Article

Tripartite Approach to Enterprise Architecture

By Janne J. Korhonen and Jouko Poutanen

Abstract

The discipline of Enterprise Architecture (EA) is still relatively immature and incoherent. The discourse is rather fragmented and lacking a shared vocabulary. To shed some light on the situation, some schools of thought on EA have been suggested, each with its distinct concerns and set of assumptions. In this article, we aim to bring more structure and clarity to EA discourse. Not only do we review the identified types and schools of EA, but we also attempt to make sense of the underlying structural and metaphysical underpinnings of the field and to ground EA in theory. As per our analysis, requisite architecture methods and tools are contingent on the level of complexity. In particular, while best practices and linear techniques are applicable in a contained operational scope, they fall severely short in addressing complex problems pertaining to non-linear discontinuities inherent in the increasingly interconnected and global business environment. On the other hand, we view that an ideal scope of an architecture "work system" is bounded by a maximum number of people able to create a shared meaning. Accordingly, we propose that architectural work in an enterprise be divided into three distinct yet interlinked architectures: Technical, Socio-Technical, and Ecosystemic. Each of these architectures is self-regulated, based on different ontological and epistemological assumptions, has its own vertical scope, and requires its own distinct methods and tools.

Keywords

Enterprise Architecture, Schools of Thought, Requisite Organization, Work System, Ontology, Epistemology

INTRODUCTION

The business environment of the 21st century is increasingly complex and characterized by continual change that is unprecedented both in pace and magnitude. Global competition and cooperation call for networked business ecosystems that pull together specialized capabilities in a non-linear fashion, eliminating time and distance barriers. The constituent organizations are increasingly complex and co-evolving socio-technical systems consist of multiple levels of interacting entities that in turn can be regarded as systems themselves. On the other hand, information technology has had fundamental consequences in organizations and the society at large: unprecedented computing power, infinity of virtual space, and ubiquitous connectivity have presented enormous potential to create enterprise effectiveness, increase flexibility, and enable entirely new business models. As the vast complexity of the entire business-IT amalgam far exceeds the comprehension of any single individual, it is increasingly important to mediate knowledge and understanding of the underlying organizational system.

Since the early 1990s, increasing interest has arisen in Enterprise Architecture (EA) as the means to manage this complexity. EA is a discipline that addresses how the elements of an organization fit together, today and in the future, and how these elements transition to support the organization's strategic plans (Hagan 2004). Traditionally, the focus of EA has been on technology and information systems architectures, but recently a greater emphasis has been put on information and business architectures. EA, as per this more encompassing view, is "a holistic, high-level approach to organizational design description and prescription" (Korhonen et al. 2009).

Not only is such EA a useful tool for technical developers, who can design more consistent and interoperable systems and solutions, but it also bears potential for supporting managerial decision-making and aligning strategy with the structure. While the representation alone helps the business decision-makers cope with the complexity, an advanced EA also comes with analytical methods that enable various kinds of impact analyses on hypothetical change scenarios, facilitate capital planning, and help sequence IT development.

The discipline of EA is still relatively immature. As Sally Bean (2010) aptly puts it, although EA aspires to improve enterprise coherence, the discipline itself seems rather incoherent. The EA literature and community discussions are fragmented and lacking a shared vocabulary (Lapalme 2011).

In this article, we aim to bring more structure and clarity to EA discourse. Not only do we review the identified three schools of EA (Lapalme 2011), but we also attempt to make sense of the underlying structural and metaphysical underpinnings of the field and to ground EA in theory.

An explanatory lens is a rigorous conceptual system that is used to create a theoretical framework (Edwards 2007). It not only helps to interpret and analyze social reality, but it also shapes new realities and behaviors. A lens is focusing attention on some things while ignoring others. In building our conceptual framework, we employed a metatheoretical approach, using other theories as the data source. We looked specifically into theories and models in organizational theory that could potentially elucidate and underpin the identified schools of thought in EA. From these theories, we identified two relevant explanatory lenses: the structural lens that addresses vertical stratification of organizations to discrete levels; and the metaphysical lens that focuses on the ontological-epistemological underpinnings of social order. We observed a relationship between these lenses – a trichotomic pattern of social organizing that is manifested both structurally and metaphysically.

Due to the discontinuous nature of social organizing, we ask if EA, too, could and should be divided into vertically distinct self-contained and self-regulated domains, each with its paradigmatic function, methods, and tools. We propose that architectural work in an enterprise be divided into three distinct yet interlinked architectures. As per this view, Technical Architecture is reductionist in nature and aimed at efficiency: traditional cataloging of IT assets paradigmatically exemplifies such a reliability-driven approach. Socio-Technical Architecture is about creating enterprise flexibility and capability to change: the focus on reliability is balanced with focus on validity in anticipation of changes, whose exact nature cannot be accurately predicted. Human judgment and analytical support for decision-making grow in importance. Finally, Ecosystemic Architecture is an embedded adaptive capability that not only addresses the initial design and building of a robust system, but also the successive designs and continual renewal of a resilient system.

We do not propose yet another EA framework with hierarchical views, but rather some meta-level guidance, informed by organizational theory, to creating new EA frameworks and aligning existing ones to the underlying organizational structure. To our knowledge, no previous work explores this area.

EA TYPOLOGIES

As a relatively young discipline, EA is lacking a shared vocabulary and a consensus definition. The discourse is still rather incoherent and fragmented, and definitions of EA range from IT-based configuration management to big picture enterprise design and management. Recently, some schools of thought on EA have been identified and some tentative typologies suggested. In the following, we discuss two such conceptualizations: the three schools of EA as identified by Lapalme (2011) and Coherency Management by Doucet and his colleagues (2008, 2009).

Three Schools of EA

Lapalme (2011) identifies three schools of thought on EA, each with its distinct belief system, scope, and set of assumptions. These schools in the order of increasing embrace and sophistication are: Enterprise IT Architecting, Enterprise Integrating, and Enterprise Ecological Adaptation.

As per the Enterprise IT Architecting view, EA is seen as "the glue between business and IT". Focusing on enterprise IT assets, it aims at business-IT alignment, operational efficiency, and IT cost reduction. It is based on the tenet that IT planning is a rational, deterministic, and economic process. The role of the Enterprise Architect is seen as the master planner/designer of the architecture.

Enterprise Integrating school (Lapalme 2011) views EA as the link between strategy and execution. EA addresses all facets of the enterprise in order to coherently execute the strategy. The environment is seen both as a generator of forces that the enterprise is subject to and as something that can be managed. The Enterprise Architect is a facilitator, whose challenge is to enhance understanding and collaboration throughout the business.

In the Enterprise Ecological Adaptation school (Lapalme 2011), EA is seen as the means for organizational innovation and sustainability. The enterprise and its environment are seen as co-evolving: the enterprise and its relationship to the environment can be systemically designed so that the organization is "conducive to ecological learning, environmental influencing, and coherent strategy execution". The Enterprise Architect faces the challenge of fostering sense-making in the organization and facilitating transformation as needed.

Coherency Management

Coherency Management (Doucet et al. 2008, 2009) is about using EA "to advance alignment, agility, and assurance in large, complex organizations". The basic tenet of the concept is that a formalized EA promotes coherency, allowing enterprises to govern in an orchestrated manner. Doucet et al. (2008, 2009) identify three modes of EA that represent progression in thought and practice: Foundation Architecture, Extended Architecture, and Embedded Architecture.

Foundation Architecture refers to the classical form of EA (Doucet et al. 2008, 2009). At its first level of maturity, the current and future states of enterprise-wide IT architecture (data and technology) are documented. The second level of maturity also addresses business descriptions that provide the input and the context for IT. Foundation Architecture is driven by technology and business standardization, systems engineering, and IT asset utilization. It focuses on cost efficiency, IT risk management, and business-IT alignment. As such, Foundation Architecture appears to be in perfect line with the assumptions of the Enterprise IT Architecting school (Lapalme 2011).

Commensurate with the Enterprise Integrating school (Lapalme 2011), Extended Architecture (Doucet et al. 2008, 2009) describes the enterprise in all dimensions, not just from the IT perspective. Architecture methods and tools are used to capture strategic goals and related business requirements to design the enterprise. Strategic drivers include business transformation, product/service leadership, business agility, and enterprise engineering. EA is measured by time to market, business responsiveness, and coherency in both IT and non-IT space.

The third form of EA that Doucet et al. (2008, 2009) identify is Embedded Architecture, in which the architecture tools, methods, and models become ubiquitously embedded in day-to-day processes. Although the authors do not particularly mention the afore-mentioned assumptions of the Enterprise Ecological Adaptation school, this mode of EA appears to have a commensurate belief system. It emphasizes full-system coherence, alignment, and design; the integrated nature of EA; and diffused governance – all of which are of essence in enterprise-in-environment co-evolution.

Structural Lens

In constructing a pertinent structural framework with which we can contextualize and position different types and schools of EA, we first turn to Talcott Parsons (1960), who identifies three general levels that are common to most social organizations: technical, managerial, and institutional. To provide further justification and corroboration of his trichotomy, we review Hoebeke's (1994) adjustment of Requisite Organization (Jaques 1989): a grounded metatheoretical construct that prescribes the "requisite" vertical stratification of organization to normative work levels, reflecting the discontinuous steps in the nature of human capability.

Parson's Model

Parsons (1960) identifies three general levels of social organizing. The first level is the *technical level*, at which the actual "product" of an organization is processed (Bernard 2005). This constitutes the protected core, which is sealed off from external uncertainties as much as possible (Thompson 1967).

The *managerial level* is where mediation between the organization and the immediate task environment occurs, where the organization's internal affairs are administered, and where the organization's products are consumed and resources supplied (Bernard 2005). Activities at this level are less formalized and more political (Thompson 1967).

The *institutional level* is about strategy and values internally and about legitimacy and resources externally (Bernard 2005); the organization derives its legitimization, meaning, and higher-level support from the larger society, which makes the implementation of organizational goals possible. At this level, the organization is very open to the environment (Thompson 1967).

Requisite Organization

In his rigorous empirical research, spanning several decades, Elliott Jaques (1989) recognized that organizations exhibit a hierarchical ordering of work complexity that reflects the discontinuous steps in the nature of human capability. In a requisitely aligned organization, or "Requisite Organization" (*ibid*.), the role complexity increases discontinuously in specific steps, stratifying varying kinds of work into natural layers, or "strata". In human organizations, Jaques distinguishes two orders of complexity:

- Symbolic-verbal order of complexity that covers Strata I through IV pertaining to activities from day-to-day first-line work to middle management levels
- Conceptual-abstract order of complexity that covers Strata V and beyond, pertaining to the higher management levels, typically in the corporate realm

Whereas the Jaquesian conceptualization of Requisite Organization regards organizations as monolithic hierarchies, Luc Hoebeke (1994) develops an alternative work systems framework based on the notion of requisite strata. According to Hoebeke, performance is better understood when work systems are seen as "the combination of a system of activities and a system of relations" and considered as "more or less loosely coupled self-regulated semi-autonomous networks". This coupling is made visible through people who are adopting various roles in work systems. The creation, maintenance, and development of shared meaning are based on the informational transactions between real people who know each other personally. As per this logic, there is a "maximum number of people able to attribute a shared meaning to the system of relations they develop through the system of activities in which they are involved".

Hoebeke argues that this "span of relations" – a maximum number of people that can be included in what he calls the adaptive group – is about 700 people. He acknowledges, however, that the maximum number of 700 is exceptionally high and that 200 is more a median. The latter number is also in better line with the notion of the Mutual Recognition Unit (MRU) by Elliott Jaques. The MRU of about 200 to 250 people is "the highest level of direct managerial leadership, of leadership by a manager who can know what is going on by personal scanning of his/her total function" (Jaques 1989). The unit members should be able to recognize the unit manager and each other.

Once an organization passes the size of the adaptive group, there is a felt need for formalization, specialization, and differentiation. The organization becomes a network of work systems that have to formalize their inter-dependencies through explicit contracts. Any larger entities than natural work systems can only be defined as "aggregates, anonymous classifications, which are social contracts, but not relevant in terms of interventions and improvements" (Hoebeke 1994).

Arguing that the "span of relations" constrains the size of natural work systems to three process levels, Hoebeke (1994) identifies recursively-linked domains, each with its own language, interests, and other emergent characteristics. The higher domain is not managing or controlling the lower one, but rather creating conditions for its viability. Hoebeke's first three domains span the symbolic-verbal and the conceptual-abstract orders of complexity, relevant to human organizations, as depicted in Figure 1.

Hoebeke (1994) refers to the lowest three Strata (I–III) as the *added-value domain*. The focus at these strata is on efficiency of operations, not on the conception of new products and services. This domain can be likened to Parson's (1960) technical organizational level, at which the organization carries out its production or service delivery function. The output of work at Stratum I is *prescribed* (Rowbottom and Billis 1987) by specifications, requirements, quality standards, and acceptance criteria. At Stratum II, the response to each case of work is *situational* (*ibid*.) and depends on judgment and interpretation. The output of Stratum III work is *systematic provision* (*ibid*.) that accommodates the varying needs of today as well as those of tomorrow.

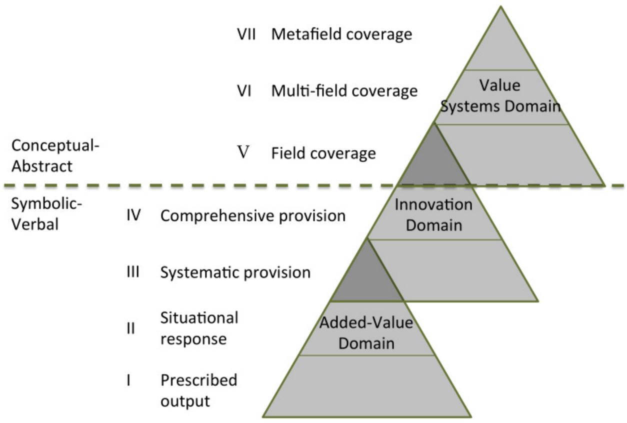

Figure 1: Orders of Complexity (Jaques 1989), Levels of Work (Jaques 1989; Rowbottom and Billis 1987), and Work System Domains (Hoebeke 1994)

Strata III–V comprise the *innovation domain* (Hoebeke 1994). Stratum III forms a "hinge" between the added-value domain and the innovation domain, as the relations between two domains need an overlapping set of common activities. Commensurate with resource facilitation and mediation at the managerial level (Parsons 1960), this domain shifts away from operational business-as-usual and is concerned with added value for the future: managing continuity and change, devising new means to achieve new ends, and letting go of obsolete means and ends (McMorland 2005). Work at Stratum IV entails *comprehensive provision* (Rowbottom and Billis 1987), where the means and ends of underlying work systems are adjusted to reshape profitability within the overall business purpose. At Stratum V, the scope extends to a framework that specifies a general field of need (*ibid*.). This level pertains to entire ranges of products and services, involves long-term strategies, and entails social, political, and financial considerations.

Strata V–VII comprise the *value systems domain* (Hoebeke 1994). Again, Stratum V forms a hinge between the innovation domain and the value systems domain. Just as at the institutional level (Parsons 1960), this domain is about establishing rules and relating to the larger society. Stratum VI represents *multi-field coverage* (Rowbottom and Billis 1987), where the task is to ensure that the output covers the whole complex of fields of need in a coordinated way. Complexity is not so readily contained, but the "great organizational divide" is crossed and the perspective is widened from an individual system such as an organization to a "whole world" view (Jaques 1989). *Meta-field coverage* (Rowbottom and Billis 1987) at Stratum VII is concerned with managing the development, formation, and construction of various complexes or conglomerates of Stratum V organizations in order to produce an output that covers the whole meta-field. Rather than responding to the needs of specific markets or sections of the population, Stratum VII work is concerned with judging the needs of society, nationally and internationally, and deciding what types of business units to provide to satisfy them.

Metaphysical Lens

Ontology is a metaphysical study of the fundamental categories of existence and elementary entities of the world. It pertains to the theory of high-level concepts and distinctions such as cause and effect, time and space, or system, underlying more specific descriptions of phenomena. The basic ontological question is whether the "reality" is external to the individual (i.e., "objective" in nature), or the product of individual consciousness (i.e., "subjective"). Epistemology studies knowledge: its nature, premises, reliability, and justification. Epistemological assumptions come down to whether the nature of knowledge is seen as "hard" and transmittable in tangible form (i.e., explicit knowledge) or as being of a softer and more subjective kind (i.e., tacit knowledge). In the following, we explore and collate the ontological Cynefin framework (Kurtz and Snowden 2003) and the epistemological scheme of inquiring systems (Churchman 1971).

The Cynefin framework (Kurtz and Snowden 2003) is a framework of sense-making, addressing how people perceive and make sense of situations in order to make decisions. It distinguishes five domains, of which four are discussed below: the ordered domains of "Known" (or "Simple") and "Knowable" (or "Complicated"), and the un-ordered domains "Complex" and "Chaos". The fifth domain of disorder has a distinct role as helping understand the conflict among different points of view. As such, it is not considered herein.

In the "Known" domain (Kurtz and Snowden 2003), cause and effect relationships are generally linear, empirical in nature, and not open to dispute. Structured techniques and processes such as single-point forecasting, field manuals, and operational procedures ensure repeatability and predictability. The decision model is to sense incoming data, categorize the data, and then respond in accordance with predetermined practice. The focus is on reliability and efficiency.

From the epistemological point of view, the "Known" domain seems to be commensurable with what Churchman (1971) calls a Lockean inquiring system. A "Lockean community" inductively learns from external empirical observations and arrives at a consensus on the labels (i.e., categorizing names) that are assigned to the system inputs (Courtney et al. 1998).

In the "Knowable" domain (Kurtz and Snowden 2003), cause and effect relationships are separated over time and space in chains that may not be fully known or are understood only by a limited group of experts. This domain favors systems thinking and methods that seek to identify cause-effect relationships through the study of properties hypothetically associated with qualities; e.g., experiment, expert opinion, fact-finding, scenario planning. The decision model is to sense incoming data, analyze the data, and then respond in accordance with expert advice or interpretation of that analysis. The focus is on validity and effectiveness.

The respective Kantian inquiring system (Churchman 1971) is able to interpret inputs and generate hypotheses based on what the system already knows and to create and incorporate new knowledge. The guarantor of the system is the fit between data and model (Courtney et al. 1998). However, due to multiple alternative models, an input is subject to different interpretations and there is no guarantee that the model represents the best solution.

In the "Complex" domain (Kurtz and Snowden 2003), cause and effect relationships between interacting agents can be perceived as emergent patterns, but only in retrospect. Any attempts to categorize or analyze the retrospectively coherent patterns in a structured way are futile, as the underlying sources of the patterns cannot be readily inspected. The decision model is to create probes to elicit the patterns, then sense those patterns and respond by stabilizing the desirable patterns, while destabilizing the undesired ones. Creating a space that is conducive to desirable patterns requires multiple perspectives on the nature of the system. The methods, tools, and techniques of the known and knowable domains render inadequate here. Narrative techniques are powerful, as they convey a large amount of knowledge or information in a very succinct way.

In the respective Hegelian inquiring system (Churchman 1971), knowledge is created through a conflictual thesis–anti-thesis–synthesis pattern, which "is a soaring to greater heights, to self-awareness, more completeness, betterment, progress" (*ibid*.). The guarantor of the system is synthesis that opposes the conflict between the thesis and its anti-thesis (Courtney et al. 1998).

In the "Chaos" domain (Kurtz and Snowden 2003), there are no perceivable cause and effect relationships. As the system is turbulent, there is no response time to investigate change. The potential for order is there, but only few can see it and have the courage to act thereupon. The decision model in this space is to act, quickly and decisively, to reduce the turbulence, sense the reaction to the intervention, and respond accordingly.

In a similar vein, the Singerian inquiring system (Churchman 1971) has no controller but authority and control are pervasive throughout the system. It must encompass the whole breadth of inquiry in its attempt to authorize and control its procedures. As the inquiring system requires a cooperative environment, in which inquiry is needed to create cooperation and cooperation is needed to create inquiry, ultimately the design of a Singerian inquiring system becomes the design of the whole social system (*ibid.*).

THREE ARCHITECTURES FRAMEWORK

In the following sections, we propound three distinct yet interlinked architectures: Technical (A^T), Socio-Technical (A^S), and Ecosystemic (A^E). Based on the literature review above, we propose that each of these architectures is based on different ontological and epistemological assumptions, has its own vertical scope, and requires its own distinct methods and tools.

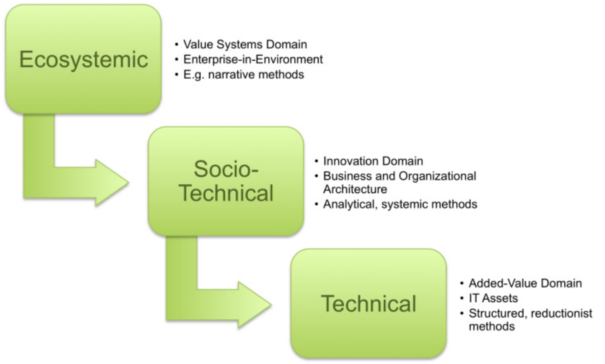

Figure 2: Overview of the Three Architectures

Technical Architecture

We propose that Technical Architecture (A^T) pertains to the added-value domain (Hoebeke 1994) at Strata I–III (Jaques 1989), or the technical level of organization (Parsons 1960), where the organization's products are produced or services are provided. This is traditionally the scope of enterprise-wide IT architecture, or foundational architecture (Doucet et al. 2008, 2009). As per the Enterprise IT Architecting view (Lapalme 2011), the architecture focuses on technical IT assets, such as applications, software components, data stores, hardware, system software, and network elements, that are aligned with business needs. This is the domain of information systems design and development, enterprise integration, and solution architecture work. A^T also addresses architectural work practices and quality standards; e.g., architectural support of implementation projects, development guidelines, and change management practices.

From the ontological point of view, Technical Architecture appears to fall in the "Known" domain (Kurtz and Snowden 2003), in which cause and effect relationships are largely visible. The key factor of this architecture is reliability. Structured formal methods are used to reduce variance in and increase predictability and consistency of information systems and solutions. Information systems and underlying technology infrastructure are viewed as separate entities that support business. Architectural design is reductionist: architectural elements are derived from business needs in a linear manner. As IT architecture design has a long history, methods are reasonably mature and results are somewhat predictable, when the organization is operating in a stable environment.

Epistemologically, knowledge is seen as uncertain and knowledge claims idiosyncratic to the individual.[1] Uncertainty and evidence are recognized as parts of the knowing process, and a "Lockean community" (Churchman 1971) is needed to arrive at a consensus on the labels that are assigned to architectural elements and their relationships. While the responsible roles are typically technical and often from the organization's IT function, representatives from business units are widely consulted and informed regarding architectural decisions. The role of an architect can be described as the master planner (Lapalme 2011).

A fundamental challenge in Technical Architecture is in eliciting and understanding business needs in order to create an efficient architecture that supports business. Another major challenge is to get executive support to EA plans and programs because technical EA's business value is difficult to prove (Lapalme 2011; Poutanen 2012; Kaisler et al. 2005).

Table 1 exhibits the paradigmatic scope of interest, exemplary EA roles and architectural elements, and essential governance vehicles of A^T at work levels, or Strata, I through III. Stratum I embraces the application and technology infrastructure: COTS applications, operating systems, infrastructure services, data stores, devices, etc. An IT systems engineer, working at this level, develops IT artifacts such as program code towards goals and criteria prescribed at higher levels. At this level, real governance does not exist, but idiosyncratic activities are guided by fixed target standards for performance.

EA work at Stratum II has emphasis on processes, work practices, and quality standards: architectural support of implementation projects, development guidelines, change management practices, etc. It supports reliable business-IT alignment and focuses on changes in the information systems landscape. Information systems are developed and integrated upon the technology and application infrastructure to support higher-level

[1] Reference epistemic position 4 in the Reflective Judgment Model (King and Kitchener 1994).

business solutions. The work of an IT system architect involves assessment of and adjustment to the varying requirements within specified limits. The architect must be able to construct a series of events; classify, group, and compare things; and comprehend cause and effect relationships (Korhonen, in press, referencing Fowler et al. 2004). Governance relies on vertical lines of command and standardization for coordination (Peterson 2004). It aims at optimizing work practices and quality standards and managing deviations from the acceptable limits of performance. Teams are endowed discretion to differentiate services to different customer groups.

A solution architect at Stratum III must be able to construct new, systemic resource assemblies that address not only the tried-and-true but also the conceivable future contingencies. This calls for the ability to construct hypothetical entities; thinking beyond the present moment and imagining possibilities; and making deductions from observable results (Korhonen, in press, referencing Fowler et al. 2004). Governance at this level is about connecting multiple teams across functions to rethink work systems and processes within an operational domain (De Visch 2010). Key mechanisms include structural means such as formal roles, committees, and councils (Peterson 2004). Whereas Stratum II specifies a framework for prescribed-output activity at Stratum I, Stratum III is about setting policies to govern open-ended, discretionary decision-making at Stratum II and to ensure systematic work.

Table 1: Levels of Technical Architecture

Stratum	Scope	Paradigmatic EA Role	Architectural Elements	Governance Vehicles
III	Domain	Solution Architect	Capabilities, solutions	Policies, structures
II	Team	IT System Architect	Information systems	Practices, standards
I	Individual	IT System Engineer	Infrastructure	Activities

Socio-Technical Architecture

We propose that Socio-Technical Architecture (A^S) spans Strata III–V (Jaques 1989) that constitute the innovation domain (Hoebeke 1994), or the managerial level of organization (Parsons 1960), where the business strategy is translated to the design of the organization. Some conceptualizations of Business Architecture (e.g., Versteeg and Bouwman 2006) come close to our notion of Socio-Technical Architecture. The purpose of A^S is to design the enterprise coherently so that enterprise strategy may be executed utilizing all its facets, including IT (Lapalme 2011). To maintain a holistic view of an organization, it takes a systemic approach to organizational and work design, wherein IT is seen as an aspect-system among other ones. Key artifacts include business domains and their assigned business activities; business functions, and business concepts that these business domains need to perform their assigned business activity; and high-level business processes that show how the business domains collaborate to achieve the organizational goals and strategies (Versteeg and Bouwman 2006). A^S is integrally linked with Technical Architecture and provides a starting point for capability architectures or solution designs within the A^T space.

Ontologically, Socio-Technical Architecture arguably bears many characteristics of the “Knowable” domain (Kurtz and Snowden 2003). To uncover the cause and effect relationships that are separated over time and space, expert know-how, systems thinking, and analytical methods are required. Architecture emphasizes validity over reliability: the future that comes in is not reliable, but assumptions about it may be proven valid, by hindsight (De Visch 2010). It also emphasizes effectiveness over efficiency: architecture is driven by agility and flexibility in the face of change rather than operational optimization and business-IT alignment.

The inquiry system of A^S is Kantian (Churchman 1971), which is best suited for moderate ill-structured problems (Malhotra 1997). This is the onset of dialectical inquiry, in which “knowledge and truth are constructed through critique of complexity-reducing formalisms, through critical inquiry using hypothesis testing; through considering the common ground of opposites and construction of holistic perspectives” (De Visch 2010). Cross-functional knowledge is essential, and more business-oriented architects are required. Knowledge involves personal insight and understanding and is filtered through a person’s perceptions and criteria for judgment. Beliefs are justified within a particular context by means of context-specific rules of inquiry and interpretations of evidence (King and Kitchener 1994). The role of an A^S architect is in essence that of an inquiring facilitator (Lapalme 2011).

We concur with the notion of the Enterprise Integration school (Lapalme 2011) that the key challenge of A^S is vulnerability to the syndrome of creating “perfect” designs for unsustainable strategies. Due to different subjective interpretations and multiple alternative models in the Kantian inquiry system (Churchman 1971), the plurality of complementary solutions may cause a “competency trap” (Malhotra 1997). Although the data fits the model, there is no guarantee that the model represents the best solution (Courtney et al. 1998).

Table 2 outlines the characteristics of different levels in Socio-Technical Architecture. Following Hoebeke’s (1994) reasoning, Stratum III forms a “hinge” between A^T

and A^S, wherein an overlapping set of common activities links the two architectures. This is commensurate with the notion of *boundary objects* (Star and Griesemer 1989) that help develop and maintain coherence across intersecting social worlds. These objects maintain a common identity across contexts and are weakly structured in common use, yet they are plastic enough to adapt to local needs and become strongly structured "in situ" (*ibid*.). The primary boundary objects at Stratum III appear to be the socio-technical work systems that use information, technology, and other resources of A^T to produce products and services in A^S.

At Stratum IV, a business architect must be able to detect gaps in the product/service portfolio and through pairwise comparisons of the as-is solution with related to-be alternatives specify requirements for solutions that address those gaps. The business architect must be able to construct systems, to analyze multi-dimensional problems, and to be aware of contradictions and inconsistencies, alternatives, and contingencies; the architect shall also appreciate inherent conceptual complexity; be capable of rigorous hypothesis testing, assessment, and re-orientation towards new goals; and logically justify world views (Korhonen, in press, referencing Fowler et al. 2004). Governance at this level is about coordinating functions and projects beyond operational domains to set goals and to devise new systems and structures. This is typically attained through organization-wide programs and strategic systems (e.g., balanced scorecard, critical success factor analysis, service-level agreements, performance management, profit sharing schemes, etc.) (Peterson 2004). Rules are established to govern policy-making.

Table 2: Levels of Socio-Technical Architecture

Stratum	Scope	Paradigmatic EA Role	Architectural Elements	Governance Vehicles
V	Organi-zational	Enterprise Architect	Business model	Relational capabilities
IV	Cross-domain	Business Architect	Product/ service portfolio	Rules, processes, strategic systems
III	Domain	Solution Architect	Capabilities, solutions	Policies, structures

An Enterprise Architect at Stratum V must be able to holistically understand the enterprise system in its entirety within the larger context. The Enterprise Architect has to understand phenomena in all their complexity, to coordinate several aspects of multiple abstractions simultaneously from different perspectives, and to recognize the relativity of all positions (Korhonen, in press, referencing Fowler et al. 2004). Governance at this level is collaborative in nature and integrates organizational functions to a coherent business entity to reshape the business model and establish respective norms. It requires relational capabilities: informal collaborative relationships, value-based practices, and normative controls (Peterson 2004).

Ecosystemic Architecture

We propose that Ecosystemic Architecture (A^E) pertains to the value systems domain (Hoebeke 1994) at Strata V-VII (Jaques 1989), or the institutional level of organization (Parsons 1960), where the organization relates to its business ecosystem, industry, markets, and the larger society. The essence of Ecosystemic Architecture is to design the enterprise systemically *vis-à-vis* its environment, to enable co-evolution with its business ecosystem and the society at large. As such, it subscribes to the Enterprise Ecological Adaptation school (Lapalme 2011).

From the ontological point of view, Ecosystemic Architecture is representative of the "Complex" domain (Kurtz and Snowden 2003). As the perspective shifts from the relatively stable, closed, and controllable system of a self-sufficient enterprise to the relatively fluid system-of-systems of networked, co-evolving entities, complex outcomes evolve from the inter-dependencies and non-linear interactions between the agents. The collective behavior of the ecosystem emerges through self-organization, but the patterns of behavior are discernible only in retrospect.

Epistemologically, A^E appears to be commensurate with the Hegelian inquiring system (Churchman 1971). The Hegelian process ensures that knowledge is subjected to continual re-examination and modification *vis-à-vis* the changing reality (Malhotra 1997). Knowledge is constructed into individual conclusions based on cross-domain information. Interpretations are based on evaluations of evidence across contexts and on the evaluated opinions of reputable others. Beliefs are justified by comparing evidence and opinion from different perspectives and contexts. Categories of comparison and evaluation are constructed. (King and Kitchener 1994).

A^E requires accepting multiple paradigm shifts of management and strategy creation. Due to the bi-directional relationship with its environment, the organization must be capable of influencing the environment, in order to make it more receptive to the organization's goals (Lapalme 2011). Ecosystemic Architecture is arguably the most challenging of the three architectures. Bringing about change in the external environment and fostering sense-making requires capacity to embrace paradox and contradiction and to tolerate ambiguity.

Table 3 outlines the characteristics of different levels in the Ecosystemic Architecture. Stratum V is the hinge level between A^S and A^E and belongs thus to both architectures. The primary boundary objects (Star and Griesemer 1989) at Stratum V appear to be business models that capture the strategic intent in A^E to be developed as products/services in A^S.

In the system-of-systems setting (Boardman and Sauser 2006) of the A^E, the independence of change in constituent systems adds significantly to the complexity of the interactions and calls for explicit recognition of evolution of systems, which in turn encourages more frequent changes (Fisher 2006). In the face of this growing complexity, an architect cannot provide complete designs for the future, but will increasingly create the conditions for self-organization and evolution of the enterprise (Lankhorst 2009). The role of the Enterprise Architect is one of nurturer or "sense-maker" (Lapalme 2011). As architectural decisions move beyond a single organization, the role of the Enterprise Architect is also increasingly that of a great negotiator (Lankhorst 2009).

At Stratum VI, a portfolio of strategic businesses is managed to determine which business models the enterprise (a business network or a corporation) pursues. At Stratum VII, the overarching mission and vision guide the construction and acquisition of these businesses (Korhonen et al. 2010). Commonly held values and purpose are used as governance vehicles at Stratum VI and VII, respectively.

Table 3: Levels of Ecosystemic Architecture

Stratum	Scope	Paradigmatic EA Role	Architectural Elements	Governance Vehicles
VII	Global	Enterprise Architect	Mission, vision	Purpose
VI	Inter-organi-zational		Business portfolio	Values
V	Organi-zational		Business model	Norms

DISCUSSION AND CONCLUSIONS

Many studies have reported that EA work's current key challenges have origins in ownership and political issues (Poutanen 2012; Hjort-Madsen 2007). Since EA has technical origins and its practitioners are mostly from the IT function, business management does not fully accept EA to deal with "higher"-level architectural concerns. The recent inclusion of higher-level business architecture elements and artifacts in EA transcends the traditional scope of Enterprise-Wide IT Architecture (EWITA), which has been discretely contained within the operational work system (i.e., the value-added domain). When IT makes inroads into the more strategic and less technical territory, it is generally seen as transgressing its jurisdiction.

Following the reasoning of Hoebeke (1994), an ideal vertical span of an architecture "work system" would be three requisite strata (Jaques 1989), denoting a maximum number of people able to create a shared meaning. It further appears that each vertical work system has its own "Weltanschauung" that sets the tone for work in each domain. As the artifacts, the methods and tools, and the very ontological and epistemological premises of each vertical domain are fundamentally different, we view that a uniform, monolithic approach to EA at all work levels is bound to fail. Specifically, the clear-cut IT architecture practice cannot be simply extended as such to the more interpretative realm of socio-technical considerations. A separate socio-technical architecture would create an explicit context for the technical architecture. This would benefit both business and IT (Versteeg and Bouwman 2006). More generally, we suggest that EA should be adapted to each work system domain separately, yet the different (sub-)architectures must relate to each other so that the artifacts are seamlessly integrated to collectively describe the entire enterprise.

In this conceptual article, we proposed that architectural work in an enterprise be divided into three distinct architectures: Technical, Socio-Technical, and Ecosystemic. Each architecture deals with different artifacts, IT assets, and business architecture and strategy elements. Each architecture has its own "way of working", requires characteristic skills and knowledge, benefits from a specific management approach, and comes with its paradigmatic tools and methods. The approaches range from engineering methods (AT) to systems thinking approaches (AS) and finally to narrative methods (AE). It is not realistic to expect that any one person or any dedicated single team would be able to manage the whole EA given this wide array of distinct views. By modularizing EA vertically, people working on each (sub-)architecture may focus on their particular skills and will be better able to create a shared meaning with each other.

Each domain can also be viewed as comprising its distinct subculture. Schein (1996) recognizes that organizational subcultures may reflect the common experiences at different levels in the organization. The vertical subcultures, based on different world views, call for specific capabilities to enable effective cross-boundary knowledge transfer. When crossing a cultural boundary, information has to be put into the appropriate language for the next level and has to reflect the values and assumptions of that level (Schein 1996). As knowledge is localized, embedded, and invested in practice, novelty generates different interests between actors that impede their ability to share and assess knowledge (Carlile 2004). To create organizational knowledge, the cultural communities must co-create common ground to provide a means of sharing and assessing knowledge at the boundary (*ibid*.) and to transform each other's contextual understanding of work in order to generate a richer and broader shared understanding of the whole (Bechky 2003). We view that boundary objects (Star and Griesemer 1989) are important to enable requisite knowledge transfer between distinct architectures. This represents an interesting area for future research.

EA frameworks typically recognize three or four architecture views that are used to structure architecture products. For instance, the Department of Defense Architecture Framework (DoDAF) specifies three views, which collectively describe the enterprise: operational view, systems view, and technical view. We are not suggesting that such architecture views be vested to different teams. What we do suggest, however, is that EA would be designed and built around organizational accountability levels (Jaques 1989) and that EA work would be divided into vertical work system domains (Hoebeke 1994). These levels and domains would then be crossed vertically by any pertinent architecture views. We view that this would promote the principle of "separation of concerns" and also help assigning the ownership and stewardship of different architectural artifacts to governance roles that are rooted in the respective decision-making levels in the organization.

This article does not put forth an EA framework or implementation guidelines, but it merely poses a question, based on theoretical scrutiny, whether the vertical modularization of EA into three distinct architectures might be justified and could help reach the value proposition of EA. Another limitation of this article is that the scope of the analysis is a single organization. However, we view that the ideas presented herein can be readily applied and adapted to multi-organizational settings. We welcome further research to elaborate on our tentative findings and to investigate the potential benefits of the approach to the EA practice.

ABOUT THE AUTHORS

Janne J. Korhonen (janne.korhonen@aalto.fi) is pursuing a PhD at Aalto University on organizational governance of IT-related aspect systems (e.g., EA, information security, data, business process management). He received his MSc degree in Computer Science at Helsinki University of Technology and BA degree in Cognitive Science at University of Helsinki.

Jouko Poutanen (jouko.poutanen@fi.ibm.com) is a PhD student at the University of Jyväskylä and holds an MBA from Warwick Business School and BSc in Information Technology. Jouko works as a Country Technical Leader and IT Architect in IBM Finland. Jouko's research focuses on adapting complexity theory to strategic management, organization design, and EA.

REFERENCES

S. Bean: Re-thinking Enterprise Architecture Using Systems and Complexity Approaches, Journal of Enterprise Architecture, November 2010, pp.7-13 (2010).

B.A. Bechky: Sharing Meaning across Occupational Communities: The Transformation of Understanding on a Production Floor, Organization Science (14:3), pp.312-330 (2003).

S.A. Bernard: Introduction to Enterprise Architecture, 2nd Edition, AuthorHouse (2005).

J. Boardman, B. Sauser: System of Systems – The Meaning of of, 2006 IEEE/SMC International Conference on System of Systems Engineering, pp.118-123 (2006).

P.R. Carlile: Transferring, Translating, and Transforming: An Integrative Framework for Managing Knowledge Across Boundaries, Organization Science (15:5), pp.555-568 (2004).

C.W. Churchman: The Design of Inquiring Systems: Basic Concepts of Systems and Organization, New York: Basic Books (1971).

J.F. Courtney, D.T. Croasdell, D.B. Paradice: Inquiring Organizations, Australian Journal of Information Systems (6:1), pp.3-14 (1998).

J. De Visch: The Vertical Dimension, Mechelen, Belgium: Connect & Transform Press (2010).

G. Doucet, J. Gotze, P. Saha, S. Bernard: Coherency Management: Using Enterprise Architecture for Alignment, Agility, and Assurance, Journal of Enterprise Architecture, May 2008, pp.1-12 (2008).

G. Doucet, J. Gotze, P. Saha, S. Bernard (Eds.): Coherency Management, International Enterprise Architecture Institute (2009).

M. Edwards: "It's just a phase I'm going through": Integral Lenses and Phase Transitions in Organizational Transformation, Annual Meeting of ECCON – Phase Transitions in Organizations (2007).

D.A. Fisher: An Emergent Perspective on Interoperation in Systems of Systems, Technical Report, Carnegie Mellon University, Software Engineering Institute (2006).

J.W. Fowler, H. Streib, B. Keller (Eds.): Manual for Faith Development Research, 3rd Edition (2004).

P.J. Hagan (Ed.): EABOK: Guide to the (Evolving) Enterprise Architecture Body of Knowledge (Draft), The MITRE Corporation, February 6, 2004.

L. Hoebeke: Making Work Systems Better: A Practitioner's Reflections, John Wiley & Sons (1994).

K. Hjort-Madsen: Institutional Patterns of Enterprise Architecture Adoption in Government, Transforming Government: People, Process, and Policy (1:4), pp.333-349 (2007).

E. Jaques: Requisite Organization: The CEO's Guide to Creative Structure and Leadership, Arlington, VA: Cason Hall & Co. Publishers (1989).

S. Kaisler, F. Armour, M. Valivullah: Enterprise Architecting: Critical Problems, Proceedings of the 38th Annual Hawaii International Conference, January 3-6, 2005.

P.M. King, K.S. Kitchener: Developing Reflective Judgment, San Francisco: Jossey-Bass Publishers (1994).

J.J. Korhonen, K. Hiekkanen, J. Lähteenmäki: EA and IT Governance – A Systemic Approach, in 5th European Conference on Management Leadership and Governance, J. Politis (Ed.), Athens, p.66–74, Reading, UK: Academic Publishing Limited, November 5-6, 2009.

J.J. Korhonen, K. Hiekkanen, M. Heiskala: Map to Service-Oriented Business and IT: A Stratified Approach, Proceedings of the 16th Americas Conference on Information Systems (AMCIS 2010), Lima, Peru, August 12-15, 2010.

J.J. Korhonen: Enterprise Architecture and EA Governance: A Stratified Approach, in Systems Thinking in Enterprise Architecture, J. Gøtze, A. Jensen-Waud (Eds.), College Publications.

C.F. Kurtz, D.J. Snowden: The New Dynamics of Strategy: Sense-Making in a Complex and Complicated World, IBM Systems Journal (42:3), pp.462-483 (2003).

M. Lankhorst: Enterprise Architecture at Work: Modeling, Communication, and Analysis, Second Edition. Berlin Heidelberg: Springer-Verlag (2009).

J. Lapalme: Three Schools of Enterprise Architecture, IT Professional, IEEE computer Society Digital Library, IEEE Computer Society, December 14, 2011; refer to: http://doi.ieeecomputersociety.org/10.1109/MITP.2011.109.

Y. Malhotra: Knowledge Management in Inquiring Organizations, Proceedings of 3rd Americas Conference on Information Systems, Indianapolis, IN, pp.293-295, August 15-17, 1997.

J. McMorland: Are you big enough for your job? Is your job big enough for you? Exploring Levels of Work in Organizations, University of Auckland Business Review (7:2), pp.75–83 (2005).

T. Parsons: Structure and Process in Modern Societies, New York: Free Press (1960).

R. Peterson: Crafting Information Technology Governance, EDPACS – The EDP Audit, Control, and Security Newsletter (32:6), pp.1-24 (2004).

J. Poutanen: The Social Dimension of Enterprise Architecture in Government, Journal of Enterprise Architecture, pp.19-29 (May 2012).

R. Rowbottom, D. Billis: Organizational Design, Aldershot, UK: Gower Publishing Company Limited (1987).

E. Schein: Three Cultures of Management: The Key to Organizational Learning, Sloan Management Review. Fall (1996).

S.L. Star, J.R. Griesemer: Institutional Ecology, "Translations" and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39, Social Studies of Science (19), pp.387-420 (1989).

J.D. Thompson: Organizations in Action: Social Science Bases of Administrative Theory, New York: McGraw-Hill (1967).

G. Versteeg, H. Bouwman: Business Architecture: A New Paradigm to Relate Business Strategy to ICT, Information Systems Frontiers (8), pp.91-102 (2006).