

**ENABLING “ON DEMAND BUSINESS” – ESSAYS ON SERVICE ORIENTATION PRINCIPLES, IT
ARCHITECTURE RECONFIGURABILITY AND ENTERPRISE PERFORMANCE**

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*This paper provides a brief overview of my dissertation work as well as a status update
as of May 2008.*

INTRODUCTION, PROBLEM STATEMENT AND RESEARCH OBJECTIVES

The IT capability of an enterprise has long been viewed as an enabler for analyzing market and enterprise data and supporting the decision process. Most IT systems were originally designed to perform standardized processes that were aligned with the static information inputs of orderly and predictable market environments. However, the proliferation of global communication architecture and the subsequent linkage of markets and enterprises have changed the nature of competition. Rather than competing in traditional markets based on assets or scale economies, enterprises find themselves in volatile markets where the market structure, market participants as well as offerings constantly change. In this information-driven economy, the volume of information grows exponentially, while at the same time veracity of information becomes harder to confirm. Decision makers are forced to make real-time decisions while often being overwhelmed with identifying the relevant information and deciding on the right course of action. Dealing with environmental complexity requires enterprises to build new organizational capabilities and to employ new strategic processes.

The increasing complexity of the turbulent environment demands agile enterprises that can create and exploit digital options. To achieve superior financial performance, an enterprise must create options and translate them into a complex action repertoire that can match or overmatch the environmental complexity. In that context, IT competence, composed of the underlying dimensions of IT capabilities and IT investment, is considered to be the main source for creating digital options (Sambamurthy et al. 2003). While the positive impact of IT investments on performance and productivity has been

demonstrated (i.e. Hitt and Brynjolfsson 1996, Bharadwaj et. al 2000), less attention has been paid to research on the actual IT artifact and its influence on IT capabilities and higher order constructs.

This dissertation research aims to answer the call of Benbasat and Zmud (2003) to refocus on the IT artifact and to develop unique Information Systems theory. The research is framed around Service Orientated Architecture (SOA) as a more recent instance of the IT artifact, which has gained considerable interest by the business community in the last five years. While many consider SOA a fad or marketing pitch to the industry, its underlying principles and practices warrant an empirical investigation on the impact of information system that are classified as service oriented. It also calls for a theory that identifies Service Orientation principles as applied to artifact design, creation of IT capabilities and subsequent IT competence, including how those service oriented artifacts, capabilities and competences shape digital options and the performance of the agile enterprise. In a sense, my dissertation is a bottom-up approach to explain enterprise performance in turbulent environments by viewing all layers of the enterprise as systems and the enterprise itself as a system of systems that can be examined through the singular lens of the proposed "Service Orientation theory."

The specific objectives of my dissertation are to:

1. Synthesize extant theory to propose Service Orientation theory, which explicates variables that explain and predict the performance of service-oriented systems.
2. Develop the propositions for Service Orientation theory
3. Operationalize the constructs proposed in the theory
4. Analyze IT artifacts in specific enterprises to gain insight in the Service Orientation impact on cross-sectional enterprise performance
5. Broaden the analysis to examine simulated longitudinal effects of Service Orientation on enterprise performance.

THE NOMOLOGICAL NET OF THE IT ARTIFACT

Service orientation is recognized as one of the premier means to achieve enterprise responsiveness. In a recent survey, 90% of Fortune 500 CEOs expect to transform their enterprises towards responsiveness (Forrester 2007). According to a Gartner (2007) study, Service Oriented Architectures are currently used in the development of more than 50% of new mission-critical operational and business processes.

Moreover, it is recognized that SOA will change both IT architectures and organizational designs, and the resulting “on demand business” will change the nature of competition (IBM 2007).

Despite all the high expectation in SOA, there is confusion of how to define and characterize Service Orientation. The term SOA originally stems from the Computer Science literature. Service Oriented Architecture refers to the platform architecture that underlies the service design and creation. Similar to the definition of IT infrastructure by Broadbent et al. (1999), SOA is typified by technologies that allow for the creation, execution and evolution of solutions built in compliance with Service Orientation design principles (Erl 2007).

Service orientation is a design paradigm comprised of a specific set of design principles which result in distinct component functionality, component modularity and interconnection attributes. In the context of Service Orientation, a service can be defined as a task that does not overlap with associated tasks. A service can provide a collection of capabilities, which are grouped together because they relate to the functional context established by the service. In summary, SOA and Service Orientation (SO) are the main factors for creating and executing services. SOA creates the platform or environment for the creation and execution of Services, while Service Orientation governs the design principles of both the environment (SOA) and the Services. Figure 1, adopted from Erl (2007) summarizes these relationships.

INSERT FIGURE 1 ABOUT HERE

Information Systems can be analyzed by examining its various components in terms of functionality, modularity and interconnection attributes, thus determining the degree of Service Orientation. Component functionality describes whether a component can process various inputs and transform them into desired outputs. The design principles of autonomy, statelessness and abstraction warrant that components are agnostic of the context and provide stable and reliable functionalities. Component Modularity is an equally important design principle. Modularity is different from functionality. Modularity is concerned with the standardization of the component interface design and a proper description of the components functionality. In the Service Orientation context, modularity is achieved through the design of the service contract. Interconnection attributes are the third measurable component characteristic. Interconnection is a direct consequence of coupling. In the context of Service Orientation, loose coupling is desired, since components need to be connected and disconnected based on the changing functional context.

The extent of the components' characteristics directly impacts intra-component relationships and the overall system characteristics. High degrees of modularity, interoperability and flexibility are the main outcomes of Service Orientation. System interoperability is created by adherence to Service Orientation and by the standardization of the component characteristics. Modularity of a system is defined as the degree to which systems components can be separated and recombined (Schilling 2000b). Service Orientation warrants that the solution logic is already distributed in the smallest possible unit. Contrary to objects of past programming paradigms, Service Orientation allows for the services to be orchestrated in a dynamic fashion. Flexibility of the IT architecture has gained importance in IT systems planning as a driver of business value (Byrd 2000). Flexibility is defined as the degree to which a system can incorporate change. Allen et al. (1991) noted that flexibility and efficiency are the most important criteria in selecting any IT system or application. The service-oriented design meets that need because it creates systems that are flexible. The component integrity, modularity and upgradeability create system flexibility as defined by Garud et al. (1995). Scalability, integrity, reliability and availability are system characteristics linked to the quality of an IT architecture (Castro et al. 2002). However, the investigation of IT architecture quality is outside of the scope of this research. A summary of the described relationships is depicted in Figure 2.

INSERT FIGURE 2 ABOUT HERE

The influence of Service Orientation on system characteristics sets the stage for the first theoretical model. As mentioned before, Information System characteristics influence the IT capabilities that enable the enterprise to create digital options. Moreover, IT plays an integral role in the modularization and integration of business processes, which enables operational agility (Sambamurthy et al. 2003). Creation of both digital options and operational agility requires the capability to reconfigure resources – or reconfigurability.

SIGNIFICANCE AND THEORETICAL MODEL

One of the most dominating topics in the recent IS research is whether investment and use of information technology (IT) is resulting in higher productivity. This so-called productivity paradox stimulated more rigorous scientific analyses of the relationship between IT and productivity (Brynjolfsson 1993; Brynjolfsson et al. 1996). These studies revealed positive and significant impacts from IT investments at the firm and country level. Moreover, researchers soon realized that investment in IT is only a necessary condition for improved business performance. Organizational factors such IT

management skills and the quality of IT labor, which were later summarized as the IT capability of a firm, were recognized as potential mediating factors in the IT investment – business value relationship (Brynjolfsson 1993). The role of the IT capability as a complementary resource has been brought forward to explain why IT can create a competitive advantage (Brynjolfsson et al. 1996)

The complementary view of IT was further refined by the resource-based view (RBV) of the firm (Bharadwaj 2000). The RBV states that competitive advantage is rooted in the deployment and use of idiosyncratic, valuable and inimitable resources and capabilities. The ability to reconfigure internal and external resources is the core concept of the dynamic capabilities research (Teece et al. 1997). The context of dynamic capacities is a surprisingly changing or turbulent environment, which enterprises need to sense and respond to with competitive maneuvers. The IT competence is considered a driver of creating digital options that influence the enterprise's agility, which is considered a dynamic capability (Sambamurthy et al. 2003).

Dynamic capabilities are concerned with the organizational capabilities of a firm that are leveraged to adapt to a changing environment. As such, IT is not considered a dynamic capability. However, IT plays an important role in enabling sensing and response capabilities of the firm (Sambamurthy et al. 2003). Recent literature on enterprise agility has stressed that IT competence can drive the development of digital options that can enhance the number of actions and the complexity of actions available to an enterprise for responding to turbulent changes in the environment (Overby et al. 2006).

The IS literature suggests that enterprises need to be able to sense changes in the turbulent business environment and then respond to those changes accordingly to achieve competitive innovation and competitive performance. IT competence is a crucial driver to achieve this kind of enterprise agility in turbulent business environments (Sambamurthy et al. 2003). While it is proposed that a truly agile enterprise will gain competitive advantage if it possesses both superior sensing and response capabilities (Overby et al. 2006), little research has both theoretically and empirically investigated the IT and organizational architecture principles that underlie this process.

Executing competitive maneuvers requires more than sensing and responding capabilities. An intermediate step where resources are redesigned and/or reconfigured is also needed to create a response. The reconfiguration of internal resources is a key aspect of the dynamic capability theory, in which the agility construct is rooted (Overby et al. 2006; Teece et al. 1997). The IS literature has

approached reconfiguration and the refigurability of processes from several different angles. Pavlou et al. (2006) proposed a distinction between reconfiguration as the deployment or goal process by which new configurations are achieved, versus the enabling processes that facilitate reconfiguration. He proposed internal enablers that facilitate reconfiguration such as market orientation, absorptive capacity, collective mind and coordination capability. Yet, both the organizational design and the design of the supporting IT architecture were not included in his discussion of reconfiguration enablers.

Following the strategy literature on dynamic capabilities, this research seeks to reemphasize the importance of reconfigurability of resources and the enabling function of organizational design and IT architecture design.

H1: Reconfigurability of resources positively influences the ability to respond to and align with turbulent environments.

While the agility literature has discussed the importance of sensing and responding, little emphasis has been placed on the intermediate step of reconfiguring the IT resource to create the response capability. IT competence has been defined as the organizational base of IT resources and capabilities, which describes the ability to convert IT assets and services into strategic applications. Most of the IT competence relates to the organizational capabilities, such as IT human capital, quality of IT capabilities and nature of the IS/partnerships.

Broadbent et al. (1999) were among the first to investigate the impact of IT infrastructure capabilities on the reconfiguration capability of the firm. In the context of Business Process Redesign, they investigated the impact of firm-wide infrastructure service on the success of organization reconfiguration. They defined the infrastructure capability as a degree of range (process complexity) and reach (communication span) of the infrastructure service. They concluded that more complex redesigning efforts need to be matched with high infrastructure capability in order to be successful. The attributes of global connectivity and reliability (subsumed as quality of IT) of the IT infrastructure are part of the firms' IT competence (Henderson 1990). In both studies, IT is seen as a complementary resource that aids the change process as a one-dimensional causation between organizational structure and IS structure is assumed. Ross et al. (1995) summarize the role of IT as to having no value apart from the processes it supports.

Malone et al. (1999) approached the influence of IT infrastructure from a different point of view. They argued that IT is driving the modularization of business processes and thus hinted at a more active

role of IT in the process of recombination of systems (Malone et al. 1999). Recent IS alignment literature has also proposed that IS structure not just complements, but also influences, the operational structure or design (Henderson et al. 1993).

Service Oriented Computing increases the active impact of IT architecture on reconfiguring business processes. Rather than complementing ongoing business practices, it will actively change the way that business is being done. The impact will be twofold. Implemented as a technological capability, SOC will support the rapid, low-cost development and easy composition of distributed applications. SOC is *designed* to continuously and dynamically adapt to changing demands of an enterprise. Second, Service Orientation will also spur the redesign of business processes into services that fulfill specific needs. Problem-solving oriented designs such as cross-functional teams are just one precursor of changes to come. While the principles of SOC are not the only organizing mechanisms in place, they promise to fit the demands of changing environments.

H2: IT architecture reconfigurability positively influences the agility of a contemporary firm.

INFLUENCE OF SERVICE ORIENTED SYSTEMS ON ARCHITECTURE RECONFIGURABILITY

The strategy literature proposes a theory of substitution to explain the impact of modular technological and organizational designs. Garaud et al. (1995) proposed that technological systems that are based on architecture of compatible components, led to system characteristics that possess integrity, modularity and upgradeability. They propose that such systems derive economies of substitution from reduced performance slippage, a quick amortization of design cost through the increasing benefit of system reuse and reduced incorporation and search cost.

Economies of substitution explain the direct benefits associated with the implementation and use of modular systems. As such, the framework provides an explanation why component-based technological systems such as SOC provide cost efficiencies. While not the main focus of this research, the direct benefits of service-oriented systems have to be tested.

H3: The implementation of Service Oriented Systems is positively related to business performance.

As proposed earlier, service oriented systems indirectly affect business performance by serving as enablers of reconfigurability. In particular, the influence of the system characteristics modularity, flexibility and interoperability on reconfigurability is examined.

The concept of modularity has gained increasing attention in the management and IS literature (Benbya et al. 2006; Schilling 2000a). Modularity has been identified as both a degree of system robustness to internal reconfigurations (Garud et al. 1995) and the degree to which the components of a system can be separated and recombined (Schilling 2000a). Schilling's definition of modularity as a continuum describes the degree to which a system's components can be separated and recombined, and it refers both to the tightness of coupling between components and the degree to which the "rules" of the system architecture enable (or prohibit) the mixing and matching of components" (Schilling 2000). Hence, modularity is a function of the degree of separability of components and the degree of recombination of the system.

Simon (1962) introduced the concept of modular design. He argued that systems consist of "nearly disposable subunits" that are mostly independent from top-down control and interdependencies from other subunits. In other words, components are autonomous and agnostic to their functional context, the system and the external environment in which they operate. Both the conditions of autonomy and agnosticity of the components serve as necessary conditions for the system to evolve faster and toward stable, self-generating configurations. Service oriented systems are designed for modularity. Thus, service oriented systems should provide the benefit of modularity to firms' IT architectures and overall reconfigurability.

H4: The modularity of Service Oriented Systems positively influences reconfigurability of the IT architecture.

Flexibility encompasses various meanings that include both temporal and intentional dimensions (Evans 1991). Service orientation encompasses several instances of flexibility. First, it creates versatile systems that ex-ante can create offensive capabilities. This capability is based on the ability to modify the systems by exchanging components. Resilience is the second meaning of flexibility that is relevant to service orientation. Because the components are designed to only minimally rely on other components, the system can operate despite the temporal loss of individual components. Thus, flexibility in the context of this research is defined as a multi-dimensional construct that encompasses both versatility and resilience.

Flexibility is a direct benefit of the design of the connections between components or organizational units. Weick (1976) formulated the subject of modular organizational design through the

concept of “loose coupling.” He observed that loosely coupled systems are characterized by situations where several means can produce the same result – a lack of coordination or absence of regulations.

The versatility attribute of flexibility enables a system to reconfigure its components based on changes in its environment. Flexibility allows an enterprise to build dynamic capabilities and enhance enterprise agility (Sherehiy et al. 2007). From a standpoint of reconfigurability, flexibility should enable systems to accommodate a variety of environmental disturbances and situational contexts. Thus, the versatility of service-oriented systems should increase the ability to reconfigure.

H5: The flexibility of Service Oriented Systems positively influences reconfigurability of the IT architecture.

Service oriented systems are designed to interoperate with external systems. The interoperability extends the set of available components to solutions outside of the realm of IT architecture. The integration of outside components increases the number and complexity of potential solutions to changes in the outside environment. Moreover, it enables the architecture to learn and source from external entities, while at the same time focusing on developing expertise in creating services related to an enterprise’s core focus (Garud et al. 1995; Sanchez 2000). The ability to draw from more and better- fitting components is the main impact of interoperability on the reconfigurability. By increasing the technological degrees of freedom, the complexity of the turbulent environment can be better matched.

H6: The interoperability of Service Oriented Systems positively influences reconfigurability of the IT architecture.

The research model and the research context are depicted in Figure 3.

INSERT FIGURE 3 ABOUT HERE

CONCLUSION AND LIMITATIONS

My dissertation research, of which a heavily summarized overview¹ was given in this proposal, contributes to IS research in several ways. First, it introduces Service Orientation as the antecedent for emerging information systems architecture and a subsequent “Service Orientation theory” is developed. Moreover, the distinct design principles, component and systems characteristics and the relationships

¹ Please refer to Appendix A, for an overview of the research methods proposed and the progress of the dissertation research.

between them are brought forward. This is a direct response to the Benbasat and Zmud's call to focus on the IT artifact and its immediate nomological and develop unique IS theory.

Second, the application characteristics of service oriented systems are theorized as enablers of the reconfigurability of resources in the context of dynamic capabilities. As proposed by Pavlou (2006), the research further enhances the understanding of the former "black box."

Third, this work provides initial empirical evidence for the positive influence of service oriented systems on reconfigurability and the succeeding business measures. Moreover, measurable operationalizations of component and systems characteristics are developed as the basis of further research.

Last, but not least, the research is an attempt to foreshadow the future impact of a computing paradigm that will have significant impact on both IS research and the business community. I look forward to continuing with my work and would sincerely appreciate the opportunity to discuss it with faculty and other doctoral students at the ICIS doctoral consortium.

FIGURES

Figure 1: Basic Relationship between Services, Service-Oriented Architecture, and Service Orientation

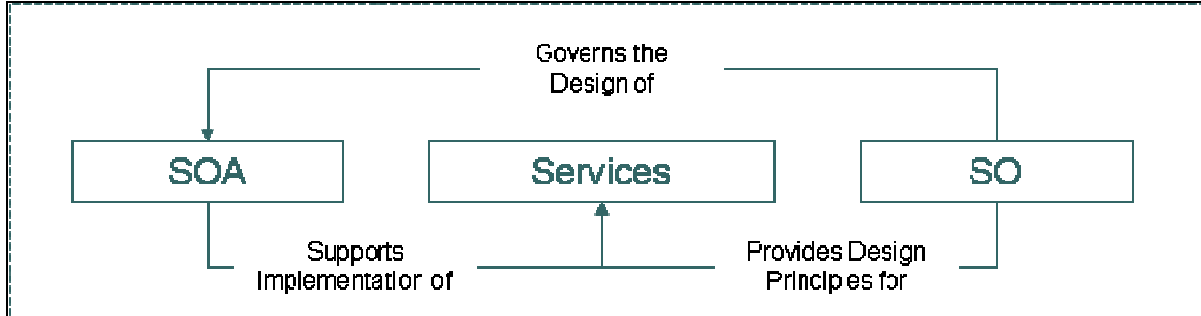


Figure 2: Influence of SOA Design Principles on System Characteristics

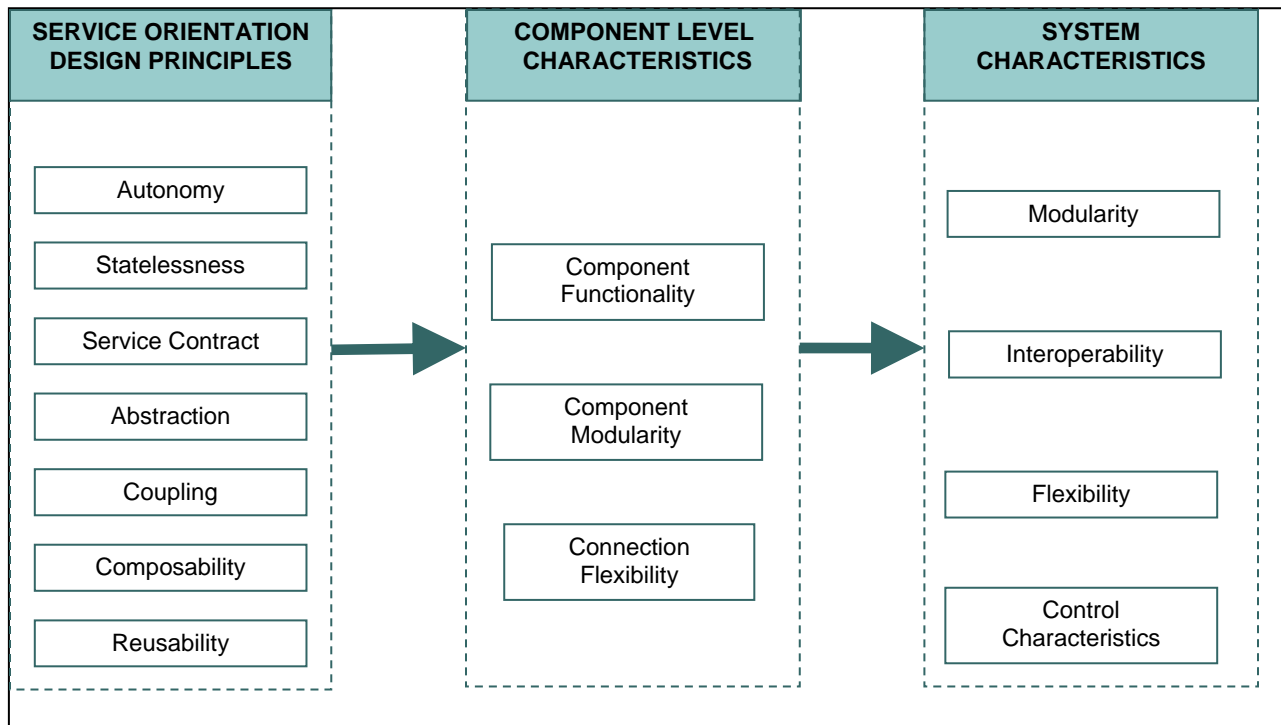
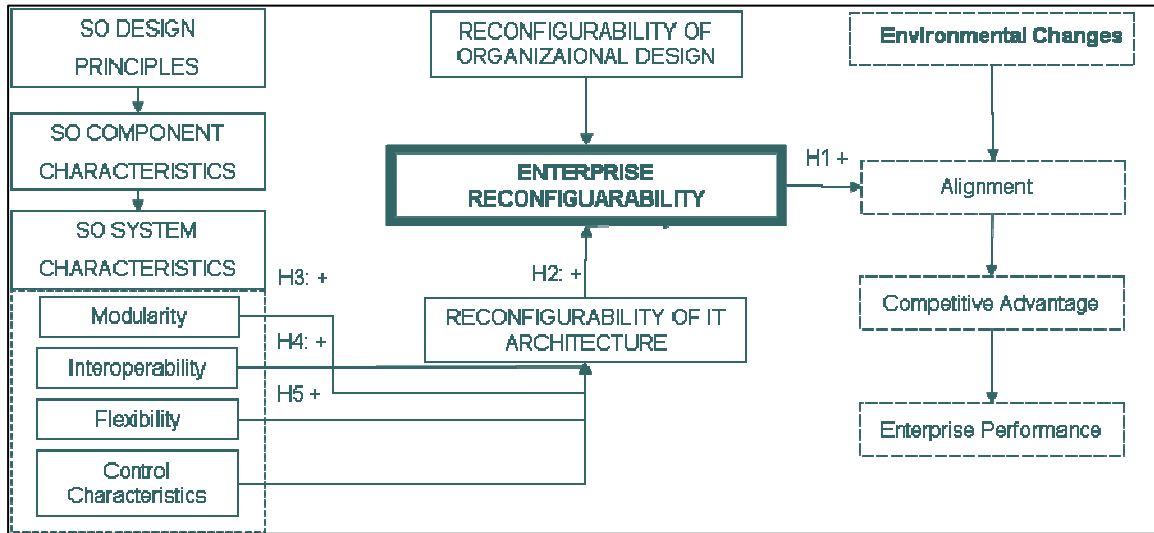


Figure 3: Research Model and Context



Appendix A: Work Still Remaining

At this point in time, (June 2008), two areas are on-going. First, after preliminary interviews with both CIOs and CEOs, I am currently refining the survey instrument. I identified a pilot group and created a mailing list. I have applied for funding to pay for the survey administration and currently await a response. The surveys should be mailed at the end of July. I hope that I can start analyzing the survey data in late November.

After the surveys are mailed, I will focus on programming a computational model that will simulate the long-term effect of Service Orientation on Enterprise performance. I have programmed a stable simulation for a previous agent-based model, including several programming changes to reflect the influence of a changing environment and the mechanisms by which performance is assessed. After the basic simulation is programmed and survey data is analyzed and integrated into a dissertation essay. I will use some of the survey data as seeds for the computational modeling activities. Assuming the need for some programming adjustments, I expect to have the results analyzed and integrated by the end of January.

Then I have about a month until mid-march for editing and proofing before I will defend my proposal, which will allow me to graduate in May of 2009.

My involvement in the ICIS doctoral consortium will help me with each of these items, and I would greatly appreciate the opportunity to participate.

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