Seven Contexts for Service System Design

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Many of the most complex service systems being built and imagined today combine person-to-person encounters, technology-enhanced encounters, self-service, computational services, multi-channel, multi-device, and location-based and context-aware services. This paper examines the characteristic concerns and methods for these seven different design contexts to propose a unifying view that spans them, especially when the service-system is "information-intensive." A focus on the information required to perform the service, how the responsibility to provide this information is divided between the service provider and service consumer, and the patterns that govern information exchange yields a more abstract description of service encounters and outcomes. This makes it easier to see the systematic relationships among the contexts that can be exploited as design parameters or patterns, such as the substitutability of stored or contextual information for person-to-person interactions. A case study for the design of a "smart multi-channel bookstore" illustrates the use of the different design contexts as building blocks for service systems.

Introduction

"Service" once only implied face-to-face interactions between two people, one offering the service and the other receiving it. Today service domains and interactions are vastly more complex. "Service systems" combine and integrate the value created in different design contexts like person-to-person encounters, technology enabled self-service, computational services, multi-channel, multi-device, and location-based and context-aware services (Maglio, et al., 2006; Spohrer, et al., 2007). Most service designers are familiar with some of these contexts, and each context has a research and practitioner literature that highlights their characteristic design concerns and methods. But few service designers are familiar with all of them, and because the design concerns and methods in one context can seem incompatible with those in others, there is relatively little work that analyzes design concerns and methods that span multiple contexts.

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This paper argues that for the substantial subset of service systems that can be described as "information-intensive," it is desirable to take a more abstract view of service contexts that highlights what person-to-person, self-service, and automated or computational services have in common rather than emphasizing their differences. The view reveals the intrinsic design challenges that derive from the nature of the information required to perform a service, and emphasizes the design choices that allocate the responsibility to provide this information between the service provider and service consumer. Taken together, the information requirements and the division of labor for satisfying them determine the nature and intensity of the interactions in the service system. This more abstract approach that applies to all contexts overcomes many of the limitations of design approaches that focus more narrowly on the distinctive concerns of each context.

Why seven contexts rather than five or nine? Like every classification system, this design framework is somewhat arbitrary, but the proposals in this paper don't depend on it being the best or the only way to analyze and organize design challenges and methods. The paper demonstrates that these seven contexts are conceptually coherent building blocks that enable the incremental design of many different kinds of service systems. Furthermore, an informal analysis of service systems in numerous domains suggests that these seven contexts are sufficient to describe those that currently exist as well as many that are likely to be developed.

Information-intensive services, defined in the second section, are those in which information processing or information exchange, rather than physical or interpersonal actions, account for the greatest proportion of the co-created value (Apte and Mason, 1995). The third section describes seven different service design contexts and recasts many of their typical design concerns and methods in terms of the information required to perform the service (sometimes called the "service interface"), and how the responsibility to provide this information is divided between the service provider and service consumer. The fourth section shows how this abstract description of services makes the different service contexts into substitutable and combinable building blocks of service systems and suggests some unifying design concepts and methods that apply to all of them.

The fifth section illustrates these new design concepts and methods using the design of a "smart multi-channel bookstore" service system that combines service components from many of the design contexts. Value propositions and information flows will be described from the contrasting points of view of customers, front and back stage bookstore employees, and the bookstore manager that taken together yield a holistic perspective on the service system.

"Information-Intensive" Services

Apte and his collaborators analyzed services in terms of the proportions of physical actions, interpersonal actions, and information actions "that involve the manipulation of symbols." (Apte and Mason, 1995; Apte and Goh, 2004, Apte and

Karmakar, 2007). Information-intensive services are those in which the information actions are responsible for the greatest proportion of value created by the service system. The most information-intensive ones are those with few or no requirements for physical and personal interactions, or where personal interactions are narrowly focused on the information exchange needed to make decisions and apply other information. Examples include accounting, data entry and transcription, translation, insurance underwriting and claims processing, legal and professional services, customer support, and computer programming. In these service domains documents, databases, software applications, or other explicit repositories or sources of information are ubiquitous and essential to meeting the goals of the service consumer or customer.

The recognition that services vary according to both the *absolute* and the *relative* proportions of physical, interpersonal, and information actions is a critical insight. The most information-intensive services are entirely information-based, with no physical or interpersonal interactions required to carry them out, and can be readily automated as information systems, web services, or computational agents.

Other information-intensive services also involve essential personal or physical interactions, including traditional classroom education, emergency and surgical healthcare, logistics, sales, consulting, and personnel resources administration. Furthermore, service types that are dominated by physical or interpersonal actions, such as physical therapy, massage, restaurant dining, and entertainment – and which are thus "experience-intensive" -- usually require information exchanges to specify and co-produce the service.

Seven Contexts for Service Design

The following sections introduce seven contexts for service design.

- The "person-to-person" (Context 1), "self-service" (Context 3), and "multi-channel" (Context 4) ones are canonical in service design.
- Context 2, "technology-enhanced person-to-person" service, is introduced here to highlight the design issues that emerge in contexts that are transitional or intermediate between "pure" person-to-person service encounters and self-service ones.
- Context 5, "services on multiple devices or platforms," combines and specializes many of the design concerns for the "self-service" and "multi-channel" contexts, but it raises additional ones that make it necessary to treat it separately.
- Context 6, called "back-stage intensive" or "computational" here, is a subset of what are often called "machine to machine" or "computer to computer" services, but these labels are less precise than needed when additional contexts are introduced.

- Context 7, "location-based and context-aware services," combines and specializes design concerns from "self-service," "multi-channel," and "back stage" contexts (3, 5, and 6), but likewise raises new ones.

Each context is introduced with a scenario from a bookstore service setting, and each successive scenario builds on the previous ones to define a progressively more complex service system.

Person to person service encounters (Context 1)

> The independent local bookstore exemplifies the person-to-person service setting with empowered frontline service employees, because such stores only survive if they provide highly personalized and empathetic service. Bookstore employees are motivated to recognize customers; greet them by name; remember their favorite subjects, authors, prior purchases, and spending budget – and use all of this information to recommend new books. If the customer is a new one, the bookstore employee asks about preferences, suggests some books and uses the customer's feedback to refine the employee's model of the customer, and perhaps gives a personalized tour of the bookstore.

Levitt's (1972) classic statement that "discretion (on the part of service employees) is the enemy of order, standardization and quality" might be true of highly routinized person-to-person transactional services. We are all too familiar with the bureaucratic inflexibility of service providers like the department of motor vehicles where we fill out a form, submit it to a service employee, and have an experience that is never personalized. We all also know from our own experiences that people would prefer services "their way." Mills and Moberg (1982) valiantly attempted to systematize techniques for "sealing off the technical core of service operations" to enable distinct levels of service flexibility on a continuum from "full" to "restricted" service. But they and other service design and operations researchers ultimately acknowledged the inherent tension between the goal of achieving standardization and efficiency for service providers and that of satisfying the often variable demands and preferences of service customers.

A way forward emerged with more nuanced analysis of service value creation in terms of "value" or "profit" chains in the "service production system" (Heskett, et al., 1977; Mills and Moberg, 1982) and the utility of recognizing an architectural boundary between "front office" or "front stage" services and those in the "back office" or "back stage" (Glushko and Tabas, 2009; Teboul 2006). Service operations of the former variety involve interactions with the customer, while those of the latter variety contribute to the former while remaining inaccessible or invisible to the customer. When services are designed with a "line of visibility" separating the front and back stages in place, frontline service employees can be empowered with the discretion to adapt the service in the front stage when necessary to satisfy customers (Kelley, 1993; Lashley, 1995; Frei, 2006) in any way that doesn't jeopardize the efficient operation of the back stage.

A premise that guides the design of person-to-person services is that the quality of the service is determined in the front stage encounter between the frontline service provider and the customer (Zeithaml, et al., 1998; Bitner, et al., 2000). It naturally follows that the typical design techniques for person-to-person services are ethnographic and participatory, immersing the designer in the customer's context to observe, participate with, and interview the customer to understand his goals and behavior (Beyer and Holtzblatt, 1998). These methods yield a customer-focused service that emphasizes the touch points that he experiences in his interactions with the service provider.

For example, the service blueprinting technique (Bitner, et al., 2008) characterizes person-to-person services as "dynamic, unfolding over time through a sequence or constellation of events or steps... that produce value for the customer." Similarly, Benford, et al., (2009) portray the sequence of touch points as a "trajectory of interaction," Dubberly and Evenson (2008) describe it as the "customer journey" or "experience cycle, Davis and Dunn (2002) call it the "brand touchpoint wheel," and Meyer and Schwager (2007) call it the "customer corridor."

Blueprinting advocates suggest that every touch point should also be associated with tangible evidence that demonstrates or signals that the service is being delivered or co-created. Person-to-person services that require substantial physical interactions have a great deal of intrinsic tangibility; clean and pressed clothes are clear evidence that a dry cleaning service was performed as expected. The physician's white coat and similar characteristic uniforms for other service providers tangibly reinforce quality expectations.

Many services are associated with information artifacts as tangible evidence, such as the service provider's business license hanging in the office, or invoices, receipts, warranties or diplomas given to the customer when the service is completed. For the most information-intensive services, the creation or processing of information is the sole intrinsic evidence of a service, so most of them are essentially invisible, and secondary information like transactional logs can be used to give them some persistence. This invisibility of information-intensive services no doubt contributes to the bias evident in most blueprints toward front stage services that more visibly produce customer value.

Technology enhanced person-to-person service encounters (Context 2)

> A customer walks into the independent local bookstore where he's bought books for years, but the longtime employee who knows him well isn't there, and the customer doesn't recognize the new clerk behind the counter. But after the customer introduces himself, the new clerk looks him up in the bookstore's computerized bookstore management application. In an instant the new clerk sees the customer's transactional history of prior purchases, along with notes about his reading tastes written by the longtime employee. The new clerk is now able to recommend some new books that have just arrived.

After information technology became readily available to businesses and service providers, service design concepts and methods were devised to handle "technology infusion" in service encounters (Bitner, et al., 2000). General purpose information technology like database systems, as well as specialized applications for catalog, order, and customer relationship management make service operations more efficient and reliable. In addition, information management technology has increasingly been used to further empower the frontline employee with the information needed to provide personalized and satisfying customer experiences. Such technology ensures that that the information available to all frontline employees is more accurate, complete, consistent and accessible than the tacit personal memories of any of them taken individually.

Nevertheless, just because some information technology has the potential to yield more consistent, reliable, and timely service, design choices must be made about whether and where to introduce it into the service system. Technology can be used solely by the frontline employee to enhance his capabilities, or by both the frontline employee and the customer to more directly enhance their interaction. Fitzsimmons and Fitzsimmons (2006) distinguish these two cases as "technology-assisted" and "technology-facilitated" encounters. But the most important choice is whether the technology should be used to replace the frontline employee entirely, leaving a self-service encounter.

For example, fancy restaurants will employ a sommelier to make suggestions (person-to-person context), but the sommelier might sneak a peek at the "Wine Snob" (WineSnob 2009) application on his PDA to refresh his memory about wines and food pairings before he heads out to the dining room (technology assisted context). And while the sommelier would never reveal to the customer that he has relied on Wine Snob to make a recommendation, in service domains like architecture or technology consulting it is easy to imagine the service provider and customer jointly using technological aids (technology-facilitated context).

A restaurant customer might launch the Wine Snob on his PDA, and might ask the sommelier for a confirmation or second opinion. This last scenario, in which the customer provides his own ad hoc technology to enhance a service encounter, is increasingly common but not easy to systematize because by definition it was not expected by the service provider (if it had been expected, the encounter would be a "technology-facilitated" one). Perhaps "customer technology improvised" is an appropriate category for this type of technology-enhanced service encounter. And of course, the customer might access the "Wine Snob" application from his home computer before heading out to dinner (self-service context).

In addition to improving operational efficiency, technology can be used to adapt a service to satisfy a specific customer or persona by personalizing it. The degree to which a person-to-person service can be personalized is limited by the extent to which the frontline employee is able to interact with the customer to obtain information about the customer's requirements and preferences (Brohman, et al., 2003; Kolesar, et al., 1998). Likewise, personalization depends on the customer's willingness or ability to provide the information. In some situations, this is limited by concerns that the service provider can't be trusted to maintain it in a private and secure manner. Finally, even if the customer provides the information, personalization is constrained by how much of it is maintained by the service provider in an accessible and technology-supported format.

Advances in information and communications technologies have enabled information-intensive activities that create information to be separated in space and time from other processes or services that use it. This is the principle that enables the "outsourcing" of services and 24x7 global customer support (Apte and Mason, 1995, Blinder, 2007). More generally, technology-enabled service disaggregation has transformed vertically integrated and centralized firms into more virtual and network-like forms that function as compositions of collaborating services that can be located almost anywhere in the world, from Boston to Berlin to Bangalore (Palmisano, 2006).

Self-service (Context 3)

When a customer logs in to identify himself on Amazon.com or similar Internet bookseller site, the generic catalog is replaced with a personalized one that reflects his shopping history and interests explicitly expressed in search queries, abandoned shopping carts and wish lists. But unlike the physical bookstore, where following the customer around would be obtrusive, the self-service context enables the easy capture of implicit preferences and interests based on the customer's browsing history. And while an experienced and insightful bookstore employee makes recommendations by reflecting on the purchases and preferences of customers he deems similar, Amazon.com and other Internet retailers employ very sophisticated recommendation services that aggregate and analyze millions of transactions and queries (Shafer, et al., 2001), while also making dynamic adjustments to catalog content and pricing based on the customer's real-time browsing behavior.

A more fundamental change in service design than introducing technology to assist a human service provider is to use technology to transform person-to-person services into self-service ones. This eliminates the frontline employee and moves back the line of visibility between the front and back stage, giving the customer access to information that was previously visible only to the frontline employee.

A more subtle way to understand the impact of introducing technology in a service encounter is that it changes the proportions of physical, interpersonal, and information actions. From this perspective, these proportions are design parameters that can be systematically adjusted by technologies that enable the different types of actions to substitute for each other. Stored information and interpersonal interactions can often replace each other; there is no need to ask a customer to supply personal or preference information that the provider already knows from previous interactions or has obtained from data brokers.

An increasingly common design pattern for technology-enhanced person-to-person services and self-service is for the provider to support the creation and aggregation of preference information or other content from the users or customers of a service. Contributing to this "community content" (Armstrong and Hegel, 2000), "collective intelligence" (Segaran, 2007), or "crowdsourcing" (Howe, 2008) is partly self-serving because it enhances the quality of future service encounters for the contributors, as when customers rate restaurants, hotels, or other service establishments and subsequently choose only highly-rated ones. But it is often an act of generosity or altruism because many people contribute far more information or effort than pure self-interest would justify, even though they know that service will also be enhanced for those who don't contribute at all.

The ergonomics of ATM and telephone keyboards, buttons, and other hardware interaction mechanisms were the foremost design concerns of self-service technology until personal computers emerged around 1980. PCs had enough local processing capability to enable graphical software user interfaces with a greatly expanded interaction repertoire. Techniques for designing, prototyping, and evaluating software user interfaces then developed rapidly and continue to evolve along with new technology platforms for self-service applications (Grudin, 1990).

The most important of these new platforms by far was the World Wide Web, which became mainstream in the mid 1990s and continues to grow at a staggering pace. Any business or organization that provides information or carries out transactions with customers now has a web site, and the usability of these sites is the dominant design concern. "Usability" has numerous definitions but at their intersection are the goals of making applications easy to learn, efficient and engaging to use, and effective in providing functions or information that satisfies user requirements. Some usability problems with user interfaces can be detected and remedied by qualitative techniques like heuristic evaluation by experts and user "walk-throughs" with prototypes (Nielsen, 1994). However, more sophisticated analysis and measurement techniques are required to understand and overcome performance and quality of service problems, especially in service systems where the user interface is a composite application or "mash-up" that presents and integrates information from applications and sources that can be running anywhere in a global service network (Edmunds, et al., 2007; Wiggins, 2007).

Because a competitor or alternate supplier is often "just a click away," the usability and quality of service in a self-service application or web site is an important concern for designers. Most usability specialists would agree with the claim that "the success of online services is largely determined by the customer experience via the web site interface" (Massey, et al., 2008).

However, an emphasis on the usability of the front stage's appearance and behavior can sometimes inadvertently de-emphasize the invisible actions in the back stage of the service system. This isn't a critical oversight for simple transactional online services in which the customer can request and quickly receive the desired service or information. But in more complex service systems that involve substantial processing of information or physical fulfillment, the back stage services have much more to do. For example, submitting an online application for employment or university admission, or ordering from an online store, initiates many actions and information flows that won't complete for days or even months. In such service systems, a narrow focus on usability of the self-service interface as a measure of service quality is seriously incomplete. An online shopping site must be usable, and many seemingly small design details can matter a lot, but the customer's ultimate satisfaction depends far more on whether what he ordered arrives when it was promised. A front-stage experience with acceptable usability is necessary, but it is insufficient and might even be counterproductive if it sets unrealistic expectations about the ultimate outcome of the service system operation. What matters far more is the effective and efficient operation of the back stage services, a service system design challenge that is discussed in an upcoming section.

Multi-channel Services (Context 4)

> A customer gets a recommendation for a new book in an online bookstore but wants it the same day. Can he reserve it online for pickup the same day in the neighborhood bookstore store? When he arrives at the store, should the bookstore employees know what other books he looked online but didn't purchase so they can offer them at a discount? When the customer next visits the online store, are purchases he made in the neighborhood bookstore reflected in his purchase history and recommendations there?

As the Web matured as a platform for online commerce and information services, upstart firms like Amazon.com with no physical presence became competitive threats to incumbents like Barnes and Noble. For these "brick and mortar" firms, creating a web channel and finding the right mix of "bricks and clicks" was an urgent and critical strategic decision, and the concept of "multi-channel services" as a distinct service design context emerged (Gulati and Garino, 2000). The Web channel also inspired the vision of "E-government" services that would radically improve service delivery to citizens and let them avoid inefficient face-to-face encounters in government offices (Osborne and Gaebler, 1993; Gronlund, 2002).

When a service provider becomes truly multi-channel by adding an Internet channel to its existing person-to-person or self-service operations, much more is involved than just adding a self-service channel like ATMs or a telephone touch-tone or IVR user interface. These self-service technologies often support only the small subset of services that can be completed in a short transaction or information request, so the self-service channel is not a full substitute for the person-to-person service.

A web channel, however, can offer many of the same services as the physical channel along with additional personalization. This greater capability and opportunity raises fundamental business model concerns about channel conflict, sales cannibalization, customer segmentation, marketing, branding, and cross-selling (Iqbal, et al., 2003; Falk, et al., 2007). The service customer's experiences and expectations about functionality and quality are synthesized from every encounter across all channels, making the predictability of interactions important (Sousa and Voss, 2006). However, cross-channel predictability is constrained by differences in channel capability, and if those didn't exist, there would be no point in having multiple channels!

Consumers go online to do product research and to learn where to buy things or find service providers. Consumers might shop for particular brands, but they don't always buy them from the same retailer. Multi-channel retailers, on the other hand, want customers to treat their different channels as complements or substitutes for each other, because this will increase sales and strengthen loyalty (Tedeschi, 2007; Bendoly, et al., 2005; Neslin, et al., 2006). So many firms offer a "ship to store" or "local pickup" service that allows a customer to purchase or reserve a product in the online channel but obtain faster delivery from the physical channel. Likewise, a "return to store" policy allows a purchase made and fulfilled from the online channel to be returned to the neighborhood store if it turns out to be unwanted or unsuitable. These services are simple to describe, but not easy to implement, because the ideal supply chains for online and physical channels are different (Metters and Walton, 2007).

What this all means is that the key strategy and design decisions for multichannel services concern the allocation of services to one or more channels and the manner in which the channels fit together. These decisions ultimately are implemented in terms of the content, direction, and reciprocity of information exchange between the channels. Making these decisions and communicating the resulting design to customers requires design concepts and notations that depict a unified cross-channel view of the service system. A promising new approach here is an extension of the service blueprinting technique to use a "service interface link" symbol to interconnect the separate blueprints for different channels at the points where the process of service delivery moves from one channel to another (Patricio, et al., 2008).

Services on Multiple Devices or Platforms (Context 5)

An online bookstore can offer many services and a richer user experience to users on the home computers, but it wants to enable them to browse for books using their mobile phones. How should the catalog content and user interface be designed for multiple platforms?

Most people also use one or more other devices other than personal computers to obtain information services. In fact, many times more people in the world use mobile phones than personal computers, and many use PDAs or other devices. These devices differ on multiple dimensions – computing power, memory capacity, portability, display size and resolution, voice recognition and synthesis capability, network bandwidth, GPS capability, and so on. These capabilities are not always correlated and bundled into devices in the same combinations. Some devices are optimized for different services, applications and information types. Other devices strive with mixed success to be hybrid gadgets that combine a phone, camera, email, music player, game console, personal information manager, and computer applications platform.

The proliferation of devices and network alternatives is a challenge for service system designers. If a service provider's intended customers use different or multiple devices, the service must be designed to work on all of them. This task might be considered an extension of the self-service design problem to multiple channels. Because the devices and networks have different capabilities, this task is also analogous to service personalization, although the service is being adapted to the device and only indirectly to its user.

Many mobile phones and PDAs support limited web browsers, which gives people the expectation that they can use them to access services originally designed for browsers on personal computers. After all, they can check webmail, read blogs, weather and news, and conduct searches from their work and home offices; why not do that while commuting on a bus or train? Many business applications for sales and customer management are inherently more valuable when they can be accessed by employees at customer sites and not just in their office locations.

People don't expect their service experiences to be identical on PCs, phones, and PDAs, but they expect them all to be satisfactory and to exhibit some degree of consistency or predictability. Unfortunately, "consistency" and "predictability" are often difficult to define (Grudin, 1989; Richter, et al., 2006). Even when these goals can be specified in design terms, the differences among devices influence the user interface for obtaining the service, the user interface through which it is delivered, the informational content of the service, and the latency of service delivery (Lumsden, 2008). Furthermore, the same device or application might operate in both "always connected" and "occasionally connected" modes, which imposes the challenges of synchronizing information flows and switching transparently between local data storage and network service (Hill, et al., 2004).

Because of the complexity of these design problems, there is little consensus about the best approach for designing services to run on multiple devices or platforms. The earliest web browsers on mobile phones and PDAs weren't very capable, so many web sites and services employed a design philosophy that could be called "dumbing down" or "graceful degradation" (Florins and Vanderdonck, 2004). Sites and services designed for the most capable platform or device were adapted to other devices by applying transformations that systematically changed the user interface for more constrained devices. For example, web pages would be reformatted to fit small screen displays and eliminate navigation and selection controls that no longer worked well. For information in non-text formats, reduced display capabilities required reductions in content fidelity and resolution, and media compression and transcoding might be necessary, sometimes even dynamically (Shanableh and Ghanbari, 2000; Zhang, 2007).

Nevertheless, design approaches for multi-platform or multi-device services that try to make the design problem scalable by applying systematic or automated transformations to a single "mother of all designs" can fail to take advantage of specialized functionality on supposedly lesser devices. For example, while phones have vastly less conventional processing power than desktop computers, they can have sophisticated audio processing capability, integrated cameras, text messaging, GPS functions, and acceleration or orientation sensors.

So an alternative to "device family" or "model-based" design is "native" design. This approach defines and implements the user experience and interface for each device to take maximal advantage of its capabilities. A telephone-based application that was originally designed to use a standard touch-tone keypad would also visually display the menu choices on mobile phones with a display screen. Devices without keyboards, or with very small ones, would rely on voice input. Mobile phones equipped with cameras and QR-code (2-dimensional barcode) detection systems can take photos of the codes on objects or in advertisements and retrieve related web pages (Rohs and Gfeller, 2004). Devices with sophisticated audio processing capabilities can even use music as inputs, as does the Shazam service, which identifies a song from a recorded snippet (Shazam, 2009).

The Apple iPhone exemplifies the optimization of applications to specific devices; as of 2009, more than 50,000 applications exist for it, and most have been built exclusively for it (Apple, 2009; Tedeschi, 2009).

"Back stage-intensive" or "computational" services (Context 6)

When a customer in the local bookstore chooses a book (or accepts a recommendation for one), pays for the book with a credit card, and leaves the store with it, the customer's service encounter to purchase a book is complete.

The customer's experience in the online bookstore seems superficially equivalent to the one in the local bookstore. He chooses a book (or accepts a recommendation), enters his credit card number and address into the shopping cart form, and with a couple of mouse clicks completes the check-out process.

But even though the online encounter has completed with what is apparently a satisfactory result, most of the work to fulfill the customer's book purchase has not yet begun. Fulfillment involves invisible physical actions by warehouse, shipping, and delivery personnel, and each action presents an opportunity for service failure. The wrong book can be picked from the warehouse, or it can be lost, damaged, or delayed in delivery because of a human error, traffic congestion, bad weather, or a host of other factors.

These back stage fulfillment services are interconnected and coordinated by information exchanges among the online retailer and other businesses. The customer's expectations about the service outcome – in this case, the delivery of the book as promised – can be managed by providing him with information about the progress or state of these services. For example, the customer can be emailed the shipment tracking number from the delivery service. The customer's order of the book might have been prompted by a message from the "just published" alerting service that notifies customers when new books by their favorite authors are available. Furthermore, this "just published" service was triggered by another back stage event when the package of new books was scanned on arrival at the warehouse.

Many online retailers are virtual firms that don't own any product inventory. Their catalogs contain the goods that they can reliably obtain from distributors. The "storefront" is a self-service front stage that collects the order information and then passes it on to back stage service providers that process credit card payments, operate the warehouses, deliver packages, and so on (see Glushko and McGrath, Section 1.1, 2005). Taken together, this pattern of physical processes and information exchanges defines a type of service system known as "drop shipment."

Some of these back stage services involved in drop shipment, such as those that check inventory, verify credit, and process payments, are "pure" information services and are typically carried out entirely by automated services without any human involvement or physical actions. Of course not every back stage service can be completely automated, and shipment tracking, credit card fraud detection, customer support, and other processes in the drop shipment service system expose user interfaces to different sorts of people who need to handle exceptional or error situations. However, to the extent that a service system relies on complex back stage choreographies of information flows and the physical actions they direct, the front stage services and interfaces contribute proportionally less to the overall service outcome and user experience.

In these "back stage-intensive" or computational design contexts, it is more important to apply the design concepts and methods for "document engineering" (Glushko and McGrath, 2005) or "service-oriented architecture" (SOA) (Erl, 2004). These design perspectives view the service system abstractly as a set of cooperating services that interact by exchanging information through well-defined interfaces that specify the inputs and outputs of each service. The efficiency of this information exchange depends on how much the services agree on the meaning and encoding of the information they send and receive.

This more abstract modeling philosophy of document engineering and SOA contrasts sharply with traditional service blueprinting and other front stage or "customer-centric" approaches in some important ways. First, it de-emphasizes the differences among person-to-person, self-service, and automated or computational services, because this makes it easier to treat them as substitutable (Glushko and Tabas, 2009). This assumption of potential equivalence is well-supported by modeling notations like sequence and activity diagrams (Pilone and Pitman, 2005) that take a "bird's eye" or top-down perspective that doesn't automatically make the human customer the focus of the process model.

In addition, two distinctive document engineering methods extend the basic SOA philosophy in service system design. The first is that document engineering assumes that in information-intensive industries, documents and other sources of structured information better embody the functional and interface specifications for services than anything else. This assumption might seem tautological, but it merely restates the contrast noted earlier between information-intensive and experience-intensive services. In the former, documents and other information sources are ubiquitous and intrinsic to the goals and activities of the stakeholders and actors, so information is the most important thing to analyze. Even if document implementation or management technology changes over time, the logical model of a document can endure far longer that the tenures of the specific people who produce and use the documents.

In contrast, in experience-intensive service contexts, the interpersonal interactions between the human participants are the most important things for designers to study. Nevertheless, experiential service domains often have documents playing essential roles; for example, it would be difficult to understand a restaurant service system without analyzing menus and following customer orders from the dining room to the kitchen.

The second key method of document engineering is its alignment with the idea of industry reference models or best practices, which it uses as design patterns that define normative or idealized services, their choreography, and the information exchanges needed to request and perform them.

Location-based and Context-aware Services (Context 7)

> A customer is browsing the shelves in his neighborhood bookstore when he receives a text message on his cell phone. The message directs him to the shelf where he can locate a book that he had recently viewed in the online website of the bookstore. He locates the book, takes a photo of its bar code with the cell phone camera, and launches a price check application. He learns that the book is available at a lower price in a competitor's bookstore a half mile away that will be open for another 45 minutes. The map application on his phone shows him the best route to the other store, and he buys the book there instead.

Many new and even some not-so-new technologies have inspired another domain of service design for location-based and context-aware services. "Location" is the most obvious context attribute, but not the only one. In a widely-cited paper, Dey, et al., (2001) defined context as "any information that characterizes a situation related to the interactions between users, applications, and the surrounding environment." The environment consists of places, people, and things, and for each entity there are four categories of context information: location, identity, status (or activity), and time. This open-ended definition is bounded only by the variety and capabilities of the sensors by which context information can be acquired from the environment (Sohraby, et al., 2007).

RFID chips, essentially bar codes with built-in radio transponders, enable location tracking and context sensing to be automated. RFID receivers can be built into store shelves, loading docks, parking lots, toll booths, to detect when some RFID-tagged object is at some meaningful location. RFID tags can be made "smarter" by having them record and transmit information from sensors that detect temperature, humidity, acceleration, and even biological contamination (Want, 2006; Allmendinger and Lombreglia, 2005).

The Global Positioning System was developed as a strategic military capability but it is far more important to most people for its commercial applications. GPS navigation systems provide directions, dispatch emergency responders to vehicles (OnStar, 2009), and combined GPS and RFID devices enable vastly more efficient inventory management in global supply chains (Baars, et al., 2008).

But the most ubiquitous and day-to-day use of GPS technology in information-intensive services is in mobile phones. After the 2001 terrorist attacks, governments worldwide mandated location tracking of mobile phones. Initially, telecom carriers used tower triangulation techniques to do this, so no location information was available in the phone itself. More recent phones have built-in GPS, so the phone can now tell other applications where it is, not just the government! Of course, phones both send and receive information, so once the phone reveals location or contextual information, applications can send location-based services to it (Rao and Minakakis, 2003; Trimi and Sheng, 2008). Location is so intrinsic to mobile services that user interfaces that integrate or "mash up" information into maps have rapidly supplanted text-oriented techniques for presenting choices or search results (Programmable Web, 2009; Raper, et al., 2007).

From the perspective of service design, once again the key principle is that information replaces interaction. There is no need to ask a customer to supply location, time, or other contextual information that the provider has obtained or inferred from a back stage service or sensor. Likewise, there is no value in providing information to the customer that isn't relevant to his location or context. For example, the results for a phone browser query for "coffee" in Seattle should filter out any coffee shops in Berkeley. Likewise, a user searching for "next bus" would ideally receive just that part of the local bus timetable that specifies the schedule for his location in the next few minutes.

The limiting factor on context-aware services might well be the willingness of people to allow service providers to use information about their current or previous contexts.

Design Concepts and Methods for Information-Intensive Service Systems

Each of the 7 design contexts has characteristic design concerns and methods, highlighted in Table 1.

Table 1. The Seven Design Contexts: Concepts, Concerns, and Methods

DESIGN CONTEXT	CONCEPTS AND CONCERNS	METHODS
1. Person-to-person	Empowerment, touch points, line of visibility	Ethnography, blueprinting, personas
2. Technology enhanced p2p	Personalization	Customer modeling and segmentation, CRM
3. Self-service	Ergonomics, usability	Iterative prototyping, heuristic evaluation, customer analytics
4. Multi-channel	Complementarity, reciprocity, integration	Process modeling
5. Multiple platforms and devices	Consistency, scaleability	Capability modeling, model-based interfaces, graceful degradation
6. Back stage, computational	Information and process standards, choreography	Use cases, data and document modeling, service oriented architecture, design patterns
7. Location-based and context-aware	Sensor technology	Managing identify and privacy

At first glance, these different design concerns and methods may seem incompatible, making it easy to understand why there has been little research or practical work in service design that spans more than a few contexts. But as described in the previous sections, there are systematic relationships among the contexts that can be exploited as design parameters or patterns. Furthermore, a more abstract look at the seven contexts suggests the unifying design concept that services and service encounters can be viewed as information exchanges. The abstraction enables the contexts to function as building blocks that follow design patterns for the incremental evolution of many different kinds of information-intensive service systems.

The Relationships Among the Seven Contexts

Figure 1 depicts the seven service design contexts to show their derivational and compositional relationships. It is inspired by and extends Figure 5.1 on page 106 of Fitzsimmons and Fitzsimmons (2004).

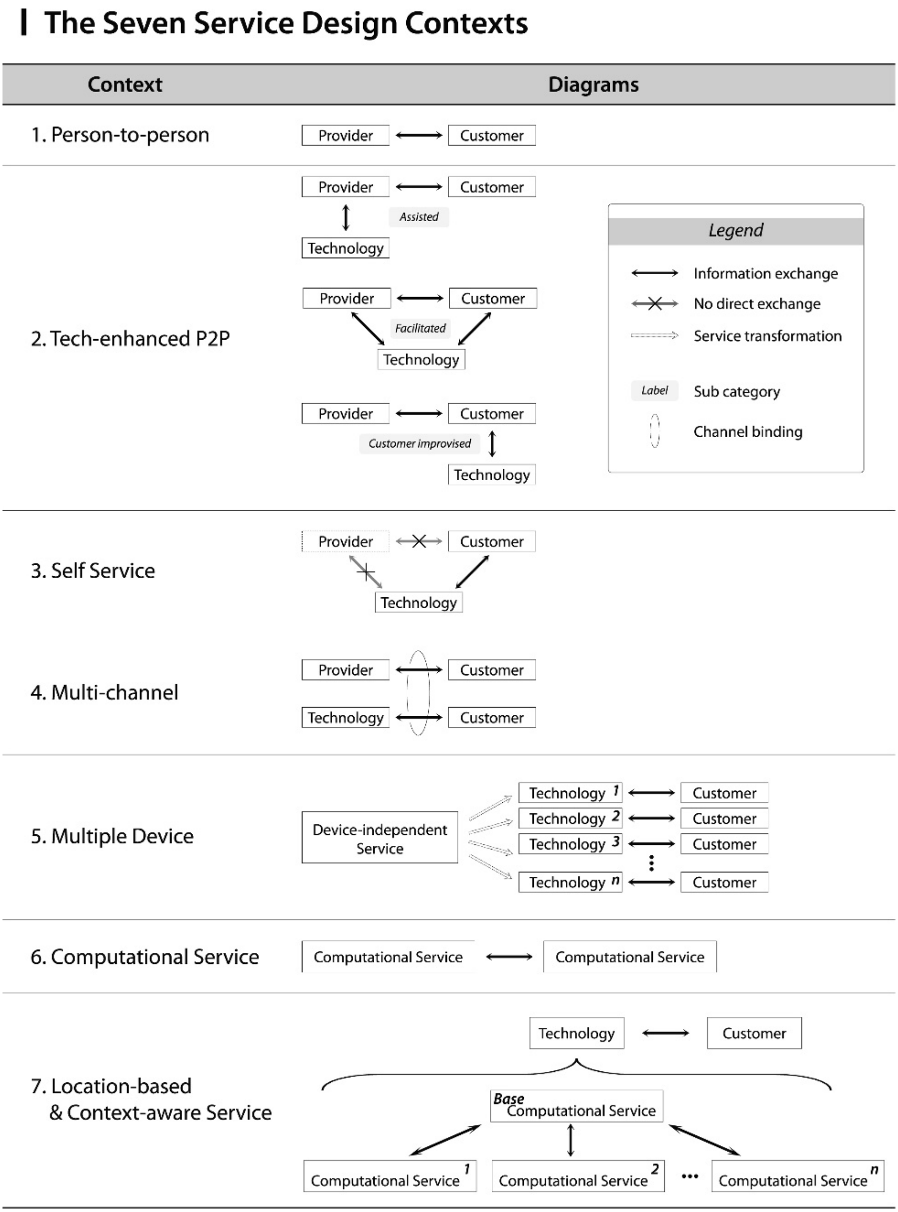

Figure 1. The Seven Design Contexts: Derivational and Compositional Relationships

- Contexts 1, 2, and 3 span a continuum of service designs that progressively incorporate technology to make services more transactional and less relational

- Multi-channel service systems (Context 4) combine person-to-person encounters and self-service by integrating information flows between them

- Multi-device services (Context 5) are self-services that run the same or appropriately transformed service on more than one device or technology platform

- Computational services (or "machine-to-machine" or "back stage" services) (Context 6) do not expose a service interface to human actors

- Computational services that transmit location, time, or other contextual information inferred from a back stage service or sensor enable location-based and context-aware services for people (Context 7)

Services and Service Encounters as Information Exchanges

Every service encounter consists of two actors: a service provider and a service consumer (Glushko and Tabas, 2009; MacKenzie, et al., 2006). "Actor" is used here in an abstract sense to include both human and computational entities, just as it is in use cases and other system modeling methods (Cockburn, 2000); services that are one-to-many can be modeled as sets of pairwise ones. The interactions between the two actors take place through an interface that describes what the service does and how it is requested. This service interface is always explicit with computational actors, where well-defined inputs and outputs are a prerequisite for the infusion of computation or automation, and where the interaction is intrinsically and exclusively an exchange of information (see the section titled "Back stage-intensive" or "computational" services in this paper; Erl, 2004; Glushko and McGrath, 2005). In contrast, the service interface is often implicit and underspecified in person-to-person encounters, and information exchange is only a part of what goes on.

Analyzing person-to-person service encounters as information exchanges might seem to ignore the essence of highly experiential service. Nevertheless, even for experiential services, it is almost always necessary for the two actors in a service encounter to engage in some amount of information exchange to identify requirements or expectations, to clarify their roles, or assess the status or quality of the service delivery.

Emphasizing the information exchange aspect of service encounters makes it easier to design and understand service systems that combine multiple design contexts because it treats them as complementary or substitutable components rather than antagonistic alternatives. It might not matter if the actor performing a translation or calculation service is a human or a computer, and the abstraction of information exchange hides the implementation. Similarly, while there is an important social dimension in service systems that use community content or crowdsourcing to enhance service quality, the aggregation of preference information or content is the underlying mechanism.

Contexts as Building Blocks for Service Systems

The numerical order of the contexts defines a typical design trajectory for service systems, as was demonstrated by the progressive complexity of the service system implied by the seven bookstore scenarios that accompanied the presentation of Contexts 1-7 in the third major section of this paper.

Contexts 1, 2, and 3 span a continuum of service designs that progressively incorporate technology to make services more transactional, with improved consistency, reliability, timeliness, and personalization. More abstract characterization of the service encounter facilitates the technological augmentation of the service provider or the substitution of a computational actor for him.

But these systematic changes in the character of the service system can reduce its experiential and relational quality. As a result, many service systems integrate person-to-person encounters and self-service (Context 4) to satisfy the types of customers who prefer the former and to provide services that create additional value through the exchange of information between channels. Banking and catalog shopping are two other categories of service that have followed this pattern of service system evolution.

Delivering some services on multiple devices or platforms (Context 5) and with location-based and context-awareness capabilities (Context 7, e.g., through sensors in mobile phones) are natural and even inevitable technology-enabled expansions of the scope of a service system. These contexts have become essential parts of service systems that run supply and distribution chains, deliver medical care, manage energy or facilities, or operate other information-intensive enterprise or inter-enterprise processes or systems of equipment (Context 6).

Instead of starting with a person-to-person service (Context 1) and adding technology contexts to it, an alternative evolutionary trajectory for service systems begins with a Context 6 back stage or computational service. Many enterprise applications, transactional systems, or sensors associated with objects or equipment generate information that is important to effective business operations but which might not initially be exposed in customer-facing interfaces. Making this information available for self-service access (Context 3) via the telephone, personal computer, or other device (Context 5) can create substantial new value, often enough to justify a secondary customer support channel to handle exception or error cases (Context 4). Self-service package tracking is an extremely successful example of this pattern where a customer-facing service was created to exploit latent value from invisible back stage services.

In a more complex example, a service system for residential energy efficiency could evolve incrementally by externalizing the information captured and created by embedded controllers and appliances (Context 6), initially giving consumers more visibility into and control of energy use with "smart" thermostats and control panels (Context 3), and then later allowing remote control access from other locations and devices (Context 5). Connecting the home system to the utility grid could enable appliances to control themselves in response to real-time energy pricing based on aggregate system demand (Context 7).

Points of View in a Service System

If complex service systems are assembled from different service contexts that share the unifying principle of information exchange, then the creation of value in the service system can be described in terms of the content and choreography of information flows within and between the contexts and their component services. The actor or service at the end of an information flow, often the stereotypical "end user" or "customer," is usually designated as the focal point of the service system, especially when the service system contains a person-to-person context. Service design techniques like blueprints or storyboards emphasize this customer-centric point of view.

Nevertheless, this point of view is arbitrary, and often many of the actors or services in a service system could be alternative or secondary points of view. What is a supply chain from one perspective is a demand chain from another. In an educational service system the conventional focus is on the teacher-student service encounter, but it is also essential to design the teacher-parent encounter. In a hospital, it is easy to default to the patient as the focal point of view, but in a teaching hospital, much of the service system is designed to educate medical students, and patients can in many ways be considered as service providers to them.

It is useful to consider multiple points of view when designing a service system, but it is essential to select one as primary. The choice shapes the priority of design requirements, constraints, and information sources; suggests relevant design patterns; identifies the front and back stages; and has profound implications for the creation and capture of value. For example, consider the restaurant service system, defined from the customer's point of view, with the front stage in the dining room and the back stage in the kitchen. Almost the same facility could be used as a cooking school, but in that service system the customers are the student cooks, the front stage is the kitchen, and the people eating the food in the dining room are back stage feedback to the cooks.

Design Case Study: "Smart Multi-channel Bookstore"

A service system for a "smart multi-channel bookstore" called "Bookland" was recently designed as a course project by a team of graduate students at the University of California, Berkeley (Blong, et al., 2008). The team – Devin Blong, Jonathan Breitbart, Julian Couhoult, and Jessica Santana – assumed the role of consultants to a large chain bookstore that also has a web retail site. Their goals were to improve customer satisfaction, increase sales, improve the efficiency of store operations, and enable the company to gather more useful marketing information. The Bookland service system is similar in many ways to the hypothetical service system implied in the presentation of the seven contexts in the third section of this paper, but the presentation here will emphasize more of the aspects of the service system that operate in the physical bookstore.

The consulting team's strategy was to build a "smart multi-channel" service system that better integrates the online and offline customer experiences, that uses RFID technology to enhance operational and customer services, and that incorporates the requirements of a broader range of stakeholders beyond the bookstore customer. Their design explicitly provides services that target both frontline and back stage bookstore employees and the bookstore manager.

Information Flow in the Bookland Service System

The operation of the Bookland service system can be described in terms of the flow of information between the different actors and contexts it contains. The key components of Bookland, highlighting the information exchanges and touchpoints where the contexts interconnect, are as follows:

- A loyalty / membership program that customers can join in either channel; the customer's membership number is the primary data key that links online and offline identities and information. Customers are issued a RFID-enabled "smart card" that they can use to sign in at self-service kiosks and customer service desks.
- A customer profile built from information about customer behavior and transactions in both the online and physical channels; used by back stage personalization and marketing services that operate in both channels.
- Book identity information encoded in RFID tags, used to track book locations and enable "finding" services for customers and "reshelving" and other inventory management services for employees.
- Customer service desks where technology-enhanced person-to-person bookstore services are provided.
- Self-service kiosks in the bookstores where customers can search for books, receive recommendations and promotions, and print out shopping

lists and store maps that show the location of selected and recommended items.

- Bookstore management "dashboards" used by employees and managers to provide customer service and perform scheduled and event-driven operational services involving RFID-tagged books.
- A "store map" composite application framework that can depict book location information in two different ways: to guide customers to find books in their normal locations, and to guide employees to find misplaced "zombie" books so that they can be returned to their normal locations.

The information flow through all of these contexts is shown in Figure 2, which schematically combines a floor plan for a physical bookstore with the online one and some of the important information sources and services. The tight integration and recurrent information flows between the two channels highlights the multichannel essence of the Bookland service system.

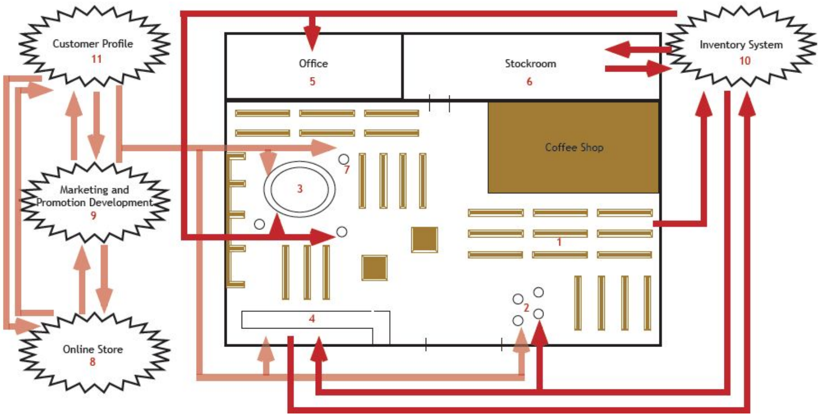

Figure 2. Information Flows in the "Bookland" Service System

1. **Bookshelves.** Each book (or item) is tagged with an RFID chip. When items are moved from the shelf, their location can be tracked anywhere in the store.
2. **Self-Service Kiosks.** Kiosks are located near the bookstore entrance (#2 in Figure 2) and throughout the store (#7), where customers can wave/swipe their membership cards or type in their customer ID to log in. These kiosks display personalized welcome pages and tailored promotions (See Figure 3). They also provide search and browsing functions and display real-time inventory and

location information on a store map. Customers can scan any item in the store at a kiosk to obtain additional information, such as customer and editorial reviews and related items, at which time the book is added to the customer's profile. The kiosks allow customers to build shopping lists and can print the store maps. If an item is not in stock in the current store but is available online or at other store locations, the kiosk will suggest alternative ordering/purchasing options, including home delivery, shipping to the current store, or pickup at nearby retail locations where the item is in stock. All customer searching, browsing, and purchasing activity on the store kiosks is combined with similar activities online and added to the customer's profile (see #11 below).

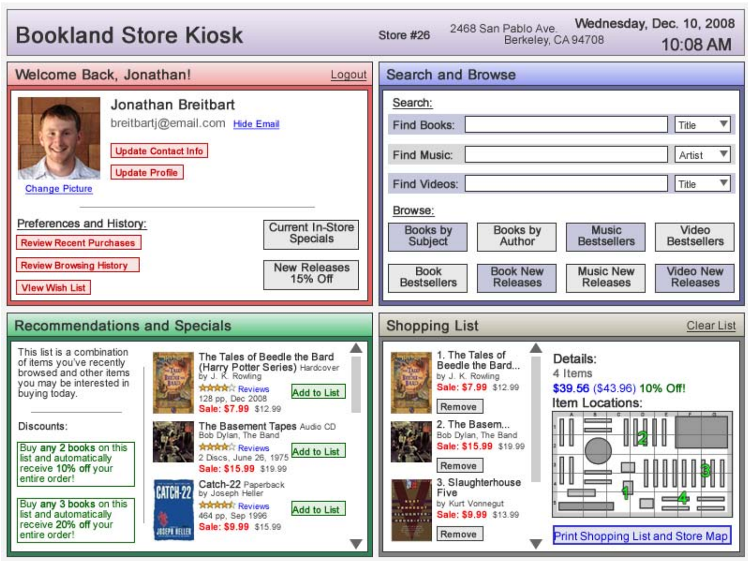

Figure 3. Customer User Interface for "Bookland" Service System

3. **Customer Service Help Desk.** Customers approaching the help desk with questions are asked to identify themselves with their loyalty cards or online customer IDs. Frontline employees use the bookstore management system's dashboard to display the customer's name, profile information including purchase and browsing history (both online and offline), and a list of tailored promotions for the customer. The dashboards also provide real-time inventory and location information for any item in the store.

4. **Checkout. Point-of-scale scanning** instantly updates the inventory system and the customer's purchase history in his profile.
5. **Bookstore Manager's Office.** The bookstore office contains the manager's workstation with various operational and management applications in addition to all of the services available in the kiosks and employee dashboards.
6. **Stock Room.** Merchandise in the stock room, like that in the bookstore, is managed using the RFID-driven inventory system that keeps track of locations. Low stock alerts for popular items automatically trigger orders to replace them. Employees can use terminals in the office or stock room or any of the kiosks to display dashboards for various operational and management services. The item alert service driven by transactional and location information is depicted in the top two panels of Figure 4; this is the same store map service that appears in the lower right panel of Figure 3, but in Figure 4 the map is "mashed up" with the locations of misplaced books so that the employee can restock them.

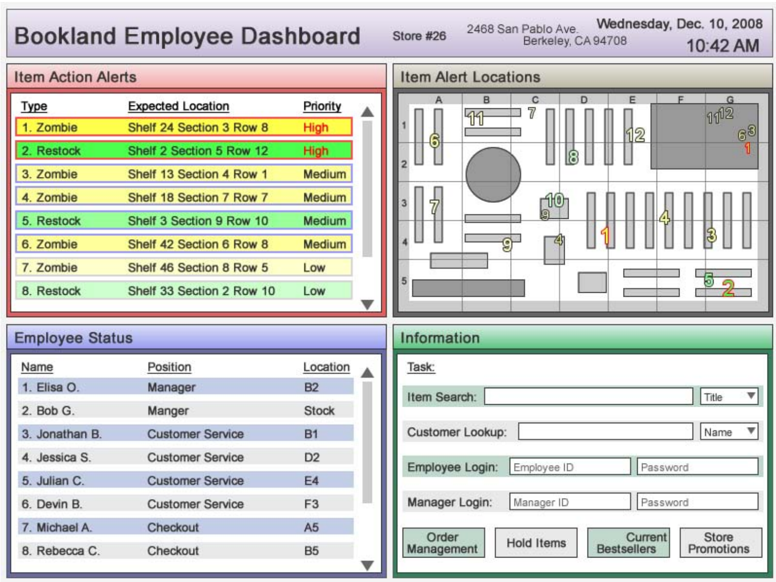

Figure 4. Employee User Interface for "Bookland" Service System

7. **Kiosks**. See 2.
8. **Online Store.** Visitors to the online store are encouraged to log in to receive personalized recommendations and promotions. Browsing and purchasing activity is added to the customer profile.

9. **Marketing and Promotions System.** Marketing and promotion services dynamically develop customized recommendations, coupons, promotions, and bundles for each customer. These will be displayed online when the user logs in or accesses kiosks in physical stores.
10. **Inventory System.** The real-time inventory system tracks the number and locations of all items in each store and warehouse. It generates fetch and restock alerts to employee dashboards and re-orders items according to business rules.
11. **Customer Profile.** All customer browsing and purchasing information (both online and offline) is fed to a customer's profile.

The In-store Service System from the Customer's Perspective

Figure 5 presents a service blueprint for the customer's in-store experience. It imposes a point of view on the service system information flow represented in Figure 2.

Physical Evidence	**Kiosk**	**Welcome Screen / Members Card**	**Member Profile Screen**	**Member Profile / Search Interface**	**Book Directions / Map, Coupon**	**Books**	**Books / Receipt**
User Actions	Customer approaches bookstore kiosk	Customer swipes members card, logs in to kiosk	Customer considers suggestions	Customer searches for book	Customer prints book location map and coupon discounts	Customer walks to book locations and retrieves books	Customer discards one book and purchases the rest
Front Stage		Welcome Screen	Members Profile Screen, Suggestions, Promotions	Kiosk search interface	Book location and tailored promotions		Checkout and registers
Back Stage		Kiosk software queries	Kiosk returns user profile, suggestions, promotions	Kiosk software queries	Kiosk returns book location, bundled promotional discounts		Systems logs customer purchases
Support		Customer Database	Marketing Database	Inventory DB / Location DB			Customer DB / Inventory DB

Figure 5. Customer-Centric Service Blueprint for "Bookland" Service System

The In-store Service System for the Employee's Restocking Tasks

Figure 6 presents a service blueprint for the bookstore employee, imposing a point of view that strongly contrasts to that of the customer in Figure 5. For example, some service system components that were invisible to the customer are now in the front stage, while others that were front stage to the customer are not visible to the employee. The bookstore blueprint shows the process of performing two kinds of restocking tasks. The first is to returning so-called "zombie" books that and have been left in the coffee shop, restroom, or any other location to their normal shelf locations. The second is restocking books that have been sold and taken out of the store.

Physical Evidence		**Employee Dashboard**	**Employee Dashboard**	**Map / Book**	**Employee Dashboard**	**Employee Dashboard**	**Map / Books**
User Actions	Employee checks computer screen	Employee sees zombie book action alert	Employee clicks on alert	Employee retrieves book and replaces it	Employee sees restocking action alert	Employee clicks on alert	Employee retrieves copies from stock and replenishes shelf
Front Stage		Employee dashboard alert section	Alert details link	Map with current book location	Employee dashboard alert section	Alert details link	Map with stock room and shelf book locations
Back Stage		Enterprise Service Bus (ESB) integrates RFID data, identifies zombie book	Employee system queries	Kiosk returns zombie book's current location	ESB integrates RFID data, identifies book that needs restocking	Employee system queries	Kiosk returns book's location in stock room and target shelf location
Support		Event Stream Processing (ESP), RFID Tracking tool, Inventory DB	Location DB		ESP, RFID Tracking tool, Inventory DB	Location DB	

Figure 6. Employee-Centric Service Blueprint for "Bookland" Service System

The differences between Figures 5 and 6 clearly demonstrate why it is useful to consider multiple points of view when designing a service system. Neither of them alone captures the complexity of the information flow between the different design contexts shown in Figure 2.

Conclusions and Future Work

Many of the most complex service systems being built and imagined today combine person-to-person encounters, technology-enhanced encounters, self-service, computational services, multi-channel, multi-device, and location-based and context-aware services. The research reported in this paper has examined the characteristic concerns and methods for these seven different design contexts to propose a unifying view that spans them, especially when the service-system is "information-intensive." A focus on the information required to perform the service, how the responsibility to provide this information is divided between the service provider and service consumer, and the patterns that govern information exchange yields a more abstract description of service encounters and outcomes. This makes it easier to see the systematic relationships among the contexts that can be exploited as design parameters or patterns, such as the substitutability of stored or contextual information for person-to-person interactions.

This more abstract perspective on service design turns the different design contexts into building blocks that enable the incremental design of service systems. One typical trajectory for service system evolution starts with a person-to-person service and adds technology contexts to it. An alternative design trajectory adds customer-facing service contexts to exploit latent value from invisible back stage services.

More thorough analysis of existing and potential services will identify design patterns that encourage service innovation at the service system level while preserving the best practices embodied in each of the service design contexts. In addition, it should be possible to extend the unifying ideas about service interfaces and information exchange to better understand service encounters and outcomes that arise in the intersection of service systems. As examples: a business traveler interacts with transportation, hotel, restaurant, and various professional service providers during a business trip; a patient interacts with his physician, hospitals and medical laboratories, insurance companies, and the benefits office at his workplace. It is surely impossible to anticipate all of these ad hoc or dynamic service system compositions, but it is surely necessary to recognize their inevitability. Techniques for designing service interfaces that facilitate composition and substitution of contexts are under development and will become increasingly important.

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