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Servitized Enterprises for Distributed Collaborative Commerce

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ABSTRACT

Agility and innovation are essential for survival in today's business world. Mergers and acquisitions, new regulations, rapidly changing technology, increasing competition and heightened customer expectations mean companies must become more responsive to changing demands. This move to agility through innovation can be possible with the service oriented solutions offered by *Collaborative Servitized Enterprises (CSE).* In this article, the authors demonstrate the architecture of a CSE and develop a multidisciplinary research program, incorporating a more science-based approach to the effective, scalable, secure, and knowledge-driven design and development of collaborative servitized enterprises, to address some of today's commoditization lead issues. The authors' primary objective is to lay the foundation of an integrated service culture, which is characterized by a cross-disciplinary attitude that fulfills customers' needs. A secondary attitude within that culture is an awareness of the complexities associated with *service tradeoff decision-making*, requiring a careful balance of value, risk, cost, and quality of service.

Keywords: Business Engineering; Distributed Systems; Internet-Based Technology; Service Science; Collaborative Technologies, Culture, Strategy

INTRODUCTION

The Internet has significantly affected the manner in which most organizations conduct business (Porter, 2001). The recent convergence of information and communication technology (ICT) design, execution, storage and transmission is creating new opportunities and also new challenges. Within a single organization, data, software and infrastructure services can be highly distributed and deployed among multiple computing platforms, e.g. software-as-a-service, infrastructure-as-a-service, cloud computing. Most organizations must also compete on a global scale, participating in *collaborative commerc*e by conducting electronic business through contact with distributed service providers (Luo & Seyedian, 2003). A multi-organizational manufacturing supply chain provides an example of this type of collaboration, creating a virtual organization where business is conducted through distributed systems integration with complex, high-volume, transactional (operational) and decision support (data warehousing) activities that must be concerned about requirements such as agility, security, auditability, availability and service level agreements (Foster et al., 2001; Singh & Huhns, 2004). Other examples of distributed applications can be found in banking, credit card processing, health care, and homeland security, requiring either material flow, information flow, knowledge flow, and/or cash flow between multiple organizations (Schoenbachler & Gordon, 2002).

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, 2008). In this paradigm, the most commonly used term is Service Oriented Architecture (SOA). In this article, we use the definition of service-oriented architecture from the Organization for the Advancement of Structured Information Standards (OASIS) (Oasis, 2006): "A paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. It provides a uniform means to offer, discover, interact with and use capabilities to produce desired effects consistent with measurable preconditions and expectations." Service-oriented architecture is not limited to just Web services, or technology or technical infrastructure either (Brittenham et al., 2007). Instead, it is about a new way of thinking about the value of commoditization, reuse and information, and creates business value (Bieberstein et al., 2005; Bardhan et al., 2010).

The service-oriented thinking is one of the fastest growing paradigms in academia and industry in response to the growing need for greater business integration, flexibility, and agility (Demirkan et al., 2009). When we look at the global economy we see that lead by the USA, the world economy is currently transitioning from a goods-based economy to an economy in which value creation, employment, and economic wealth depend on the service sector (Chesbrough & Spohrer, 2006; Spohrer & Maglio, 2008). Services account for 75% of the U.S. gross domestic product (Pal & Zimmerie, 2005) and 80% of private sector employment in the U.S. (Karmakar, 2004). They also play a similarly important role in all of the Organization for Economic Cooperation and Development countries. The OECD has thirty member countries, representative of the leading economies in the world. They include: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States (www.oecd.org). Moreover, industries that deliver consulting, experience, information, or other intellectual content now account for more than 70% of total value added in these countries (Spohrer, 2005). Market-based services, excluding those provided by the public sector (e.g., education, health care, and government) account for 50% of the total, and have become the main driver of productivity and economic growth, especially as the use of Information Technology (IT) services has grown (Spohrer, 2005). Similar to many other areas, this service-oriented global economy started to influence information technology field as well. According to Babaie et al. (2006), worldwide end-user spending on IT services will grow at a 6.4% compound annual growth rate through 2010 to reach US$855.6 billion, with positive growth in nearly all market segments.

Spohrer et al. (2007) defines a service as the application of competence and knowledge to create value between providers and receivers. This value accrues from the interactions of service systems that dynamically configure people, technology, organizations, and shared information in addition to language, laws, measures, models, and so on (Spohrer et al., 2007). Driving forces for service, service science and service systems are the growing need for focusing more on: 1) service offerings instead of product offerings, 2) customization instead of standardization, 3) stakeholder relationships instead of short term profit, 4) coordination oriented instead of function oriented, 5) build to change instead of build to last, 6) enterprise solutions, 7) loosely coupled, 8) distributed federated model, 9) revenue expansion through services, 10) improved ability to communicate, and 11) storing and processing information. When we look at these driving forces, we notice that they are about multi disciplinary concepts, knowledge and practices and. Today, most researchers are studying service in their own discipline. The overall goal of this article is to provide a multidisciplinary research agenda to the dynamic, scalable, secure, and knowledge-driven design and development of a service environment (or service ecology) with collaborative servitized enterprises, fostering the development of academic researchers and industry professionals with the ability to work in diverse, interdisciplinary teams for engineering adaptable solutions to distributed computing problems.

The remainder of the article is organized as follows. §2 provides an architectural view of the layers that typically exist in a service-oriented environment (i.e., servitized enterprise, service oriented enterprise). §3 explains the integrated service culture and multidisciplinary research agenda. §4 presents a multidisciplinary education and training plan for servitized enterprise professionals. Finally, conclusions are provided.

COLLABORATIVE SERVITIZED ENTERPRISE

Figure 1 provides an architectural view of the layers that typically exist in a *Collaborative Servitized Enterprise (CSE)*, ranging from low-level infrastructure layers to middle-level application services layers to top-level business processes. These top-level processes represent the knowledge-intensive business strategy that drives the ultimate purpose of the enterprise system, adding value to the organizations involved in the collaborative activity (Babcock, 2007). Servitized enterprise takes performance advantage of the commoditization of hardware (e.g., on-demand, utility computing, cloud computing, software oriented infrastructure with virtualized resources, infrastructure service providers), software (e.g. the software-as-service model, software oriented architecture, application service providers), and even business processes (e.g. ITIL, SCORE) (Davenport, 2005). For service-orientation, companies must co-create their offerings with customers, and break siloed business processes into modular independent services that can be reused on-the-fly in loosely-coupled dynamic business processes or "out-tasked" to external service providers. Out-tasking is smaller in scale than traditional outsourcing. It is about outsourcing individual tasks or parts of a business process.

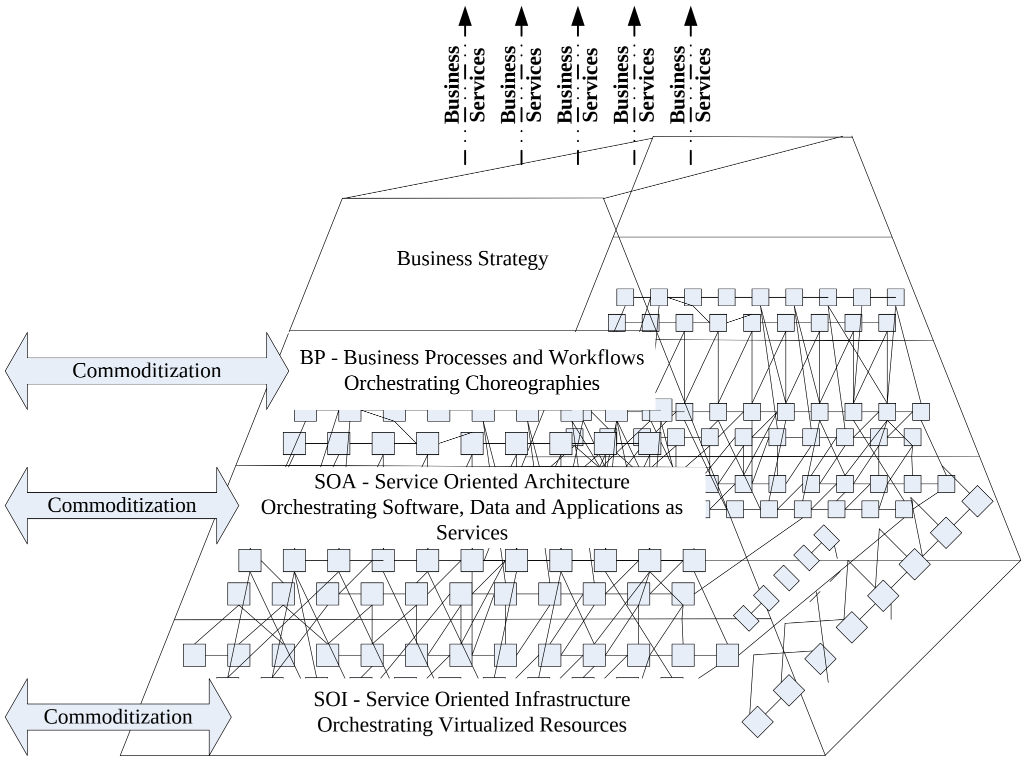

Figure 1. Layers of Servitized Enterprise

Currently, production of information technology researchers and industry professionals is aligned with the horizontal layers in Figure 1. Service-oriented computing and the prevailing global shift to a service-based economy, however, have together altered the delicate equilibrium between enterprise computing infrastructures and the support they provide for product-generating business processes. In the emerging service-oriented model, the infrastructure for provisioning collaborative enterprise service offerings is characterized by market-driven volatility. This volatility has major implications for dynamic sourcing strategies, requiring a deeper knowledge of how volatility affects interoperability within the horizontal layers *and* through vertical cross-sections of the layers – a concept that IBM refers to as *component business modeling*. These dynamic sourcing strategies also imply a need for intelligent and *autonomic* behavior with respect to participation in collaborative activities (Martin-Flatin et al., 2006), supporting self-monitoring, self-healing, and self-management of the service environment in response to the dynamics of the business-to-business (B2B) context as well as the business-to-customer (B2C) concept of self-service (Kephart & Chess, 2003) for collaborative commerce as depicted in Figure 2. The concomitant consumption, co-production, and delivery of service capabilities require new scientific foundations, research methodologies and trained scholars to investigate emerging equilibrium issues and to realize self-alignment principles.

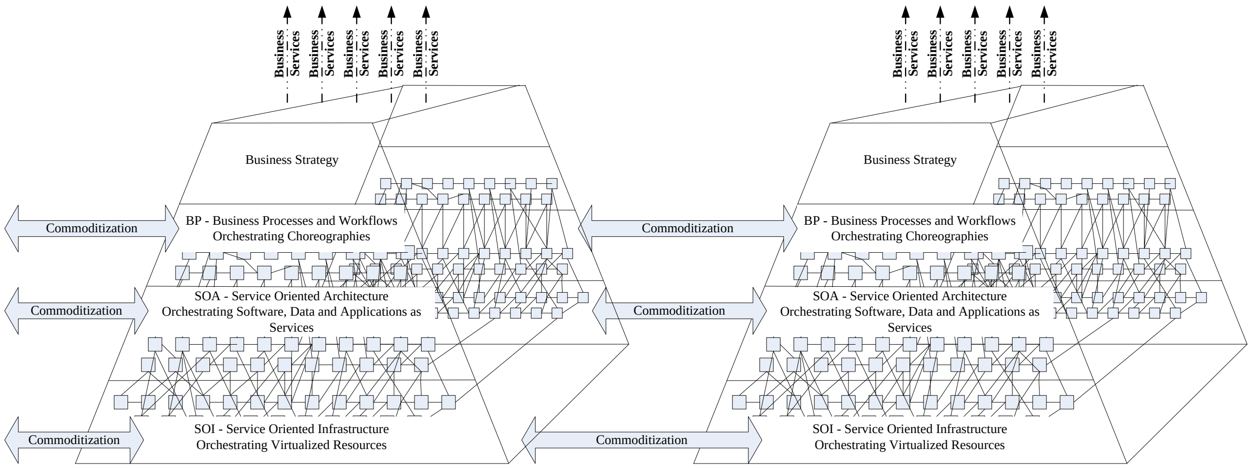

Figure 2. Collaborative Servitized Enterprise (CSE) for Distributed Commerce

The thematic basis of this research is that autonomic, service-oriented solutions must be studied in the context of a *CSE*. Understanding the complex switching costs for acquiring and interconnecting new service capabilities and un-connecting others--while simultaneously provisioning those necessary for enterprise continuity--must capture the essence of enterprise collaboration that is constantly balancing conflicts, as outlined in Figure 3.

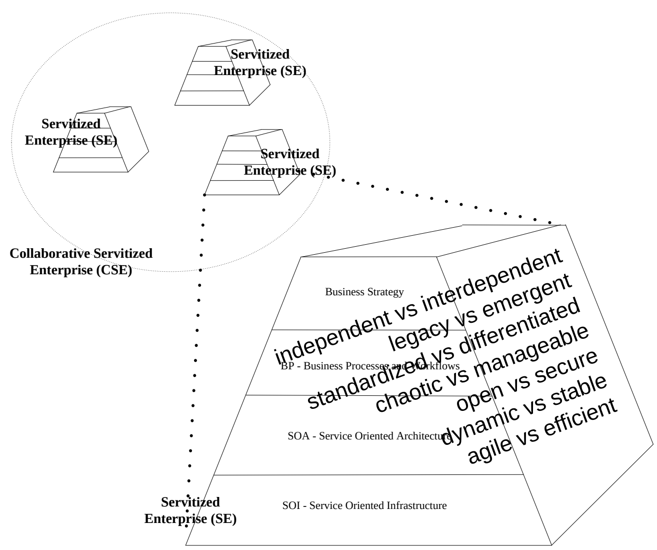

Figure 3. Opportunities and Challenges for Collaborative Servitized Enterprises

This new approach to computing will “pose daunting challenges to every user and vendor,” and will cause an upheaval that has never before been witnessed in the history of information technology (Carr, 2005). *Advancements for conducting distributed commerce in a service-oriented model will only occur by coupling a hard sciences foundation with a cultural change in the research and education process – one that brings business, management engineering and social sciences researchers together to study integrated solutions to the difficult challenges of service computing. This inter- and multi-disciplinary approach to research and education is essential to the success of the service sector of businesses that drive our economy and quality of life.*

INTEGRATED SERVICE CULTURE AND MULTIDISCIPLINARY RESEARCH AGENDA

Research agendas in the disciplinary areas affiliated with the design, development, and implementation of enterprise computing solutions have traditionally evolved independently. Recently there is convergence towards service-oriented themes represented in each disciplinary research stream, as shown in Figure 4. In addition, a “service culture” is now pervasive in the management philosophies of modern organizations - including those units typically assigned responsibility for elements of enterprise computing projects. Highly complex enterprise computing projects require an up-front configuration phase to assess the needed level of engagement from each unit to produce a robust and effective solution (Cameron, 2002). This configuration phase results in an “engagement model” that involves some or all of those service units. When each service unit ascribes to its discipline-based focus, the resulting engagement model requires significant integration overhead due to lack of common vocabulary, alternative perspectives of the problem domain, and lack of a common understanding of each discipline’s toolsets being brought to bear in the analysis of that problem domain. The personnel who are typically self-taught to become effective inter-service unit integrators often come to be in such high demand that they bottleneck the efficient and cost-effective delivery of a portfolio of ongoing projects.

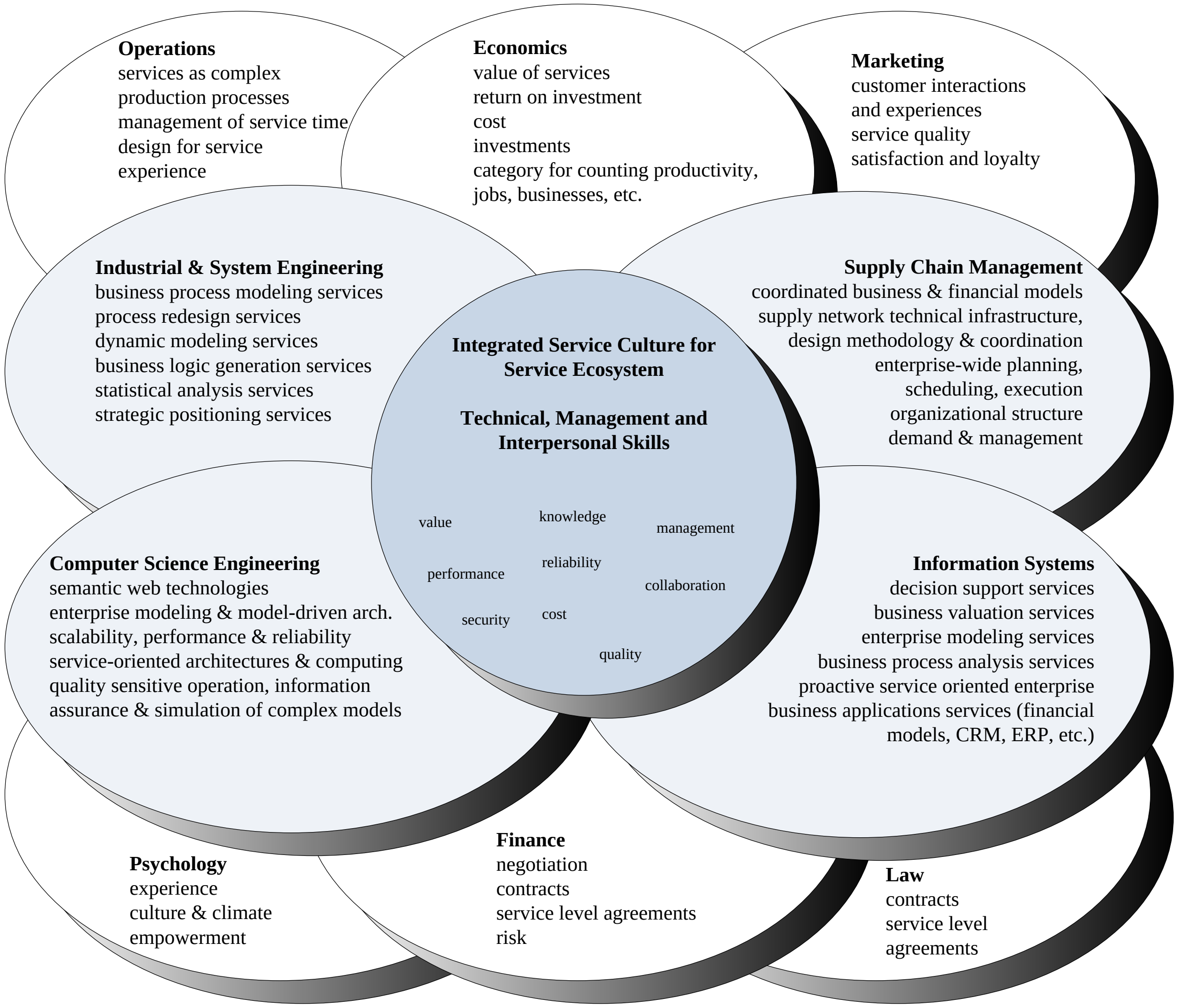

Figure 4. An integrated service culture

A multi-disciplinary research perspective is required to develop the strategies, processes, training pedagogy and toolsets for lean engagement models that reduce integration overhead and that concomitantly prepare the next generation of service specialists (e.g., T-shaped professionals) who possess highly-evolved integration skills. At stake is the ability to deliver cost-effective solutions from inter-dependent CSEs.

In this following, the article presents the several challenges, issues and opportunities from four disciplines that described in Figure 4 to demonstrate some of the research needs.

Computer Science: *SOA* focus on the use of data grids, Web Services, Grid Services, component technology, middleware, and agent technology to create an infrastructure for enterprise integration (Kostoff & Schaller, 2001; Singh & Huhns, 2004). A significant SOA challenge is the development of the *Semantic Basis for Service-Oriented Computing*, including the development of application domain ontologies, semantic web technologies, and knowledge-based techniques for service discovery and selection (Abowd, 2003; Dey, 2001). Advancements in *Enterprise Application Modeling* are needed for the use of software engineering standards, events, business rules, and business-to-business design patterns in business process modeling and collaboration (Dietrich et al., 2001; Ahamed et al., 2000; Orr & Hester, 2004; Singh & Huhns, 2004), including automated software specification and test data generation.

Economics: While there are many possible implications for economics research, as change accelerates understand the mechanisms of change seems central. North (2005) argues that a complete theory of economic change must include demographics, growth of knowledge (technology), and institutional or organizational change. A simplifying assumption that he proposes is that humans have worked throughout history to make their environment more predictable. Baumol, Litan, and Schramm (2007) argue for a better understanding of the role of the entrepreneur and entrepreneurial capitalism. Research that explores the roles of individuals and institutions, the two extremes of economic entities, in producing change is a high priority for the futuree.

Finance: Maximizing financial resources for shareholders and other stakeholders is a primary function of enterprises in a competitive environment (Hunt 2000). Superior financial performance is pursued in an environment of costly to obtain information, and in which some entities have privileged access to funds at the discount rate from central banking authorities and other entities have superior technical capabilities. Financial engineering methods are perhaps allowing risk taking of economic entities to run ahead of the system of laws and rules that shape and constrain their activities.

Industrial and Systems Engineering: *Process Redesign* recognizes that we find data errors and discrepancies between the actual inventory in stock and the IT data. Research issues are focused on (1) estimating the economic impact of various data quality problems, (2) evaluating the economic effectiveness of RFID, and (3) determining control policies that perform robustly in systems with less-than-perfect data. *Dynamic Modeling* addresses when decisions are made, by whom, with what timing and with what data. *Decision Support Systems for Supply Chain Management* focus on the development of decision support frameworks that can accommodate diverse concerns of multiple entities dispersed geographically across the supply chain (Narasimhan & Mahapatra, 2004).

Information Systems: Research is required to develop new types of decision support infrastructures that link lower-level architecture to virtual support environments likely using an underlying algebra for unified enterprise meta-modeling to instantiate decision support service environments into interconnected organizational networks (e.g., Goul & Corral, 2005; Sen et al., 2005). These decision support service environments require *Business Process and Valuation Services* to support investment decision making. Recently probabilistic approaches have gained popularity, including real options evaluation (Scwartz & Zozaya-Gorostiza, 2000). However, their limitation has been an inability to address sequential investment decisions including ongoing service level agreement negotiation in co-sourcing contexts (Goul et al., 2005; Soper et al., 2005; Satyavikas et al., 2003).

Laws: Laws, regulations, and in general governance mechanisms provided by government entities and other authority-oriented stakeholders play a major role in shaping and constraining interactions of CSE. Adams (2000) suggests that risk seeking entities find ways around regulations as a major source of positive and negative innovation. Arrow (1974) in describing the limits of organizations explores the non-market methods of government entities in directing and contolling the economy and society in general. Coase (1990) observes that lawyers routinely view economic entities as buying and selling bundles of rights, including access rights to capabilities and other resources. Williamson (1999) provides a comprehensive view of the way the institutional environment sets the rules of the game and provides explanation for many puzzles of economic organization.

Marketing: Christopher, Payne, and Ballantyne (1991) emphasize that traditional marketing has been about getting customers, but that relationship marketing is about getting and keeping customers. Customer loyalty is an area of increasing research interest as the economic cost of switching providers drops. Rust, Zeithhaml, and Lemon (2000) argue for more research to better understand the concept of customer lifetime value to help service providers reshape their strategic decision making when it comes to investing in their customers.

Operations: The fields of operations management and operations research are broad and influential. In the past, they have been applied mostly to understanding manufacturing-oriented enteprises (Bohn and Ramchandran, 2005). An important research area is to understand what new methods or revisions are needed to address service-oriented enterprises (Davis and Heineke, 2005).

Psychology: Psychology and the broader areas of social sciences such as business anthropology and interdisciplinary areas such as experimental economics provide the foundations for better theories of human decision making. Since Simon (1945), decision-making of individuals has been connected to better understanding of the complex decision-making processes in organizations. More recently, Checkland and Howell (2005) see psychology as a primary field in understanding information systems design. An important research agenda for the future is a better understanding of the the psychology that underlies reasoning about value in multi-stakeholder systems.

Supply Chain Management: The goal of *Integrated Demand Management* is to understand and incorporate the dynamics of the "buy" side into all design, planning, execution and financial decisions (Chang, 2004). Key to this area is the ability to proactively and robustly manage the demand fluctuation paradox referenced by Hau Lee (1997). *Design Methodology and Coordination* focus on rapidly design/redesign the supply network to respond to changes in market conditions, business climate, and technology. The fundamental research agenda questions are: how can supply networks be designed to include aspects such as extensibility, flexibility, scalability, and mass customization (Pine, 1993).

Interdisciplinary Theme

The overall goal of this paper is to build on the core foundation of an integrated service culture. Such a culture is characterized by a cross-disciplinary attitude that recognizes that fulfilling clients' needs is the primary objective. A secondary attitude within that culture must be an awareness of the complexities associated with what we refer to as *service tradeoff decision making*. Service tradeoff decisions are those that require a careful balancing of project value, risk and cost, project management benefits associated with alternate development methodologies (e.g., Boehm & Turner, 2004; Saaty, 1986), and cost and capability versus quality of service (including performance, security and reliability aspects). Service specialists will need to collaborate in making these service trade-off decisions throughout a project's lifecycle, and practical experiences with real use cases drawn from global contexts, combined with exposure to relevant theoretical models, together represent the only viable pedagogical vehicles to attain the needed skill-set. In short, the ability to make these decisions requires a synergistic combination of value-based technical and managerial skills.

While each discipline contributing new science-based knowledge to CSE innovation will make progress independently, the core attitudes surrounding the service culture, its project orientation and service trade-off decision-making will provide the common threads to interweaving the major research issues. Another common thread relates to the ability to maintain and reuse engagement model patterns. Pattern representations, searchable ontologies, the role of patterns in engagement configuration, and the unification of project management strategies within pattern classes represent synergistic research topics that will be a focus of our multi-disciplinary perspective.

EDUCATION AND TRAINING PLAN

Based on the common threads of the proposed multi-disciplinary research, the challenge of the education and training process is to create an environment that 1) exposes students to the difficult services computing problems of actual industry case studies, and 2) provides an opportunity for students to work in interdisciplinary teams in the study of such case studies. Students must also gain a deep knowledge of their chosen discipline to develop cutting-edge solutions to difficult problems in a multi-disciplinary context.

A multidisciplinary education and training plan for servitized enterprise professional should include specific discipline and multidisciplinary course work in addition to rigorous science theories, and relevant applied case studies and applications, as shown in Figure 5. The intersection in Figure 5 represents the core multidisciplinary course work that needs to be developed, integrating a minimum of two of the disciplines, but in some cases all disciplines. All students should be encouraged to take the multidisciplinary core courses to establish an integrated view of how service science, management, engineering, and design issues converge in the difficult research problems associated with servitized enterprises. This convergence of issues will provide the context for further study of the disciplinary science and theory that will lead to needed solutions to research problems.

The students in this multidisciplinary curriculum will have breadth of knowledge across the disciplines and depth of knowledge within at least one of the many disciplines represented. Students should learn foundational theories and be apply to real life use cases. Students should take course work intended to increase their depth of knowledge in one or more of the four core areas. They will continue to be involved with the multidisciplinary research, produced in teams and in conjunction with industry partners, and work in the common laboratory space provided (Probert & Radnor, 2003). In addition to the course work, students should take multidisciplinary seminars and workshops; work on multi disciplinary projects and thesis, and complete internships.

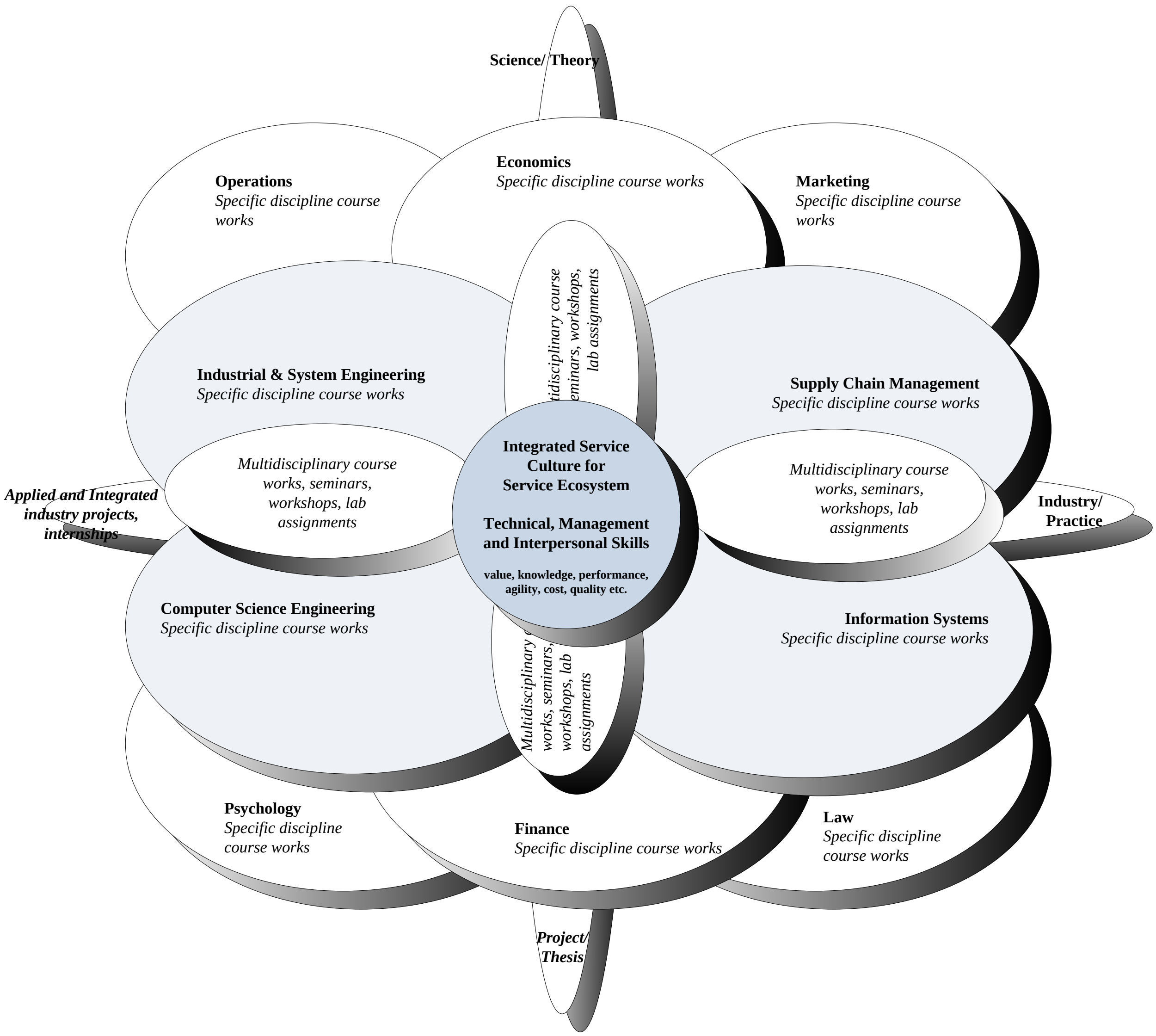

Figure 5. A multidisciplinary education and training plan for servitized enterprise professionals

CONCLUSIONS AND FUTURE RESEARCH

Globalization and commoditization are creating challenges and opportunities for companies. Agility and innovation are essential for survival in today's business world. Mergers and acquisitions, new regulations, rapidly changing technology, increasing competition and heightened customer expectations mean companies must become more responsive to changing demands, i.e., become more agile. This move to agility through innovation can be possible with collaborative servitized enterprises. It is almost impossible to be successful in today's very competitive and complex business world without understanding the building blocks of today's enterprises, and opportunities and challenges for collaborative servitized enterprises. This article contributes to the growing body of literature in service science by designing an architecture of a *Servitized Enterprise* and a *Collaborative Servitized Enterprise (CSE).* Also, it provides a multidisciplinary research agenda to the dynamic, scalable, secure, and knowledge-driven design and development of collaborative service environment with servitized enterprises, fostering the development of academic researchers and industry professionals with the ability to work in diverse, interdisciplinary teams for engineering adaptable solutions to distributed computing problems. Relating existing disciplines to the emerging area of service science has also been explored in Spohrer & Kwan (2009) and Spohrer & Maglio (2010).

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