

## Service Oriented Architecture: Challenges for Business and Academia

By: Amelia Maurizio\*, James Sager, Peter Jones\*, Gail Corbitt and Lou Girolami\*

\* from SAP AG and Sager and Corbitt from California State University, Chico

### Abstract

*Today, the means for attaining competitive advantage with information technology (IT) has shifted from efficiently managing the organization's operations to discovering ways to collaborate with industry partners to provide products and services to markets that are otherwise uneconomical to pursue. Current IT challenges center on ways to integrate diverse systems into function rich business processes that span organizational boundaries. Though Service Oriented Architecture (SOA) is poised to become a mainstream technology, its success may hinge on a meeting of the minds between the architects and developers of web services and business process modelers who map out corporate requirements. This paper defines SOA, discusses how SOA relates to business process management, and provides an illustration of enterprise SOA applied in an enterprise resource planning (ERP) environment. The paper also describes how SOA motivates change in IT governance, enumerates the fundamentals of SOA success, and reflects on implications for IT education.*

In the decade of the 1990s, the business world at large decommissioned a wide mix of functional area information systems developed in-house or purchased from software vendors. In most cases these systems were replaced with a single integrated suite of business applications, an enterprise resource planning (ERP) system, purchased from a single vendor. The ERP software revolution enabled companies to not only effectively manage core business processes but it also allowed them break their focus on functional area concerns and adopt a process-oriented view of the enterprise. Although early adopters of ERP systems may have enjoyed a brief competitive advantage, the systems soon became commoditized and are now considered to be the price of entry for running a business and for being connected to other enterprises in a network economy. [8, 22]

Today, the means of attaining competitive advantage with information technology has shifted from efficiently managing the organization's internal operations to finding ways to collaborate with industry partners to provide products and services to markets that are otherwise uneconomical to pursue. Current IT issues center on ways to integrate diverse systems into complex or function rich business processes that span organizational boundaries.

The latest "silver bullet" or the next disruptive technology candidate is Service Oriented Architecture (SOA) a technology by which loosely coupled services are made available on a network to support the orchestration of business processes. While the term SOA is relatively new, many of the underlying concepts have been around for more than a decade. SOA has been described as "an external, cross-application form of object-oriented programming" (OOP) because it employs reusable collections of data and functionality that can be accessed via Web services [22]. While SOA shares a conceptual lineage with OOP, it promotes reuse at a higher level of abstraction and puts the business process at the focus of system design [15].

### 1. Introduction

Despite Fredrick Brooks' 1989 declaration that "building software will always be hard" and that there "is inherently no silver bullet" [1], the search for simple, cost effective solutions to the problems inherent in imagining, designing, building, and modifying software has continued unabated. The landscape of computing has changed dramatically since 1989 with the introduction and widespread adoption of disruptive innovations such as graphical user interfaces, object-oriented design and development, open standards, open source, and ubiquitous networking. Nonetheless, issues in developing and deploying software solutions are still associated with the four dimensions identified by Brooks: complexity, conformity, changeability, and invisibility (which refers to software's inherent lack of an intuitive visual representation) [1].

This paper explores the issues surrounding successful deployment of SOA in a project sponsored by SAP at the General Electric Appliances Division. The paper defines SOA and then uses the GE example to illustrate how successful SOA projects need to address the issues of Business Process Management and corporate governance. The authors conclude by identifying key areas in which SOA might impact an MIS curriculum.

## 2. Defining SOA

In the SOA reference model released by the information standards group OASIS, SOA is defined as a “paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains” [19]. In simpler terms: SOA is a standardized set of methods for getting things done using whatever capabilities you have, wherever those capabilities reside, and in whatever fashion those capabilities can be organized or combined to deliver maximum benefit to the enterprise [19]. Therefore the journey into SOA begins by thinking differently - from how to build effective systems to how to get business done most effectively.

In the context of SOA, a service is a function or a collection of functions or activities that an application performs. In more traditional systems that do not rely on services, these functions are built into the system itself. If the same function is performed in multiple locations within an application, it is beneficial to code (or recode) the function once and then re-use or reference that function from wherever it is needed. Rather than being hard coded into an application, SOA provides the mechanism whereby a function (or set of functions) can be written as a stand alone service that performs a specific task and is called upon as needed [5]. SOA is the shape of distributive computing in the Internet age. At the heart of SOA is a set of standardized practical approaches for designing and sharing reusable services. SOA permits IT groups to treat a decentralized multiplatform environment as a unified computing fabric.

The advantages of SOA (including increased code reuse, flexibility, reduced integration expense, and greater business agility) outweigh the increased organizational discipline required to implement a standardized services architecture

[21]. The processes, standards, and regulations that make it possible for SOA to work must eventually be deployed as an underpinning that spans the entire organization. SOA success may depend on a commitment to design rules that specify interfaces that eliminate certain paths from consideration and delineate the boundaries between subsystems.

## 3. The Role of Business Process Management in SOA

Business Process Management (BPM) is a discipline which combines software capabilities and business expertise to accelerate process improvement and facilitate business innovation [2]. Sandy Carter, Vice President of SOA and WebSphere Strategy at IBM says: “As a management discipline, BPM replaces the traditional views of business based on discrete functional organizations, systems and metrics with those based on cross-functional core processes aligned with high-level business objectives. As a technology platform, BPM provides the set of software tools needed to optimize performance, make abstract performance goals concrete, connect them to process data, automate and monitor process activities and provide a platform for agile performance improvement” [2].

Finding new ways to improve and automate business processes without requiring additional resources is becoming a focal point for most businesses. It has been suggested that BPM is based on the principles of SOA as both attempt to enable an enterprise to more quickly adapt and respond to changing market conditions that may arise from unplanned events such as competitor moves and/or mergers and acquisitions [21]. In order to benefit from these events and other opportunities through SOA, companies need to align their business processes to eliminate reinventing the wheel.

Based on the GE project it appears that several factors are driving the increased focus on BPM. These include: consistency throughout the organization (especially as it applies to compliance), optimization of processes for maximum efficiency, automation of processes to reduce time associated with administrative tasks, mitigation of risks by having a single view of the organization, and integration of complex and sometimes redundant processes. While using

and reusing existing technology investments, BPM delivers greater flexibility throughout the enterprise. The need to model business processes before they are deployed in SOA is becoming increasingly important and the powerful combination of employing BPM to streamline business processes within an SOA strategy helps position companies to become industry leaders.

Although process modeling has been around for some time, the combination of process modeling and SOA is new enough that analysts and consultants often have strong and differing ideas and opinions about best practices [7]. For example, to add business value, it is important to choose the right process for an initial SOA effort based on its potential contribution. Start with a work shop to get the right stakeholders in the room to get the discussion started. Ignore organizational constraints when evaluating processes. Don't be too rigid with the technology. Work top down and bottom up, simultaneously mapping out business process and goals as well as service capabilities. Keep in mind that processes extend outside the organization to vendors, customers and partners. Make a long term commitment to process modeling, and set aside intractable disagreements until the easier problems are solved.

#### **4. Application of Enterprise Service Oriented Architecture in an ERP system using the SAP solution**

It is important to realize that without the advances in system architecture and overall advancements in web based technology SOA is not possible. In a basic ERP environment the company takes advantage of the basic processes vertically in a business solution rather than looking across the business and viewing the overall business process between different levels and areas. This more encompassing view is possible with the implementation of SOA. An example of this is a company which is reviewing the overall integration of their sales cycle. The players in this process are production, marketing, sales, administration, customer service and IT. Figure 1 illustrates how a typical ERP system might be configured.

While the activity within the different environments is being leveraged there is very little integration across the different life cycles. Therefore IT is positioned as a support mechanism rather than a business driver. The other areas of the company are working individually to develop and roll up the results of their activities. For example, the product planning system is working separately from the marketing system and delivering individual information to the consumer, dealer, employee and delivery service rather than combining with all other groups to deliver a focused, organized, and integrated solution for the problem(s). In this case, issues at the service level do not benefit from the functionality of IT. To achieve SOA in a company, the need is to understand that it requires all of the differing aspects of the company's processes - business and technology - to accomplish the overall goals. In this example the company must understand the issues that can come about with the use of a best of breed ERP system versus an SOA based approach where the emphasis is not on siloed areas but based on overall process integration.

Some of the issues that SOA can solve in this situation are:

- Use of a central data repository for all marketing information;
- Ability to define and manage relationships between and among products to allow cross-selling, up-selling, and bundling of products;
- Integration with back-end legacy systems;
- Ability to store and manage all documents and image types related to the product data;
- Flexible data structure to accommodate new brands and new product introductions;
- User-friendly interface for data import, maintenance, search, and export;
- Support for scheduled distribution of product information to all B2C, B2B, and intranet Web sites;
- One touch point for maintenance with global change capability;
- Support for external content delivery to customers and suppliers;
- Support for internal content delivery to sales, product management, and marketing; and
- Fast and effective search capability.

By implementing an SOA system, you can overcome a number of technical and business challenges, including platform considerations, network topology, and legacy content conversion. For example, SAP's NetWeaver platform, SAP's SOA, is flexible enough to overcome all these issues. As you can see in figure 2, the whole organization has been realigned into a total business process oriented approach. The functionality of the IT, production, marketing and other areas are focused and drive a consistent business process thru to the customer groups.

There are no silo type activities occurring and all of the functionality and efforts of each area are combined and organized to generate the most effective result. In these cases most companies are able to retire one or many other legacy software systems, thereby saving on maintenance and administration costs. Further, since all product, marketing, and collateral information are managed centrally in a single, enterprise wide repository, there is no longer any need to enter data in multiple systems, further reducing costs and making the data more accurate and consistent.

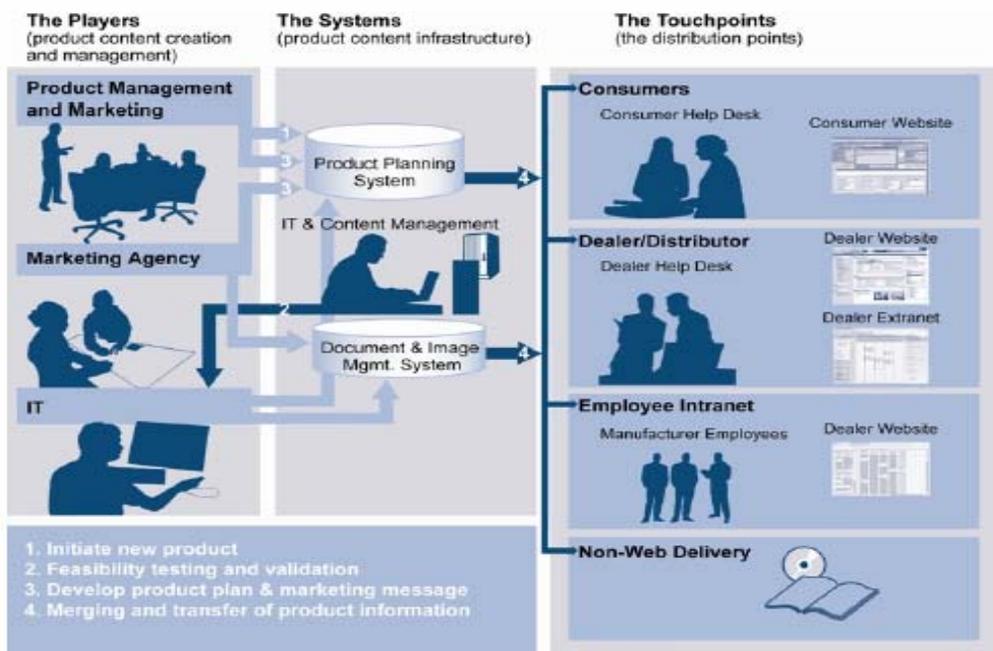


Figure 1: Original process for creating, managing, and distributing product information which requires manually merging two disparate databases. [12]

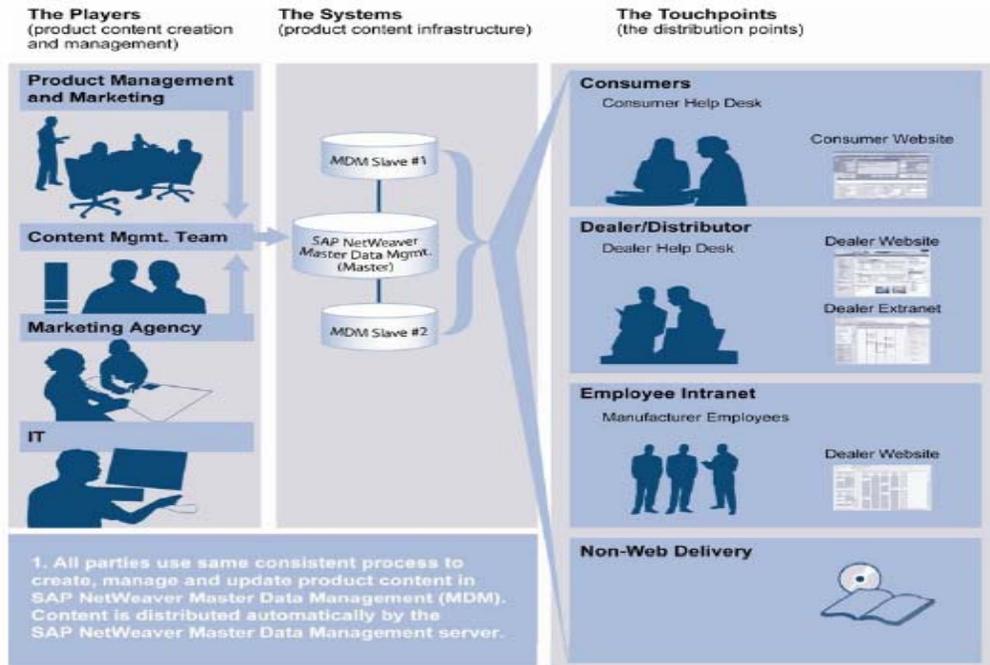


Figure 2: SAP NetWeaver Enterprise SOA streamlines the management, organization, and distribution of product information [12]

In this example [12], the use of a single-source approach to supporting the various selling and support channels has allowed the division to eliminate duplicative processes and achieve substantial savings. Content can also be more easily syndicated to distributors and exchanges. With the previous process, the content had to be manually converted to various XML formats before distribution. With the implementation of an SOA system the company can immediately see an increase in productivity, an increase in system efficiency and less downtime or maintenance efforts. In our case, additional benefits can be seen with Call Center efficiencies by reducing the manual activities for cataloguing information since the system is automated to do these activities. Changing the focus of IT to future activities rather than having to manage the operational activities in the current systems, can increase revenue and reduce maintenance costs. Moreover there may be an additional increase in opportunity cost for the time that was spent on maintenance of systems and analyzing information.

## 5. IT Governance and SOA

One can not discuss enterprise architectures like SOA without mentioning IT governance.

Weill and Ross define governance as “specifying the decision rights and accountability framework to encourage desirable behavior in the use of IT” [20]. According to Anil John, enterprise architect at Johns Hopkins University, “SOA Governance should be considered an extension of existing IT governance that deals with the decision rights, processes, and policies that are put into place to encourage the adoption and operation of a SOA that may cross ownership boundaries” [4].

Service Oriented Architecture is recognized as a way to improve business flexibility, adaptability and better align IT through the breakdown of technology-driven barriers among internal and external organizations. The promise is powerful but SOA raises unique challenges and can be derailed unless an effective governance framework is established to clearly identify roles and responsibilities. According to a Gartner report, “SOA governance is not an option, it is an imperative”. Gartner estimates that the failure to implement working SOA governance mechanisms will be the most common demise of SOA projects. Malinverno, Vice President of Research at Gartner further suggested that “Reuse is not a benefit of SOA but a hurdle that needs to be overcome in order

to improve business agility and lower software maintenance [the two key benefits of SOA] [16].”

Internal SOA promoters are critical in the top-down governance model needed when many software developers are unfamiliar with SOA. Policy-driven control over software development is a key aspect in the design of SOA governance [6]. Others suggest that regardless of the form of IT governance, policies should be reviewed and revised continually based on feedback from those who must abide by the policies. Done right, governance aligns the goals of SOA with the incentives in the organization [21].

Suggested best practices for good governance might include creating a board of review, developing an interoperability framework that details the protocols used by your organization, communicating early and often, and creating policies that are not too granular but still have some teeth [10].

## 6. Fundamentals of a successful SOA

SOA provides a mechanism for fixing systems that have been inoperable for years and with SOA in place, organizations can leverage existing systems in a dynamic environment. While it is widely understood that SOA involves tools, integration web services technologies and process modeling, it may not be as obvious as to the needs for a successful SOA implementation. Fortunately with so much SOA activity, lessons of experience are plentiful. Gartner, in the report *Applied SOA: Transforming Fundamental Principles Into Best Practices*, listed six keys to SOA success: (1) instill SOA discipline in your organization, (2) plan big but start small, (3) invest in integration infrastructure, (4) design services systematically, (5) invest in meta-data management, and (6) anticipate obstacles; don't give up [11].

## 7. Implications for IS Education

The impact of SOA on IS education will no doubt be profound. If the promises and challenges of SOA are met, the transformation facing Business curricula may be as pronounced as those brought about by the introduction of Enterprise Resource Planning (ERP) into IS curricula beginning in the mid-1990s and continuing to this day [14]. As with ERP, the

introduction of SOA into academia is likely to be motivated by a desire to provide students hands-on experience with cutting-edge technology and to reinforce textbook theory with real-world practice [17]. SOA promises to deliver the capability for new business processes to be designed as needed using visual modeling tools (BPM) by a new kind of system architect – any manager who is familiar with the day-to-day operation of her business unit [22]. Thus the technology of SOA may finally deliver the scenario described by Porter and Millar [13:149] in which “executives have a growing awareness that the technology can no longer be the exclusive territory of [the] IS department.” The executives of the future need to be trained to recognize the need and possess skills that allow direct involvement in the management of the technology [13].

One of the major academic challenges facing departments is to train existing faculty to teach the various technologies that support the SOA infrastructure. As with ERP, many universities will choose industry partners and standardize their curriculum on the SOA backbone and the tools provided by major vendors such as SAP or Oracle. For example, one university may choose to instruct Business Process Modeling using the ARIS Toolset<sup>tm</sup> while another may choose to illustrate the technology using the NetBeans IDE's Business Process Execution Language (BPEL) support. Regardless of the specific toolset chosen, however, XML web service standards need to be introduced and used to enable processes that are designed and orchestrate from a repository of either custom developed or purchased services. This is a fundamental change from designing systems from scratch, which is typical in many IT academic programs.

Another challenge facing IS faculty is to decide which of the current course offerings can be retired in favor of new SOA-oriented offerings. Although IS graduates are still being heavily recruited, enrollments in IS programs have dropped significantly in the past few years [9]. Anecdotal evidence suggests that a requirement to complete multiple courses in computer programming is at least one factor that discourages students from declaring and fulfilling an IS/MIS/CIS major. SOA promises to melt the boundaries between business units and IT as both need to learn to think in terms of

services. Does this mean that academic departments need to “melt their discipline boundaries” as well so that IT gets infused into each business discipline?

Within the IT/IS discipline itself, using SOA, business analysts design, configure and implement business processes using high level modeling tools backed by a repository of services. While specification and development of service components (i.e., programming) remain a valued skill, most of the technical development efforts are likely to be relegated to third parties. The major value added by IS personnel is derived through the design of business process to support an organization’s competitive strategy. Although IS professionals still need background knowledge in the theory of software objects, a requirement to complete multiple semesters of computer programming may be unnecessary.

When one or more classes in computer programming are removed from the curriculum, room is freed up for a specific course (or courses) in business process modeling (BPM). In effect, IS students and the IS faculty need to begin thinking at a much higher level of abstraction [23]. The ramifications of raising the abstraction level through SOA can also spill into the arenas of systems analysis and design where traditional topics such as software development life cycles and agile design methodologies are likely to become obsolete or replaced by Service-Oriented Analysis and Design (SOAD) [23].

SOA promises to radically reshape the landscape of corporate computing and induce ramifications for IS professionals and for management personnel at all levels of the organization. Business students in all disciplines need to be cognizant of the capabilities provided through SOA so that they are prepared to contribute to the process of identifying business opportunities, designing business process, and selecting and configuring the right SOA-based services to accomplish business objectives. The traditional survey course in IS needs to reflect these changes. In addition, enrollment in IS-related courses such as BPM should increase over time as SOA begins to deliver value for the enterprise.

## 8. Conclusion

There is no doubt that Service Oriented Architecture has gained acceptance as a way to exchange data previously trapped in legacy systems and isolated databases. According to a 2006 study by AMR Research, 35% of executives said their companies had implemented one or more projects using SOA [3]. A survey of 179 technology executives published by CIO Insight found that 79% expect their company’s technology architecture will be based on SOA, web services and related technologies in the next five years [18].

As with other technologies, business has learned that technology alone does not fix broken processes. SOA requires both business and IT leadership to establish ownership of the initiative and fund it. Businesses must embrace the technology and own the processes. Further, it is important for both IT and business leaders to understand functional and technical requirements and how they relate to their business. In addition, users and other stakeholders must be engaged at an early stage of SOA implementation.

Similarly, academics need to step up to the plate and decide how to incorporate SOA into their respective curricula. Is SOA something that can be used to infuse IT throughout the business curriculum or do the changes need to be made within the IS/IT discipline only? In either case, there are some indications that replacing traditional programming with BPM/SOA tools and implementation projects may benefit graduates more than the current programs. At the very least, systems analysis and design courses need to incorporate SOAD and IT students need at least one course focused on BPM in order to be ready for the workplace of the future.

## 9. References

- [1] Brooks, Frederick P. Jr., “No Silver Bullet: Essence and Accidents of Software Engineering”, *Computer*, (20:4), April 1987, pp. 10-19.
- [2] Carter, Sandy, The Role of Business Process Management in SOA, *DM Review*, May 2007, pp. 30-32, <http://www.dmreview.com>

- [3] Gaughan, Dennis and Ian Finley, "SOA Pace Accelerating Into 2007," AMR Research, November 30, 2006, <http://www.amrresearch.com/Content/View.asp?pmillid=20017>.
- [4] Hannon, Neal J., "Leverage Business Reporting: Use Service-Oriented Architecture", *Strategic Finance*, (87:5), November 2005, pp. 57-58.
- [5] Hashimi, Sayed, "Service-Oriented Architecture Explained", August 18, 2003, <http://www.ondotnet.com/lpt/a/4108>.
- [6] Katz, Jonathan, "SOA: The Next Disruptive Force", *Information Technology*, March 2007, p. 41, <http://www.industryweek.com>.
- [7] Kobielus, James, "Coders gone wild", *Network World*, October 16, 2006, <http://www.networkworld.com>
- [8] Kumar, K. & Van Hilleberg J (2000) ERP – Experiences and evolution. *Communications of the ACM*, 43 (4); 22-26.
- [9] Lomerson, William L., Lissa Pollacia, "CIS Enrollment Decline: Examining Pre-College Factors," Proceedings of the 2006 Southern Association for Information Systems Conference, pp. 93-103.
- [10] Margulius, David, SOA Planning: Sizing Up Your Business Processes, *InfoWorld*, March, 2006, pp. 18 – 24, <http://www.infoworld.com>
- [11] McCormick, John, "6 Keys to SOA Success", *Baseline*, May 14, 2007, <http://www.baselinemag.com/article2/0.1540.2139359.00.asp>.
- [12] Perry, Randy and Morris Edwards, "GE Appliances Division Increase Productivity and Enhances Revenue and Customer Satisfaction with SAP NetWeaver MDM Solution" SAP sponsored project
- [13] Porter, Michael E. and Victor E. Millar, "How information gives you competitive advantage". *Harvard Business Review*, (64:4), pp. 149-160.
- [14] Sager, James, Gail Corbitt, Jim Connolly and Jim Menshing, "Instruction-Based Alliances between Technology Companies and Universities: Why is it so hard to document the industry benefits?" *Enterprise Resource Planning: Teaching and Research, Innovation Monograph II*, Kelley School of Business at Indiana University, November 2006, pp. 51-63.
- [15] Saunders, Shelly, Margaret Ross, Geoff Staples and Sean Wellington, "The software quality challenges of service oriented architectures in e-commerce", *Software Quality Journal*, (14), 2006, pp. 65-75.
- [16] Saran, Cliff, "SOA will fail without governance warns Gartner," <http://ComputerWeekly.com>, September 7, 2006.
- [17] Strong, Dianne, Jane Fedorowicz, James Sager, Glenn Stewart, and Ed Watson, "Teaching with Enterprise Systems." *Communications of the Association for Information Systems*, 2006, (17), Article 33, pp. 728-755.
- [18] Violino, Bob, "SOA's Next Phase," *Baseline*, March 8, 2007, [http://www.baselinemag.com/print\\_article2/0.1217.a=200394.00.asp](http://www.baselinemag.com/print_article2/0.1217.a=200394.00.asp).
- [19] Voelker, Michael, *Speed-Oriented Architecture*, Techdecisions, A National Underwriter Publication, March 2007, pp. 22-28.
- [20] Weill, Peter and Jeanne Ross, *IT Governance: How Top Performers Manage IT Decision Rights for Superior Results*, Harvard Business School Press, Boston, June 2004.
- [21] Windley, Philip, *Teaming up for SOA*, *Infoworld*, March 2007, pp 25-26, <http://infoworld.com>
- [22] Woods, Dan and Thomas Mattern, *Enterprise SOA: Designing IT for Business Innovation*, O'Reilly, Sebastopol, California, 2006.
- [23] Zimmerman, Olaf, Pal Krogdahl and Clive Gee, "Elements of Service-Oriented Analysis and Design," *IBM developerWorks*, June 2, 2004, <http://www.ibm.com/developerworks/library/ws-soad1/>.