for service science.

In order to differentiate from competitors, those organizations frequently expand their offerings (Becker and Krmar 2008; Böhmman et al. 2008). ... product-oriented organizations follow the notion of servitization and develop and market product-related services (Vandermerwe and Rada 1988), while service-oriented organizations apply the idea of productization to include products in their services or market services as products (Baines et al. 2007).

Herzfeldt et al. 2010

The servitization of processes, architectures and technologies (e.g. service-oriented organizations, service-oriented architectures, service-oriented computing and service-oriented infrastructures) have evolved as a new paradigm for enterprise systems development, supporting intra-enterprise and inter-enterprise collaboration through access to autonomous, implementation-independent interfaces to data, software and infrastructure services.

Demirkan and Spohrer 2010

Services account for 75% of the U.S. gross domestic product (Pal and Zimmerie 2005) and 80% of private sector employment in the U.S. (Karmarkar 2004).

Demirkan and Spohrer 2010

According to these quotations, product firms can servitize their offerings, service firms can productize their offerings, and 75 percent of U.S. GDP is in services. Across both product firms and service firms, it is possible to servitize processes, architectures, and technologies through service orientation. In combination, the above quotations and other parts of the service science literature, such as IfM and IBM (2008), seem to say that service science is a general umbrella that covers:

- things ranging from totally automated computer-to-computer interactions (e.g., client/server computing and service-oriented architectures) to personal services produced by providers for customers through direct person-to-person interaction (e.g., tutoring and physical therapy)
- things ranging from locally situated service activities (queuing systems in banks and grocery stores) through gigantic service systems such as entire governments, water and electricity systems, international monetary systems, and systems for policing large populations
- things ranging from the classification of industrial enterprises (as service, industrial, or agricultural) through the operational details of specific service systems within organizations that produce services and/or industrial or agricultural products

CONTRIBUTION

This paper is a conceptual contribution to ongoing discussions related to service-oriented thinking and service-orientation in IT. It presents eight challenges as an organizing scheme for exploring basic questions about the nature and subject matter of service science. The challenges are related to topics such as the definition of service and service system; the desirability of privileging service and servitization over products and productization; the treatment of co-creation of value and value constellations; recognition of tradeoffs between conflicting stakeholder interests; clarity about whether people are viewed as fallible humans, dutiful components of service systems, or totally predictable components of machine-like service systems; and maintaining analytical rigor without losing the spirit of service. Premises underlying an integrated view of service marketing, service operations, and service computing may be a step toward addressing the challenges described in this paper.



During its infancy as a new discipline, there is nothing wrong with treating *service science* as an umbrella term encompassing everything that has the term *service* in its name. Thus far, it has entailed a diverse set of research reports, theoretical specifications, case descriptions, and practitioner viewpoints, plus some search for commonalities, distinctions, and principles related to systems, methods, and even ecosystems. An earlier working title of this paper, “Servitizing or Productizing—Should That Be the Question?” addresses the spirit of many challenges related to central issues that affect the future development of service science. Overall, what should service science talk about? Is the main question in service science really about services and servitizing? What do we really mean by *services* and *servitizing*? Should we be interested in servitizing but not in its mirror image, productizing? Should we be concerned that servitizing processes and systems is often linked to commoditization of processes (Davenport 2005; Demirkan and Spohrer 2010), which usually enhances product-like characteristics? Should service science espouse symmetrical vocabulary and treatment of services for human customers and services consumed by computerized entities?

Each of this paper’s eight challenges for service science is stated as a potentially valuable direction in theory development and research. Many of these challenges can be pursued initially by simply looking at existing research to see what it says about the object of the challenge. Others call for new research, or at least new syntheses of previous research. Some of the challenges may be controversial because they touch on topics that some researchers view as relatively settled (such as the definition of service and service system), even at this early stage in the development of service science. Other challenges might seem to be outside the realm of service science. Consideration of this combination of challenges might lead to new ideas for developing service science.

CHALLENGE #1: USE A BROADLY APPLICABLE DEFINITION OF SERVICE

A good definition of *service* would have the following characteristics:

- It would emphasize the essence of service and would conform to everyday understandings of what service is.
- It would differentiate between products and services in typical real world situations.
- It would not introduce unnecessary restrictions on what service is.
- It would cover every type of activity that most people consider services, including services for external customers and for internal customers; automated, IT-reliant, and non-automated services; customized, semi-customized, and non-customized services; personal and impersonal services; repetitive and non-repetitive services; long-term and short-term services; services with varying degrees of self-service responsibilities.

Unfortunately service science does not currently have a commonly agreed-upon, readily usable definition of *service* that applies to almost all situations that business professionals; marketing, operations, and organizational researchers; computer scientists; and other researchers would consider services. Existing definitions either do not apply very well to many common services or they treat almost any economic activity as a service. To illustrate this point, we expand on the way Alter (2011) considered whether common definitions of service would categorize the original Netflix CD rental business as a service. We look at a broader example in the form of five medical services:

- Surgery to install an artificial hip
- Extended courses of physical therapy for recovery from serious injuries
- Pre-employment physical exams
- Vaccinations provided at a public health clinic
- Provision of a vendor’s standardized Web-based wellness course for employees of a university

Consider whether these services would be considered services in light of a series of published definitions of service:

1. Kotler and Keller (2006, p. 402) defines service as “an act or performance that one party can offer to another that is essentially intangible and does not result in the ownership of anything.” All five of the medical services involve acts or performances. While there is some degree of intangibility in each case (and in relation to almost any product or service), the processes of performing surgery or helping a patient recover physical function are fundamentally about physical and material concerns rather than intangibles, such as the aesthetics of the facility where services are delivered. The results in terms of functional recovery within an expected time span are relatively tangible and measurable. Contrary to the definition’s stipulation about ownership, hip surgery involves transfer of ownership of the artificial hip to the patient and the vaccination transfers a dose of the vaccine to the patient.



2. Pine and Gilmore (1999, p. 8) defines services as “intangible activities customized to the individual request of known clients.” While the surgery for the artificial hip and the physical therapy are highly customized, the vaccination is not customized at all and the pre-employment physical is probably conducted in as standard a way as possible for the sake of efficiency.
3. IBM Research (2009) defines service as “a provider-client interaction that creates and captures value.” Surgery, physical therapy, physical exams, and vaccinations all involve interactions with the patient, although the nature and duration of those interactions differ across the cases. In relation to capturing value, notice that much of the value of the pre-employment physical accrues to the employer, who is not present during the provider–client interaction. The Web-based wellness course may involve interaction if the employee pays attention, although the interaction itself may not create value if the employee ignores the wellness information.
4. Fitzsimmons and Fitzsimmons (2006, p. 4) defines service as “a time-perishable, intangible experience performed for a customer acting in the role of a co-producer.” Surgery and physical therapy are not well described as time-perishable, intangible experiences because the same actions can occur at a different time and because physicality and materiality are central concerns. While the patient is definitely a co-producer during the course of physical therapy, and while a preoperative or postoperative patient needs to cooperate with medical providers, an anaesthetized patient is not a co-producer in a significant sense and ideally does not experience the surgery at all.
5. Rai and Sambamurthy (2006, p. 328) says that a reasonable triangulation of definitions of service emphasizes “a simultaneous or near-simultaneous exchange of production and consumption, transformation in the experience and value that customers receive from engagement with providers, and intangibility in that goods are not exchanged.” While near simultaneous exchange of production and consumption may describe physical therapy, the product of the surgery may last for twenty years or more and, therefore, is not consumed as the surgery is produced. The online wellness course was produced before any employee watched it, and may be watched many times. The surgery and the vaccination involved transfer of ownership of physical things, specifically, an artificial hip and a dose of the vaccine.
6. Sampson and Froehle (2006, p. 331) defines service as situations in which “the customer provides significant inputs into the production process.” The basic cooperation from the patient that is required during medical procedures may or may not be viewed as “significant inputs” into the production process. Depending on which insurer or government agency pays for the surgery, the patient may or may not have much control over the selection of the surgeon and the timing of the surgery. Instead of providing significant inputs into the production process, most patients have little to say about how the surgeon performs the surgery, how the medical provider injects the vaccine, or how the provider of the wellness course produces the wellness course.
7. Hill (1977, p. 318) describes service as “a change in the condition of a person, or a good belonging to some economic entity, brought about as a result of some other economic entity, with the approval of the first person or economic entity.” All the medical examples involve a change in the condition of a person. On the other hand, there are various situations in which the patient may not approve of the service and may feel coerced, such as when taking an unwanted physical exam or receiving an unwanted vaccination required by an employer or government agency.
8. Grönroos (2011, p. 285) defines service as “value-creating support to another party’s practices. As suggested by Normann (2001), this support may either relieve customers from taking on some task or enable them to do something that otherwise would not be possible to accomplish or would be accomplished less efficiently or effectively.” This definition applies in various ways to all five medical examples. The surgery, physical therapy, and vaccination all enable the patient’s body to perform activities that otherwise would be difficult or impossible. On the other hand, the vaccination might have been delivered by a pill that might be viewed as a product rather than a service. Interestingly, this definition is consistent with the fact that the customer for the pre-employment physical exam is the potential employer, not the potential employee who is being examined.
9. Vargo and Lusch (2004a, p. 2) defines service as “the application of specialized competences (knowledge and skills) through deeds, processes and performances for the benefit of another entity or the entity itself.” This definition applies to all five medical examples, but it also applies to any economic activity, including activities that most people would not view as services, such as manufacturing airplanes. This definition also does not distinguish between economic activities and noneconomic activities, such as hiking or playing a violin for one’s own enjoyment.
10. IfM and IBM (2008, p. 16–17) proposes a similar definition: “the application of competences (knowledge, skills, and resources) by one entity for the benefit of another entity in a non-coercive (mutually agreed and beneficial) manner.” While this definition applies to most instances of the five types of medical service, there are situations in which the manner of providing the service may not be mutually agreed on (e.g., due to

coercion from an employer) and in which the process may not be mutually beneficial (e.g., when a pre-employment physical exam disqualifies a person who otherwise might qualify for a job).

The conclusion at this point is that none of the above definitions satisfies all desired characteristics of a definition of service that were mentioned earlier. Most of the definitions introduce restrictions that would disqualify one or more of the medical services. Vargo and Lusch (2004b) stated a similar criticism in different terms, arguing that four prototypical characteristics often believed to distinguish services from goods—intangibility, inseparability, heterogeneity, and perishability—“(a) do not distinguish services from goods, (b) only have meaning from a manufacturing perspective, and (c) imply inappropriate normative strategies.”

Shortcomings of the above definitions lead us to propose a simple, dictionary-like definition, “Services are acts performed for others, including the provision of resources that others will use” (Alter 2010). A more general version that also covers totally automated services replaces the word *others* with *other entities*, whereby services are acts performed for other entities, including the provision of resources that other entities will use. By this definition, almost any economic activity is a service, regardless of whether it is directed at external customers or internal customers. By this definition, all five of the medical services mentioned above qualify as services. The obvious shortcoming of this definition is that it does not attempt to differentiate between products and services. Not trying to differentiate between products and services is consistent with the third foundational principle in service-dominant logic, “goods are distribution mechanisms for service provision” (Vargo and Lusch 2004a).

A challenge for service science is to move forward even though the fundamental distinction between products and services has proven elusive. The approach implied by the third foundational principle in Vargo and Lusch (2004a) and stated explicitly by the definition in Alter (2010) is basically to say that all economic activities are services because they are acts performed for others. The alternatives include finding a definition that applies rigorously to all services or continuing to use purportedly general definitions that apply to many services but do not apply to many others.

As service industries increasingly dominate advanced economies, focusing more energy on differentiating neatly between products and services seems less and less useful except for supporting researchers concerned with calculating percentage breakdowns that characterize entire economies or industrial sectors. For those researchers, traditional distinctions among agriculture, industrial production, and service production are problematic due to the use of SIC codes that were developed long ago. Those SIC codes increasingly exhibit what might be called inadequate requisite variety (e.g., Ashby 1962) because classifications into predetermined categories simply ignores current flexibility related to productization and servitization strategies, e.g., Neely’s (2009) identification of twelve different forms of servitization for manufacturers.

A final issue related to definitions of service is that referees, editors, and authors should insist that a given journal article should (1) define what it means by service and (2) stick to that definition so that their readers will know what the article is talking about (unless its explicit purpose is to compare different definitions of service or to look at different connotations of the term *service* in different settings). This issue is especially important in discussions of “IT services,” which can mean anything from organized human activities (e.g., help desks, incident tracking, and access management) through totally automated systems and subsystems that operate through computer-to-computer messages by using highly formalized protocols for expressing and responding to unambiguous requests.

CHALLENGE #2: USE A BROADLY APPLICABLE DEFINITION OF SERVICE SYSTEM

Service science has been termed a science of service systems (Spohrer et al. 2008) because almost all services that are significant enough to analyze are produced through service systems. This implies that it is important to consider the definition of service system. Here are three alternative definitions:

A service system is “an integrated and interdependent combination of component resources that satisfies service requirements. A service system encompasses everything required for service delivery, including work products, processes, facilities, tools, consumables, and human resources. Note that a service system includes the people necessary to perform the service system’s processes.”

Glossary of CMMI (Capability Maturity Model Integration) for Services,
version 1.3 (Software Engineering Institute 2010, p. 498)

A service system is a work system that produces services. A work system is a system in which human participants and/or machines perform work using information, technology, and other resources to produce products/services for internal or external customers (Alter 2006; 2008). All work systems involved in economic exchange are service systems because they perform work to produce something for the benefit of others. A very small percentage of work systems are not service systems because they involve someone



performing work only for personal benefit, such as cleaning one's own office or making one's own lunch in a repeatable way.

Alter 2011, p. 7

"Service systems are complex adaptive systems." A customer service system "is a service system from the viewpoint of a customer or consumer. A customer service system searches provider value propositions looking for win-win value-co-creation opportunities." A provider service system is "a service system from the viewpoint of a provider. A provider service system aims to meet the customer's needs better than competing alternatives consistently and profitably (in business contexts) or sustainably (in non-business contexts). Provider service systems seek deep knowledge of customer service systems ... to improve existing, and create new, value propositions.

IfM and IBM 2008, p. 16

The first and second definitions can be applied in a relatively straightforward way to all five of the medical examples. A typical manager or analyst could probably identify the work products, processes, facilities, tools, consumables, and human resources mentioned in the first definition and the participants, customers, process steps, and other elements mentioned in the second definition.

The third definition came from a White Paper on service innovation generated by a Cambridge UK symposium of service science leaders (IfM and IBM 2008). It is based on earlier conceptualizations by Normann (2001), and has been refined further by Maglio and Spohrer (2008), Vargo and Akaka (2009), and Spohrer et al. (2010). This definition provides an interesting way to look at economic exchange by encompassing both a customer's view of the service system and a provider's view. However, in real world situations, such as many instances of the medical examples mentioned above, it would be difficult to articulate the boundaries or other properties of the customer service system and provider service system that are included in the definition. In medical examples, such as getting a vaccination from a public health clinic or receiving a pre-employment physical exam, it would be difficult to describe how a customer service system actually "searches provider value propositions" or how the provider service system "seeks deep knowledge of customer service systems."

The challenge for service science is to find alternative definitions that are more usable than any of the three mentioned above and that lead directly to insights that can be used for improving specific service systems. The first two definitions are designed to understand and evaluate the operation of service systems. The third definition is designed to understand the economic negotiation that led to the form and capabilities of the service system. Better definitions would be broadly applicable and would also reflect and emphasize characteristics of service systems that would help managers and researchers think about such systems in more depth.

CHALLENGE #3: TREAT SERVICIZING AND PRODUCTIZING SYMMETRICALLY

As explained above, service science has not produced an encompassing definition of service that fits all situations and that distinguishes between products and services in a clear way. Somewhat similarly, the term *servitizing* has been used with different, almost contradictory meanings and connotations. Ideally, *servitizing* should be treated symmetrically with *productizing*. From a business viewpoint, the distinction between products and services (and between productizing and servitizing) is much less important than providing a mix of product-like and service-like features that internal or external customers want and find beneficial. The designer's decision (as opposed to the classification decision) is about finding the right location along a series of design dimensions (Alter 2010).

As an example, consider a traditional textbook, an online version, an online version with interactive exercises, an online version with interactive exercises and interaction with an expert, and, finally, a person-to-person tutorial by an instructor. Each successive modification transforms the book into something that is more service-like until the last approach is clearly a service. Steps toward productizing the person-to-person tutorial service lead in the direction of the traditional textbook; steps toward servitizing the traditional textbook lead in the direction of person-to-person tutorials. In another example, provisioning of meals can be productized by moving step-by-step toward pre-packaged fast food meals; it can be servitized by moving toward a fine dining experience that is much more service-like, even though it includes delivery of tangible things to customers. Many similar examples involve various forms of information distribution, medical care, and many kinds of work that are performed for customers.

Table 1 shows how to view productizing and servitizing in relation to a series of design dimensions. The endpoints of the dimensions in Table 1 are deemed "product-like" or "service-like" in relation to characteristics that are often associated with products and with services. Instead of referring to any of the definitions of service that were mentioned earlier, Table 1 uses *product-like* and *service-like* in a metaphorical sense and is fundamentally about finding the right combination of characteristics for an offering to customers. This table positions each of the five medical services along each of the dimensions, demonstrating that each of the medical services is more product-like

in relation to some dimensions and more service-like in relation to other dimensions. The specifics of any particular situation might call for movement in the direction of productizing or servitizing along any of the dimensions. Regardless of whether the topic is the products and services produced by a work system within an organization or a firm's economic offerings for its external customers, servitizing whatever is produced generally implies moving toward the right in Table 1, with any particular offering falling in different locations along different dimensions. Similarly, productizing whatever is produced generally implies moving toward the left along the same dimensions. Much more interesting than whether a product or service is being produced is the question of whether the overall offering for the internal or external customers of a system or firm has the right balance of product-like and service-like features across all of the dimensions. Overall, there is no business reason to believe that servitizing is somehow superior to or more interesting than productizing.

Table 1: Approximate Placement of Five Medical Services Across Dimensions for Designing Products/Service Offerings (for illustration only; not based on a specific instance of each service)

More product-like	<<----->>	More service-like
Customer value from things that the customer receives	-----E-----D-A-----C--B	Customer value from provider actions
Customer value from things that the customer uses	-----E----- D-A -----C--B	Value from experience that the provider produces
Production of value by the provider	-----D-----C--A-E-----B-	Co-production of value by the provider and customer
Standardized, scripted interactions and products	-E-D-----C-----AB--	Customized, non-scripted interactions and products
Value from tangible features of whatever the provider produces	-D-A-B-----C----E-----	Value from intangible features of whatever the provider produces
Transferred to customer and used later	--E-----A--D---BC	Consumed by customer during production
Produced by provider with little or no co-production	---D-E-----C-----A--B-	Customer plays extensive role in co-production
Transfer of ownership	----AD-----E-----BC--	Non-transfer of ownership
Transaction-based interactions	-EDC-----A-----B-	Relationship-based interactions
Interactions not concerned with internal state of customer	----E-----D---C-----AB-	Interactions trying to discern and respond to internal state of customer

- A = surgery to install an artificial hip
- B = extended courses of physical therapy for recovery from serious injuries
- C = pre-employment physical exams
- D = vaccinations provided at a public health clinic
- E = standardized, Web-based wellness course provided by a vendor for employees of a university

An additional issue related to productizing vs. servitizing is that servitizing processes, systems, and organizations actually makes interactions between providers and customers more product-like in terms of the dimensions in Table 1. Consider the view of services conveyed in an issue of *IBM Systems Journal* devoted to the service-orientation:

A service "is generally implemented as a coarse-grained, discoverable software entity that exists as a single instance and interacts with applications and other services through a loosely coupled (often asynchronous), message-based communication model."

Brown et al. 2005

The component that consumes business services offered by another business component is oblivious to how the provider created the business service.

Cherbakov et al. 2005

With that view of services, interactions between providers and customers in servitized processes, systems, and organizations are characterized by standardized formats for service requests and service responses. In an automated service regime described by the quotations above, service interactions occur through message-based communication protocols, and the customer (the component that consumes business services) does not care and cannot know how the provider produced the business service. Bringing service orientation to the enterprise level, Demirkan and Spohrer (2010) say that a servitized enterprise takes performance advantage of commoditization of hardware, software, and even business processes, thereby moving toward the product-like side of Table 1. While passing unambiguous messages passing back and forth between providers and customers has many advantages in technical architectures and even in highly repetitive production processes (e.g., tenets about clear communication in the Toyota Production System), mechanical interactions are rarely expected or desired in customer-centric, high-touch situations where impressions, relationships, and feelings are more important than technical efficiency and technical flexibility.

Overall, the dichotomy between productizing vs. servitizing raises several challenges for service science. To date, service science seems to privilege services and servitization over products and productization. For example, a Google Scholar search on {"service science" + services + servitization} found 162 hits, whereas a search on {"service science" + products + productization} found 52. Ideally, service science should move beyond privileging service and servitizing over products and productizing. Servitizing and productizing should be viewed as opposite strategy directions that apply across multiple dimensions, as shown in Table 1. In any particular situation, it may be beneficial to change five dimensions of a product/service offering in the direction of servitizing while changing the other dimensions of that same offering in the direction of productizing. In addition, service science should resolve what seems like contradictory meanings and connotations of the same concept. Servitizing of product/service offerings implies adding, reinforcing, or accentuating service components of offerings to customers, often through a combination of customizing for unique individual needs, providing beneficial experiences for customers, involving customers extensively in co-production, performing services based on relationships rather than transactional logic, and trying to discern and respond to the customer's internal state. Servitizing should not have opposite connotations in relation to processes, systems, and organizations.

CHALLENGE #4: REPLACE "THE CUSTOMER" WITH CLEAR DISTINCTIONS BETWEEN VARIOUS CUSTOMER GROUPS AND OTHER STAKEHOLDERS WHOSE DIFFERENT INTERESTS MAY CONFLICT

The service science literature often uses the vague and nonspecific concept of "the customer." That concept is insufficient for many service systems whose multiple customer groups and other stakeholders have conflicting perceptions and priorities related to the need for and quality of the various products/services that the service system produces. Instead of assuming the existence of "the customer," service science should assume that most service systems in organizations have multiple customer groups and stakeholders whose interests may conflict. Any particular customer may be in several of the following categories simultaneously:

- External customers, who receive services produced by a service system and are neither employees nor contractors of the enterprise that produces the services
- Internal customers, who receive services produced by a service system and are employees or contractors of the enterprise that produces the services (e.g., customers of payroll systems, internal corporate training systems, and HR systems)
- Direct customers who receive and benefit directly from whatever service is being provided
- Indirect customers who reap benefits that follow from the services received by direct customers (e.g., parents who have more time available because their children participate in after-school activities)
- Paying customers, who pay for services that may or may not be received by other customers (e.g., insurance companies that pay for medical services received by employees of firms that purchase insurance policies)
- Nonpaying customers, who receive services that are paid for by others and who, therefore, may feel less motivated to use those services efficiently
- Voluntary customers, who want to be customers of a particular service system
- Involuntary customers, who are coerced into being customers of a particular service system



- Other stakeholders, who are not customers but are affected directly or indirectly by conditions surrounding the arrangements for providing service or the results of providing service. Examples include nonparticipating executives who are responsible for specific service systems and managers in other departments whose power is increased or decreased by the circumstances under which services are delivered by another department.

The various types of customers appear in different guises in the five medical examples in Table 1. Many medical systems have both external and internal customers. Patients are usually *external customers* because they usually are not employees or contractors of the medical providers that produce the medical services of interest. On the other hand, most medical systems directed at external customers also have *internal customers* because they generate extensive information that is used within the provider enterprise by departments or functions such as billing, scheduling, and quality assurance. The patients receiving medical services are *direct customers* of most medical services, such as hip replacement, physical therapy, and vaccination. In contrast, the person who receives the pre-employment physical exam might be viewed an *indirect customer* because the potential employer requested the exam and needs the information that it produces. *Indirect customers* of many medical service systems include nonparticipating employees or departments that will provide subsequent services and, therefore, will be affected by the success or difficulties of previously provided services. The gulf between the direct customers and *paying customers* of medical services is cited widely as a factor in many of the problems in health systems. In many situations, the costs that the patient will bear affect the patient's choices about the quality and quantity of medical care or medication to obtain. The distinction between *voluntary customers* and *involuntary customers* appears in situations where vaccinations are required in order to attend school or where medical examinations are a precondition for employment, regardless of whether the patient wants the service.

Identifying different groups of customers is a step toward identifying conflicting perceptions, interests, and priorities of different customer groups, thereby penetrating the over-simplified concept of "the customer" in complex service systems. For example, satisfying government organizations that require the reporting of specific information in specific formats may conflict with compiling related information in a way that is more useful for management. In that case, there is conflict between the needs of management customers and the need of government customers for related information. In supply chains, conflicts may arise concerning the degree of visibility that is available to different supply-chain partners who have conflicting interests related to transparency and priorities. Similar issues arise in many complex systems in society, such as water systems, transportation systems, and medical systems.

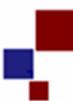
In addition, interests of the various groups of customers often conflict with the interests of providers because customers are most concerned with the cost, quality, reliability, and other characteristics of whatever they receive or experience from a service system. In contrast, providers are also concerned with the service system's efficiency and effectiveness in using the provider's internal resources. There are many situations in which internal efficiency reduces responsiveness to customers and may increase their costs. For example, an organization's accounting system may be designed to maximize efficiency in the accounting department and may disregard the possible uses of information that could be valuable to other departments within the firm.

The challenge for service science is to recognize and embrace the multiplicity of customer groups and customer types and the related multiplicity of divergent goals in important service systems. Those divergences generate so many conflicting goals that pair-wise accommodations between specific groups of customers and providers may conflict with beneficial outcomes for other stakeholders.

CHALLENGE #5: HIGHLIGHT CUSTOMER AND PROVIDER RESPONSIBILITIES FOR VALUE CREATION

The idea of value has received a great deal of attention in marketing, service, and other fields. Vargo et al. (2008) notes that Aristotle differentiated between value-in-use and value-in-exchange over 2000 years ago. Ramirez (1999) notes that "the value of offerings is established only partially in terms of the activity which the supplier has poured into these [offerings]." Value to the customer includes "labor saving value, whereby customers do not have to carry out the activities 'crystallized' in the acquisition," and enabling value, which is related to "the enhanced ease, productivity, safety, elegance, and/or effectiveness" in the acquirer's value-creating actions.

Although value to the customer is obviously a central issue, the service science literature contains differing views about how value is produced. As stated in previously mentioned definitions of service, Fitzsimmons and Fitzsimmons (2006) and Sampson and Froehle (2006) view co-production or co-creation of value as a defining characteristic of services. Ramirez (1999) traces the history of the concept of value co-production for 290 years, and notes that Normann and Ramirez (1993, 1994) "extended the notion of services to cover all activities in which obtaining actual utility value requires customer value creation." "The customer is always a co-producer" is



foundational premise #6 in Vargo and Lusch (2004a), the original article on service-dominant logic. Subsequently, Vargo and Lusch (2006) restated that premise as “the customer is always a co-creator of value.”

Coming at value co-creation from a different viewpoint, Grönroos (2011) dissects the concepts of value creation and value co-creation in depth and concludes that foundational premise #6 is misleading even though it is “repeated over and over again in the literature” (p. 292). Grönroos (2011) proposes revising a number of the foundational premises from Vargo and Lusch (2008). For instance, FP #6 becomes “fundamentally, the customer is always a value creator.” FP #7, “the enterprise can only make value propositions,” is revised as “fundamentally, the firm is a facilitator of value for the customer.” Co-creation of value is not required in the sense of FP #6, but rather, is optional, i.e., “provided that the firm can engage with its customers’ value-creating processes during direct interactions, it has opportunities to co-create value jointly with them as well.” Furthermore, “the firm is not restricted to offering value propositions only, but has an opportunity to directly and actively influence its customers’ value creation as well” (p. 293).

Alter (2008) proposes a service value chain model that is more consistent with the Grönroos view than the Vargo and Lusch view. With the service value chain model, service instances involve both service provision by the provider and customer responsibilities. Both the service provision and the customer responsibilities appear in steps such as set-up, service request, service fulfillment, and follow-up, with each step possibly having both front-stage and back-stage activities. Service interactions can occur throughout any of the steps. In service systems that produce multiple service instances, the service instances are often preceded by a negotiation phase that determines service level agreements and other agreements that govern subsequent instances of service provision. With that view, any co-production of the service occurs during the front-stage interactions, although there is no necessity that all front-stage actions provide value for the customer, such as when a front-stage interaction supports the provider’s internal information needs or even when a front-stage interaction has negative value for the customer. Alter (2008, 2010) attempts to incorporate aspects of the value exchange concept by noting that value capture occurs for both the provider and the customer across the entire service value chain. For example, the provider might capture some value through the way the customer facilitates negotiation of the service level agreement and makes other aspects of the provider’s activities more efficient and, hence, more beneficial to the provider. In such situations, the additional value for providers may lead them to differentiate charges to customers based on differential amounts of provider resources that different customers absorb.

It is possible to test these different views by looking at the five medical examples mentioned earlier. Table 2 shows aspects of value creating activities that do or do not involve co-creation of value.

Table 2: Value Creation in the Five Medical Examples

Example	Value co-creating activities	Value creating activities not involving co-creation
Surgery to install an artificial hip	Patient cooperation in preoperative and postoperative interactions (Co-creation does not occur during the surgery itself because the patient is unconscious.)	Achieving value related to increased mobility and decreased pain depends on the patient’s compliance with medical advice related to postsurgical therapies and activity guidelines.
Extended courses of physical therapy for recovery from serious injuries	Extensive cooperation between patient and therapist during sessions	Achieving value related to improved functioning depends on the patient’s compliance with the therapist’s advice related to activities and exercises outside of the therapy sessions.
Pre-employment physical exams	The potential employee cooperates with the medical provider giving the exam.	The potential employer decides how to use the information generated in a specific exam.
Vaccinations provided at a public health clinic	The patient appears at the appointed place and time and cooperates with the clinic’s personnel.	The patient’s immune system creates protective antibodies in the days after the vaccination. That part of the value creation for the patient is unrelated to provider actions after the time of the vaccination.
Provision of a vendor’s standardized Web-based wellness course for employees of a university	The employee uses the Web-based wellness course that is provided by the vendor.	The employee receives health-related value by behaving in accordance with the information in the wellness course.

In regard to understanding, analyzing, and improving specific product/service offerings, the interesting question is the extent to which the customers are or should be co-producers or co-creators of value. The changes might be in the direction of more co-creation or less. For example, customers who just want something to be done might prefer reducing or even minimizing the extent of co-creation, as might apply for a service such as cleaning houses or shoveling snow. In contrast, customers who want to be involved might prefer increasing the extent of co-creation, such as finding ways to engage more directly with service providers whom they find interesting or inspiring.

The design dimension in Table 1 that is devoted to co-production ranges from production of value by the provider (more product-like) through co-production of value by the provider and customer (more service-like). Treatment as a design dimension says that different service situations involve different degrees of co-production or co-creation. Instead of focusing on value co-production or co-creation as part of the definition of service, assume that service usually is co-produced and then look at the continuum from minimal co-production by the customer to extensive co-production by the customer. With minimal co-production customers do nothing or do little more than requesting a service. With more extensive co-production, customers participate in several or many aspects of service fulfillment processes (as happens in the examples of the vaccination and the pre-employment physical exam). With even higher degrees of co-production, service occurs through multiple service interactions, including direct participation by customers (as happens in the physical therapy example). When self-service approaches are used, the service provider creates and provides the means by which the customer performs self-service processes and activities that create value.

The challenge for service science is to make genuine use of the concept of co-production or co-creation of value, rather than just using it in a definitional sense. For example, focusing on co-creation might provide an interesting direction for research related to topics such as IT-related services, the value of IT, and IS/IT analysis and design. In regard to IT-related services, it would be interesting to look at the extent of co-production or co-creation of value in real-world examples of the various service systems covered by the Information System Infrastructure Library (ITIL), which is summarized in itSMF (2007). ITIL proposes best practices for services such as incident management, request fulfillment, access management, and release and deployment management. It would be interesting to characterize the extent of co-production in ITIL's proposed best practices and to test empirically whether the extent of co-production proposed by ITIL is actually beneficial in practice for some or most of the ITIL processes. In regard to the value of IT, it would be interesting to correlate the extent of co-production of value in IT-intensive processes in organizations and to see whether co-production of value tends to increase customer satisfaction and/or provider efficiency within common types of service processes, such as supply chain, hiring, customer service, and management processes. In regard to systems analysis and design, it would be interesting to see whether the concept of co-production of value is even on the radar screen in most textbooks. It would be more interesting to develop concepts, methods, and tools that characterize the extent of co-production in an existing or proposed system and that could identify potential changes in a system that might achieve a more appropriate level of co-production, regardless of whether that level involves more or less co-production/co-creation of value by customers.

CHALLENGE #6: LOCATE SERVICE SYSTEMS WITHIN VALUE CONSTELLATIONS

Porter (1985) introduced the idea of value chain analysis in relation to how a particular firm operates through primary (value-adding) activities and support activities. Normann and Ramirez (1994) extended value chain analysis with the concept of *value constellation*, where "value is coproduced by actors who interface with each other. They allocate the tasks involved in value creation among themselves and to others, in time and space, explicitly or implicitly." The idea of value constellation is of great potential importance in service science because few if any firms can produce everything that is needed to support value creation and co-creation by their customers. Along these lines, Vargo et al. (2008) note that Spohrer et al. (2007, 2008) see "service science as the study of service systems and of the co-creation of value within complex constellations of integrated resources."

Attempts to locate and analyze service systems within value constellations would go beyond merely identifying outsourced or "out-tasked" activities. This would require more of a system view and would focus on characterizing both the individual service systems within a value constellation and the value constellation itself as an overarching service system. A proposed step in that direction is a metamodel for service design (Alter 2011, 2012b) that integrates the following three levels: service activities, service systems, and value constellations. That metamodel or its successors might be extended and improved using ideas from past research on value configurations (Stabell and Fjeldstad 1998), networked value constellations (Tapscott et al. 2000), and various business modeling techniques.

The challenge for service science is to develop a consistent way to talk about service systems and the value constellations in which they operate, especially since a given service system might be part of many different value constellations. Many complications may occur, starting with various layers of intermediate customers. For example, the contributions of some service systems within a value constellation may be invisible to end-customers. The interactions between service systems may not be coordinated well. Resource utilization within a value constellation



may be skewed in a way that undermines the overall effort, as happens when payment subsystems for medical providers encourage doctors to perform medical procedures by paying much more for procedures than for other forms of interaction with patients.

CHALLENGE #7: CLARIFY ASSUMPTIONS ABOUT THE NATURE AND INTENTIONS OF SERVICE SYSTEM PARTICIPANTS

Service analysts and theorists treat service system participants in quite different ways, sometimes as inconsistent and fallible humans driven by personal and group motivations; sometimes as dutiful components of service systems doing their best to meet expectations; and sometimes as flawless cogs in precise and highly repeatable mechanical systems. Needless to say, expectations about the operation of service systems will depend on which assumption is used.

Clarification of assumptions about people and organizations is especially important in service science because its scope is so broad, encompassing situated person-to-person interactions, large impersonal systems at the level of entire enterprises or geographical regions, and also architectures for building software. Parts of service science that are inspired by computer science and service-oriented architectures sometimes seem to assume that people are nonparticipants in systems (but perhaps users of technology) or that they are dutiful components of service systems who will perform specified processes and activities consistent with designers' intentions and management's goals. It is almost as though any people who are included within service systems are humans simulating machines (e.g., see Alter 2012a). At the other side of service science, there is recognition that people are fallible components of relatively fragile service systems that cannot control participants' activities directly, but can only guide those activities through a combination of training, incentives, punishments, monitoring, and feedback. The literature of organizational behavior and socio-technical systems is full of issues related to human variability, motivation, information asymmetry, moral hazard, workarounds, bricolage (making do with whatever is available), and emergent change. While it is often both reasonable and useful to view service system participants as dutiful, if occasionally error-prone components of those systems, there are many other situations where it is equally useful to view them as fallible humans or essentially as reliable machines performing work in a prescribed manner.

The challenge for service science is simply to make sure that researchers and authors inform readers about whatever view of people is incorporated in their research effort and publications.

CHALLENGE #8: MAINTAIN ANALYTICAL RIGOR WITHOUT LOSING THE SPIRIT OF SERVICE

Much important service science research attempts to model complex service systems with the goal of improving their efficiency, reliability, and other aspects of their performance. While such goals are important, the formalization needed for such research sometimes seems to drain the spirit of service out of the discussion. Thus, there is some tension between the quest for answers in the style of "hard science" and inspiration and guidance in the style of "soft science."

On the soft side, the more informal and aspirational parts of the service science literature are sometimes vague, with terms such as *service*, *IT service*, *servitization*, *customer*, *value*, and *value proposition* defined unclearly or not at all. Too often, interesting examples of service and service systems do not conform to definitions of service and service system, even in the same paper. While the spirit of that part of the literature sometimes comes through in a clear and actionable manner, there are other times in which the ideas are not clear enough to transfer to other situations.

On the hard side, initial steps toward rigor involve formalization that appears as clear definitions of terms and relationships, and as genuine effort to match terms, relationships, and theories to the specific situations that are being discussed. The most complex formalization appears in abstraction from real world situations into mathematical notations that are difficult or impossible for all but Ph.D. level researchers to understand.

In relation to the balance between the hard side and the soft side, the highly formalized parts of the service science literature often uses mathematical notations that may obscure as much as they illuminate, at least from the view of a reader uninvolved in the original research. For example, assume that the discussion of a service situation starts with the statement that a service offering consists of services s_i , delivered by providers p_j , to customer $C_{m,k}$ within customer segments C_m , with provider-related cost $c_{i,j}$ and provider-related value proposition $vp_{i,j,k}$. Assume that that notation is part of a complex mathematical determination of an equilibrium condition or a market clearing price related to a service offering. While the economics and management science literature abound with valuable theory papers that express concepts using complex notations, Greek letters, and subscripts and superscripts, it is unlikely that notations of that type can capture things such as the quality of service interactions that are mentioned in Carlzon's (1989) book about the "moments of truth" when service is delivered.

A challenge for service science is to recognize the tension between simply being vague, on the one hand, and using such a high degree of formalization that the spirit of service disappears from the analysis. At its best, service science should be rigorous enough to produce clear concepts, analyses, and conclusions that will not be misconstrued, and to package those ideas in forms that make them understandable and usable in practice.

CONCLUSION

This paper tried to capture the spirit of some of the challenges that service science faces in relation to becoming a more coherent, valuable, and teachable discipline. Many of those challenges involve fundamental disconnects and minimal commonality of theory, conceptual development, or real world application between service marketing, service operations, and service computing. The service science literature contains many claims that service science is interdisciplinary or multidisciplinary (e.g., 1680 Google Scholar hits on {"service science" + interdisciplinary} and 1180 hits on {"service science" + multidisciplinary}). Ideally, this paper's presentation of challenges for service science will contribute to future discussions, theory development, and real world applications that will lead to a higher degree of overlap and genuine integration.

The future path of service science depends in part on how this paper's challenges (and many other issues not mentioned here) are addressed. Combined with structural ideas from a previously mentioned metamodel (Alter 2011, 2012b), some of the main ideas in this paper's discussion of challenges for service science may provide a new starting point for articulating an integrated view of service-related topics that is simultaneously applicable to service marketing, service operations, and service computing. The following list summarizes that possible starting point:

- Services are acts performed for other entities including the provision of resources that other entities will use. That definition encompasses services for people and totally automated services performed by one computerized entity for another. When thinking of services for people, a simpler version of the definition suffices: services are acts performed for others.
- Almost any economic activity is a service (by the above definition).
- Services use resources that may include human resources, informational resources, technological resources, and other types of resources such as readily available water or sunshine.
- Services are performed by actor roles that may include noncustomer participants (providers), customer participants, and automated agents.
- Services in general do not have defining characteristics such as intangibility, inseparability, heterogeneity, and perishability. Instead, any specific service may exhibit a variety of characteristics that are often viewed as product-like or service-like in everyday speech.
- A service system is a work system that produces services. A work system is a system in which human participants and/or machines perform processes and activities using information, technology, and other resources to produce products/services for internal or external customers.
- Service systems may have human participants or may be totally automated. Automated agents are totally automated service systems. Decomposition of socio-technical service systems usually isolates subsystems that are automated agents.
- Services within a service system may produce resources and conditions that are used by, are necessary for, or that initiate other services within the same service system.
- Co-production and co-creation of value are optional for specific services and for service systems. In other words, it is possible but not essential for customers of services or service systems to participate in service activities within those service systems.
- Both services and service systems may have multiple customers who may have divergent or conflicting goals regarding whatever the service or service system produces.
- Human participants in service systems may totally fulfill the intentions of system designers, may try to fulfill those intentions with varying degrees of accuracy and success, may not be aware of designer and/or management intentions, and may pursue goals and interests that may conflict with the service system's goals.
- A value constellation can be viewed as a large service system consisting of multiple service systems, any one of which may change in function or form based on decisions made by owners of that service system. Value constellations may come into existence, may change over time, may absorb or slough off service systems, and may disappear without conscious decisions by a central owner or controller.

Some of the above ideas are consistent with widely accepted views within the service science community. Other ideas are departures in new directions. It would be nice to have a widely accepted, integrated view of service and service systems that provides insights for service marketing, service operations, and service computing. On the other hand, there is no reason to believe that every corner and layer of service science should look and sound the same. At this early stage in the development of service science, it is worthwhile to develop a number of different comprehensive views that try to integrate fundamental concepts. Ideally, careful attempts to compare comprehensive reference models of service will provide an important contribution to the development of service science.

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