

Demirkan, H. and Spohrer, J. C., (2010) “Servitized Enterprises for Distributed Collaborative Commerce,” *Inter. Journal of Service Science, Management, Engineering & Technology*, 1 (1), 68-81.

Servitized Enterprises for Distributed Collaborative Commerce

*Haluk Demirkan, Arizona State University, USA
James C. Spohrer, IBM Global University Programs, USA*

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 commerce* 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.

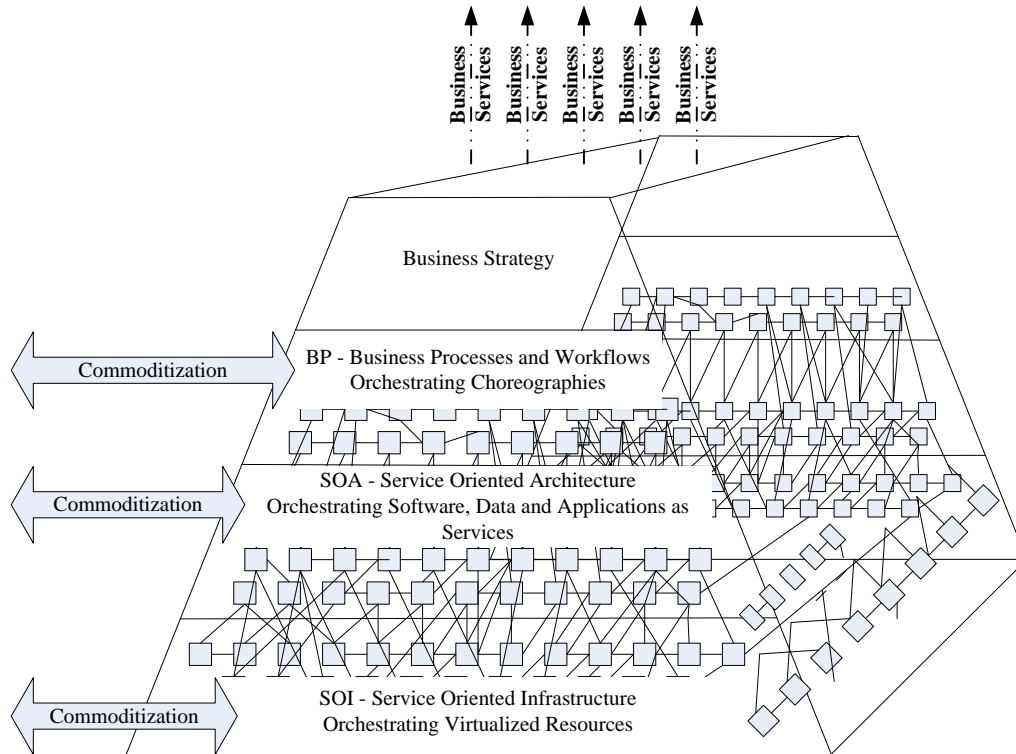


Figure 1. Layers of Servitized Enterprise

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.

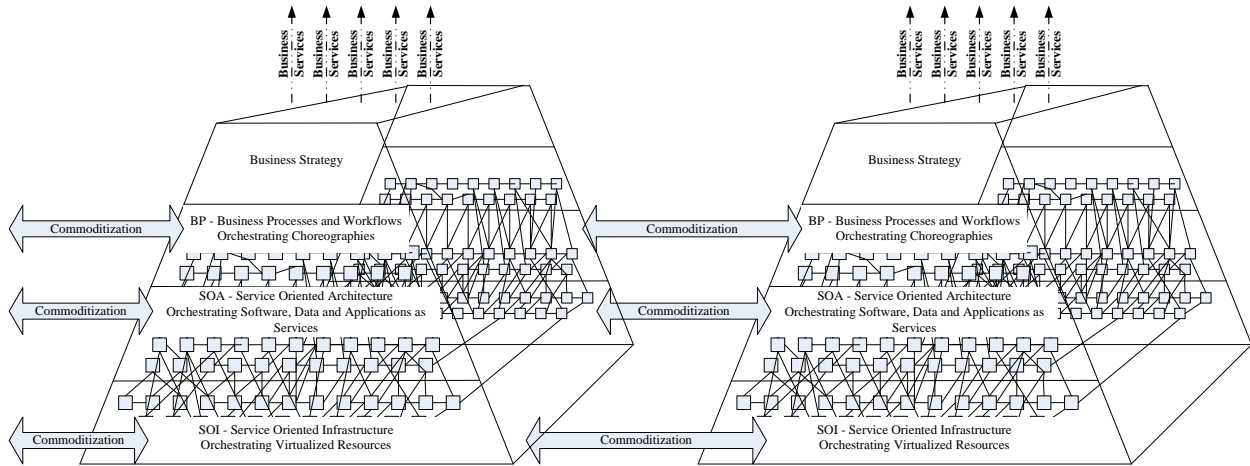


Figure 2. Collaborative Servitized Enterprise (CSE) for Distributed Commerce

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.

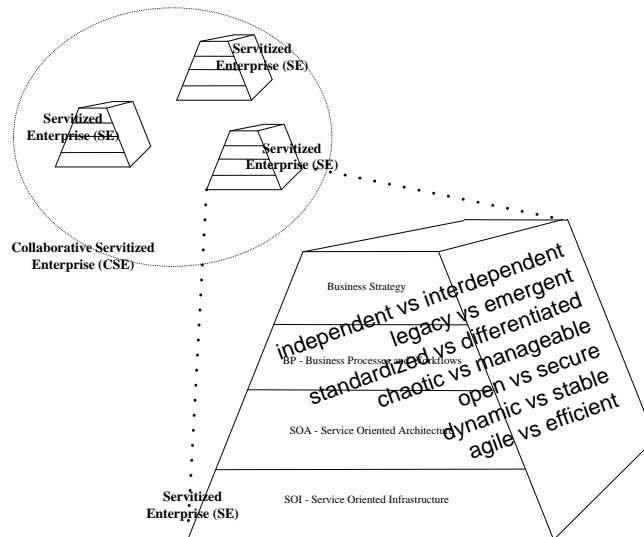


Figure 3. Opportunities and Challenges for Collaborative Servitized Enterprises

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.

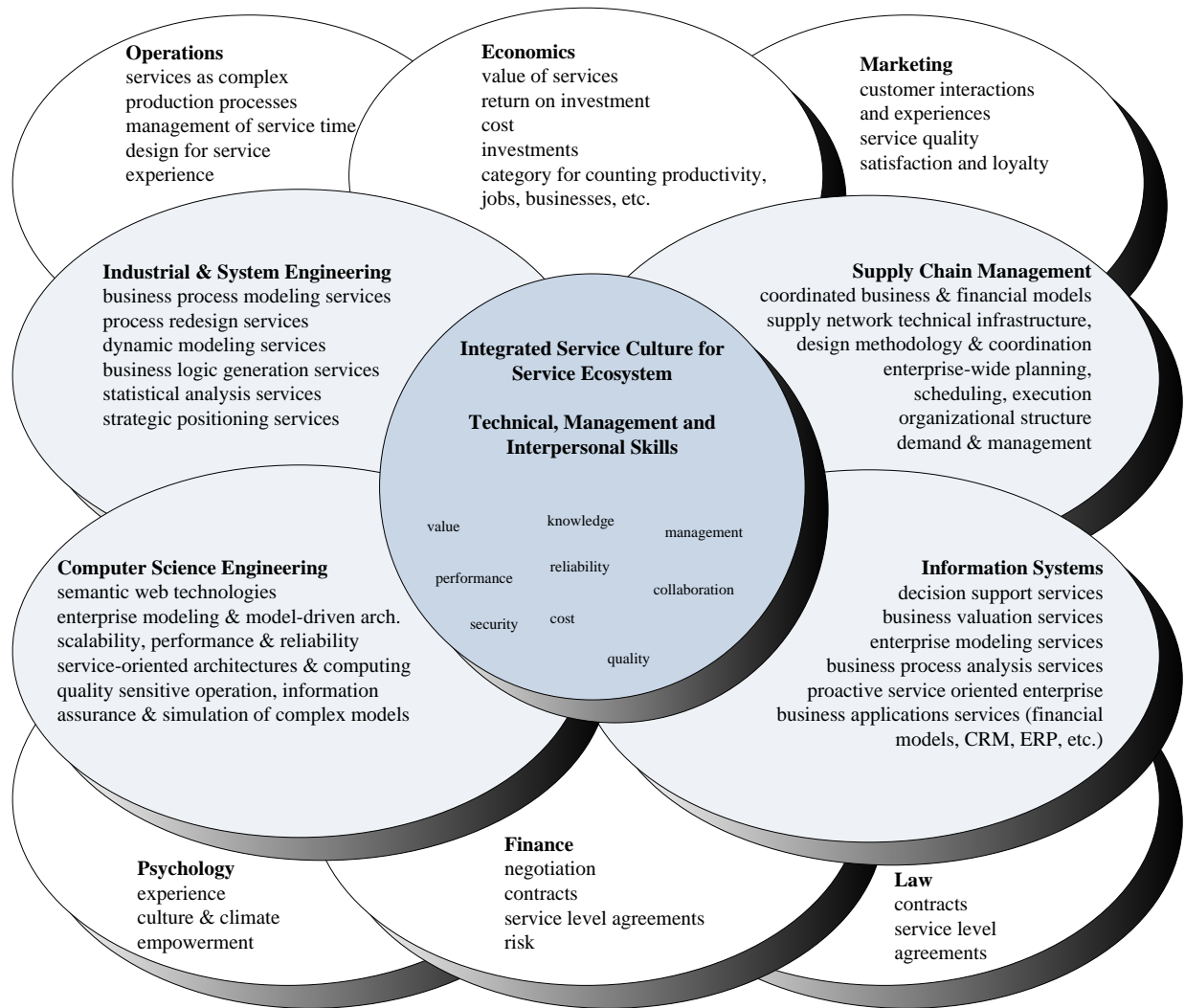


Figure 4. An integrated service culture

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 future.

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 controlling 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, Zeithaml, 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 enterprises (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.

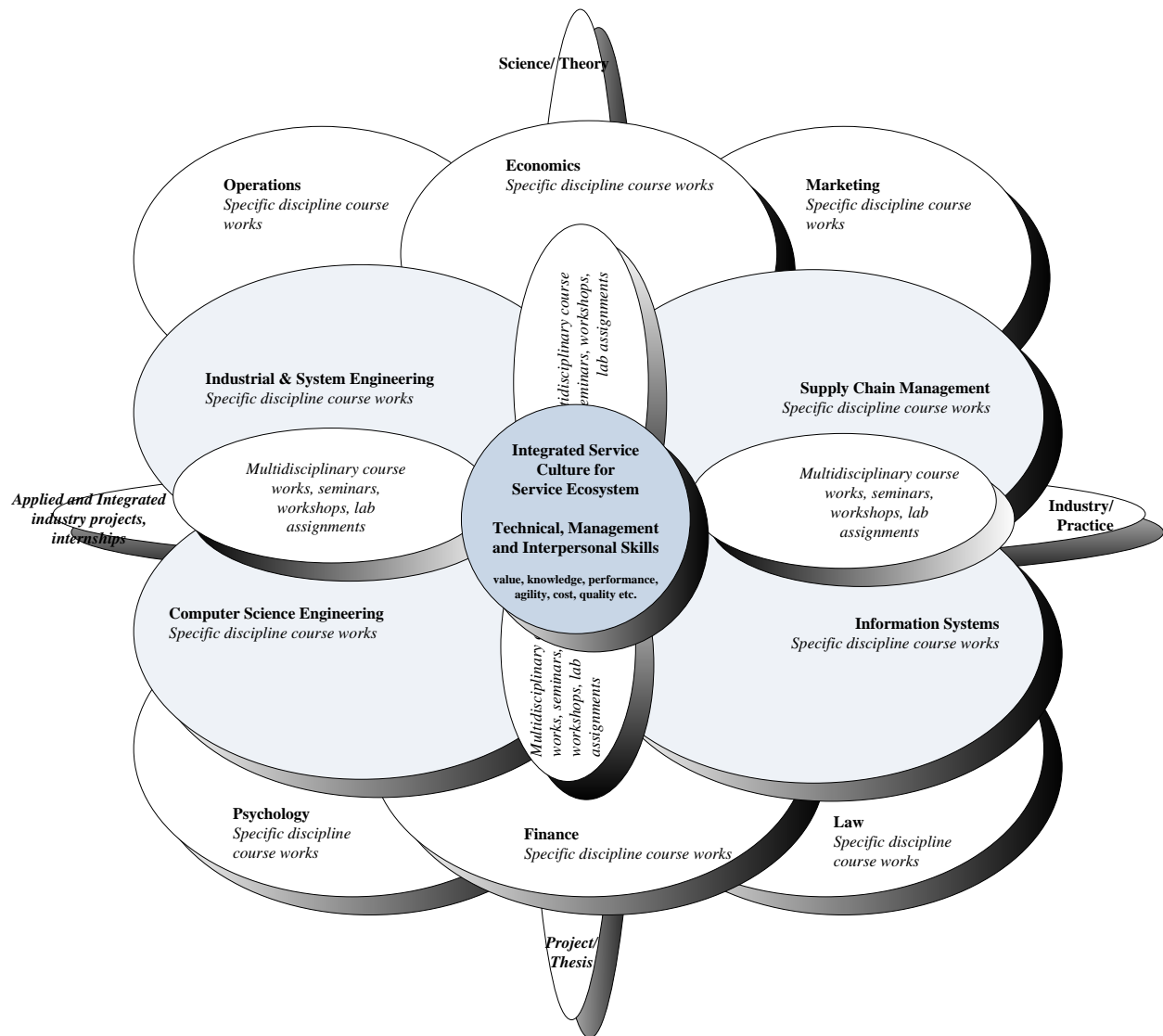


Figure 5. A multidisciplinary education and training plan for servitized enterprise professionals

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).

Acknowledgments

We wish to thank Editor-in-chief Dr. Miguel-Angel Sicilia for his support.

REFERENCES

- Abowd, G., Dey, A., Brown, P., Davies, N., Smith, M., & Steggles, P. (1999). Towards a Better Understanding of Context and Context-Awareness. In *Proceedings of the 1st International Symposium on Handheld and Ubiquitous Computing* (LNCS 1707, pp. 304-307).
- Adams, J. (2000). *Risk*. Routledge, London, UK
- Ahamed, S., Ali, S., Bingham, D., Dawra, A., Ha, L., Luong, T., et al. (2000, April 12-13). Software Requirements on the Web. In *Proceedings of the 3rd Int. Conf. on Business Information Sys* (pp. 134-144). Poznan, Poland.
- Arrow, K. J. (1974). *The Limits of Organization*. W.W. Norton & Company. New York, NY.
- Babaie, E., Hale, K., Souza, R. D., Adachi, Y., & Ng, F. (2006, November 30). *Forecast: IT services, worldwide, 2003-2010*. Gartner Group.

- Babcock, C. (2007, May). Software Ecosystems: Can Salesforce, Google, and Facebook Be Fertile Grounds for Third-Party Development? *News & Analysis*.
- Bardhan, I., Demirkan, H., Kannan, P. K., Kauffman, R. J., & Sougstad, R. (2010). An Interdisciplinary Perspective on IT Services Management and Services Science. *Journal of Management Information Systems*.
- Baumol, W. J., Litan, R. L. & Schramm, C. J. (2007). *Good Capitalism, Bad Capitalism, and the Economies of Growth and Prosperity*. Yale University Press. New Have, CT.
- Bieberstein, N., Bose, S., Fiammante, M., Jones, K., & Shah, R. (2005). Service-Oriented Architecture (SOA). *Compass: Business Value, Planning, and Enterprise Roadmap*. Upper Saddle River, NJ: FT Press.
- Boehm, B., & Turner, R. (2004). *Balancing Agility and Discipline: A Guide for the Perplexed*. Upper Saddle River, NJ: Pearson Education.
- Brittenham, P., Cutlip, R. R., Draper, C., Miller, B. A., Choudhary, S., & Perazolo, M. (2007). IT service management architecture and autonomic computing. *IBM Systems Journal*, 46(3), 565-581.
- Cameron, J. (2002). Configurable Development Processes. *Communications of the ACM*, 46(3), 72-77.
- Carr, N. (2005, April 15). The End of Corporate Computing. *MIT Sloan Management Review*, 46(3), 66-73.
- Chang, Y., Makatsoris, H., & Richards, H. (2004). *Evolution of Supply Chain Management*. Boston: Kluwer Academic Publishers.
- Checkland, P. & Holwell, S. (1998/2005). *Information, Systems, and Information Systems: Making Sense of the Field*. Wiley. Chichester, UK.
- Chesbrough, H., & Spohrer, J. (2006). A research manifesto for services science. *Communications of the ACM*, 49(7), 35-40.
- Christopher, M., Payne, A. & Ballantyne, D. (1991). *Relationship Marketing: Bringing quality, customer service, and marketing together*. Butterworth-Heinemann. London, UK.
- Coase, R.H. (1990). *The Firm, the Market, and the Law*. University of Chicago Press. Chicago, IL.
- Davenport, T. (2005, June 1-2). The Coming Commoditization of Processes. *Harvard Business Review*.
- Davis, M. M. & Heineke, J. (2005). *Operations Management: Integrating Manufacturing and Services*. Fifth Edition. McGraw-Hill Irwin. Boston, MA.

- Demirkan, H. (2008). The Servitisation of Processes, Architectures and Technologies. *The International Journal of Services Sciences*, 1(3-4), 197-205.
- Demirkan, H., Kauffman, R. J., Vayghan, J. A., Fill, H.-G., Karagiannis, D., & Maglio, P. P. (2009). Service-Oriented Technology and Management: Perspectives on Research and Practice for the Coming Decade. *The Electronic Commerce Research and Applications Journal*, 7(4), 356-376.
- Dey, A. (2001). Understanding and Using Context. *Personal and Ubiquitous Computing*, 5(1), 4-7.
- Dietrich, S., Urban, S., Sundermier, A., Na, Y., Jin, Y., & Kambhampati, S. (2001). A Language and Framework for Supporting an Active Approach to Component-Based Software Integration. *Informatica*, 25, 443-454.
- Foster, I., Kesselman, C., & Tuecke, S. (2001). The Anatomy of the Grid: Enabling Scalable Virtual Organizations. *International Journal of High Performance Computing Applications*, 15(3), 200-222.
- Goul, M., & Corral, K. (2005). Enterprise Model Management and Next Generation Decision Support. *Decision Support Systems*, 43(3), 915-932.
- Goul, M., Corral, K., & Demirkan, H. (2005). Database Schema Design for a Web Services Supply Chain Manager: Requirements and Proposed Infrastructure. *Information Systems Frontiers*, 7(3), 257-271.
- Hunt, S. D. (2000). *A General Theory of Competition: Resources, Competences, Productivity, Economic Growth*. Sage Publications Thousand Oaks, CA
- Karmakar, U. (2004). Will you survive the services revolution? *Harvard Business Review*, 82(6), 100-107.
- Kephart, J., & Chess, D. (2003, January). The Vision of Autonomic Computing. *IEEE Computer*, 41-50.
- Kostoff, R. N., & Schaller, R. R. (2001). Science and Technology Roadmaps. *IEEE Transactions on Engineering Management*, 48(2), 132-143.
- Lee, H., Padmanabhan, P., & Whang, S. (1997). Bullwhip Effect in a Supply Chain. *Sloan Management Review*, 38, 93-102.
- Luo, X., & Seyedian, M. (2003). Contextual Marketing and Customer-Orientation Strategy for E-Commerce: An Empirical Analysis. *International Journal of Electronic Commerce*, 8(2), 95-118.
- Martin-Flatin, J., Sventek, J., & Geihs, K. (2006, March). Self-Managed Systems and Services. *Communications of the ACM*, 49(3), 36-39.

- Narasimhan, R., & Mahapatra, S. (2004), Decision models in Global Supply Chain Management. *Industrial Marketing Management*, 33, 21-27.
- North, D. C. (2005). *Understanding the process of economic change*. Princeton, N.J.: Princeton University Press.
- OASIS. (2006). *A reference model for service-oriented architecture*. Billerica, MA: Organization for the Advancement of Structured Information Standards.
- Orr, L., & Hester, R. (2004, November). Beyond MDA 1.0: eXecutable Business Processes from Concept to Code. *MDA Journal*, 1-7.
- Pal, N., & Zimmerie, R. (2005). *Service innovation: a framework for success*. University Park, PA: eBusiness Re-search Center, Smeal College of Business, Pennsylvania State University,.
- Pine, B. (1993). *Mass Customization*. Boston: Harvard Business School Press.
- Porter, M. E. (2001). Strategy and the Internet. *Harvard Business Review*, 79(3), 62-78.
- Probert, D., & Radnor, M. (2003). Frontier Experiences from Industry-Academia Consortia. *IEEE Engineering Management Review*, 31(3), 28.
- Rust, R., Zeithaml, V. & Lemon, K. (2000). *Driving Customer Equity : How Customer Lifetime Value is Reshaping Corporate Strategy*. Free Press, New York, NY.
- Saaty, T. L. (1986). A note on the AHP and expected value theory. *Socio-Economic Planning Sciences*, 20(6), 397-398.
- Satyavikas, V. K., Demirkan, H., & Goul, H. (2003). Towards Web Services Standards for Fault Tolerance Capabilities in Interorganizational Workflow Management Systems. In *Proceedings of International Conference on Web Services* (pp. 90-96).
- Schoenbachler, D. D., & Gordon, G. L. (2002). Trust and Customer Willingness to Provide Information in Database-Driven Relationship Marketing. *Journal of Interactive Marketing*, 16(3), 2-16.
- Schwartz, E. S., & Zozaya-Gorostiza, C. (2000, November 18). *Valuation of Information Technology Investments as Real Options*. Retrieved from <http://repositories.cdlib.org/anderson/fin/6-00>
- Sen, S., Demirkan, H., & Goul, M. (2005). Towards a Verifiable Checkpointing Scheme for Agent-based Interorganizational Workflow System "Docking Station" Standards. In *Proceedings of the 38th Annual Hawaii International Conference on System Sciences (HICSS'05)* (Vol. 7, pp. 165a).
- Simon, H. A. (1997). *Administrative Behavior: A study of decision-making processes in administrative organizations*. Free Press, New York, NY.

Singh, M., & Huhns, M. (2004). *Service-Oriented Computing: Semantics, Processes, Agents*. New York: John Wiley & Sons.

Soper, D., Demirkan, H., & Goul, M. (2008). Evaluating the Applicability of Socially-Oriented Perspectives to the IT Service Level Agreement Negotiation Process: A Theory-Driven Exploratory Study. *International Journal of Services Sciences*, 1(3-4), 267-287.

Spohrer J. & Kwan, S. K. (2009). Service science, management, engineering, and design (SSMED): an emerging discipline – outline & references. *International Journal of Information Systems in the Service Sector*, 1, (3), 1-31.

Spohrer, J. & Maglio, P. P. (2008). The emergence of service science: toward systematic service innovations to accelerate co-creation of value. *Production and Operations Management*, 17(3), 1-9.

Spohrer, J. & Maglio, P. P. (2010). Service science: Toward a smarter planet. In W. Karwowski & G. Salvendy (Eds.), *Introduction to Service Engineering*. Wiley, New York, NY.

Spohrer, J. (2005). *Services sciences, management, engineering: a next frontier in education, innovation and economic growth*. Paper presented at Services Marketing Workshop, Center for Services Leadership, Arizona State University, Tempe AZ.

Spohrer, J., Maglio, P. P., Bailey, J., & Gruhl, D. (2007). Steps toward a science of service systems. *IEEE Computer*, 40(1), 71-78.

Urban, S. (2004, November). *Enterprise Computing*. Paper presented at the Enterprise Computing Academia and Industry Collaboration, Computer Science Engineering, Arizona State University, Tempe, AZ.

Williamson, O. E. (1999). *The Mechanisms of Governance*. Oxford University Press. Oxford, UK.

Haluk Demirkan is a Professor of Information Systems and a Research Faculty of Center for Services Leadership. His doctorate is in Information Systems and Operations Management from University of Florida, and his research in service science, and service-oriented management and technology solutions have included recent industry-sponsored research projects with American Express, Intel, IBM, MicroStrategy and Teradata. His research appears in a number of journals, including *JMIS*, *JAIS*, *EJOR*, *IEEE Transactions*, *ECRA*, *IS Frontiers*, *CACM*, *ISEBM*, *International Journal of Services Science*, and other leading journals. He has authored or co-authored over forty articles in refereed journals or conference proceedings. He has fifteen years of consulting experience in the areas of service-oriented information systems and technology solutions, information supply chain, business intelligence and strategic business engineering with Fortune 100 companies. He is the recent recipient of the IBM Faculty Award for a research project titled “Design Science for Self-Service Systems.”

James C. Spohrer is a Director of IBM Global University Programs since 2009, Jim founded IBM's first Service Research group in 2003 at the Almaden Research Center with a focus on STEM (Science Technology Engineering and Math) for Service Sector innovations. He led this

group to attain ten times return on investment with four IBM outstanding and eleven accomplishment awards. Working with service research pioneers from many academic disciplines, Jim advocates for Service Science, Management, Engineering, and Design (SSMED) as an integrative extended-STEM framework for global competency development, economic growth, and advancement of science. In 2000, Jim became the founding CTO of IBM's first Venture Capital Relations group in Silicon Valley. In the mid 1990's, he lead Apple Computer's Learning Technologies group, where he received the DEST (Distinguished Engineer Scientist and Technologist) award. Jim received a Ph.D. in Computer Science/Artificial Intelligence from Yale University and a B.S. in Physics from MIT.