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Christine A. Hoyland
Old Dominion University

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RQ-Tech, A Strategic-Level Approach for Conceptualizing Enterprise Architectures

Christine A. Hoyland*

Old Dominion University, 4111 Monarch Way, Suite 402, Norfolk, VA 23508-2563

Abstract

The purpose of this study is to present a system-theoretic based methodology and corresponding model for Enterprise Architecture development. Enterprise Architecture models can assist managers by illustrating the systemic relationships of their business and the impact their decisions can make. Unfortunately, today's modeling practices are proprietary, time-consuming, and generally ineffective as tools for communicating strategic-level planning across and down all levels of the enterprise. This research explored the most significant factors that must be considered when translating authoritative text and rich pictures of business doctrine into semantic models. An ontology, namely RQ-Tech, was used to parse and tag representative samples of strategic, operational, and tactical Department of Defense Joint doctrine publications and the results were analyzed with respect to how well the data could represent a holistic model of the business enterprise. The results of this research have the potential to add to the existing body of knowledge in systems theory, systems-based methods, and software engineering by expanding the domain of systems methodologies useful for assessment and evaluation of complex systems. This generalizable and transportable framework, the RQ-Tech methodology, was found to be useful for focusing attention on solving the right business enterprise problems.

Keywords: Enterprise Architectures, System of Systems, Complex Systems

1. Background

Architectures within the Department of Defense (DoD) are created for a number of reasons. From a compliance perspective, the DoD's development of architectures is compelled by law and policy (i.e., Clinger-Cohen Act, Office of Management and Budget (OMB) Circular A-130). From a practical perspective, experience has demonstrated that the management of large organizations employing sophisticated systems and technologies in pursuit of Joint

* Corresponding author. Tel.: +1-757-747-7379.

E-mail address: chrishoyland@yahoo.com

missions demands a structured, repeatable method for evaluating investments and investment alternatives, as well as the ability to effectively implement organizational change, create new systems, and deploy new technologies (DoD, 2007). In other words, enterprise architectures (EA) are the *blueprints* used to understand and change organizations, i.e., ...*the rules and standards and systems life cycle information to optimize and maintain the environment which the agency wishes to create and maintain by managing its IT portfolio.* (OMB, 2000, p. 14)

Many of the analogies at the core of DoD's EAs were developed in response to the *software crisis* between 1965 and 1985 (Gibbs, 1994). Currently, major capabilities of DoD's organization continue to be modeled as separate functional systems that are assumed to be repetitive, like the activities carried out on a factory assembly line. By law, *as-is* architecture views of military systems must be constructed to illustrate current processes. However, the modern warfighter's challenges range from peacekeeping duties in Afghanistan, to rescuing hostages from Somali pirates, to distributing aid to earthquake survivors in Haiti, and to post hurricane clean-up in New Orleans. Some have characterized this as the *world of the unexpected*, and this work cannot be considered completely routine (Taylor & Felten, 1993). In addition, the modern warfighter's environment is composed of a plethora of communication technologies including the Global Information Grid (GIG) (OASD, 2007). The standards that govern access to global information, are in a state of flux as modern technology initiatives, such as Service Oriented Architectures (SOA), promise to transition the DoD to a more intelligent web structure using the Semantic Web (W3C, 2004a).

The root metaphor of a factory is no longer representative of the military user's enterprise. This method of framing also does not appreciate the emergent nature of the context within which the DoD enterprise must exist and contend. It is reasonable to think that the resultant EAs based on this image may not be useful for modeling the organization's environment and modern organizational challenges.

2. Purpose

The purpose of this study is to develop and apply a system-theoretic based methodology and corresponding model for EA development:

- Systems-theoretic; meaning grounded in the systems principles that comprise an open systems perspective with emphasis on the circular organization of living systems, and their resistance to change (Jackson, 2003).
- Methodology; that is, a framework that embodies nine critical attributes: transportability, theoretical and philosophical grounding, guide to action, significance, consistency, adaptability, neutrality, multiple utility, and rigor (Adams & Keating, 2011).
- Models for EA development; meaning they can assist managers, to appreciate the systemic relationships of their business and the impact their decisions can make, and to change their mental models before business improvement can become possible (Jackson, 2003).

This study underscores the fact that a holistic view of the DoD enterprise currently exists only in the volumes of text and rich pictures that make up the Joint doctrine publications that warfighters are trained to carry out. However, the corresponding holistic modeling paradigm depicting the essence of these strategic-level documents as useful EA *blueprints* does not exist today.

3. Deficiencies in Current EA Modeling Techniques

Both the Zachman Framework (Zachman, 1987) and the Purdue Enterprise Reference Architecture (PERA) frameworks (Williams, Rathwell, & Li, 2001) were developed to evaluate the many facets of EAs in a modeling-language agnostic fashion. These frameworks are often used to critically assess and rate EA modeling methods and languages. A state-of-the-field literature search found that no product built by major vendors today claims to satisfy either Zachman's or PERA's criteria in order to be designated as *capable of modeling uppermost strategic layer of a large, complex enterprise.*

At the strategic level, the DoD publishes doctrine in an authoritative set of Joint publications and other DoD

policy and directives (text), to guide strategic and operational planning. These publications include various templates and diagrams (rich pictures) to convey military processes. Joint doctrine takes precedence over all Service-specific (Army, Navy, Air Force, Marine Corps) doctrine. It would be logical to posit that if EA's could represent Joint doctrine and the associated scope-level national security documents, military leadership would be able to critically identify and analyze their capability needs for planning and executing military missions. Studies (GAO, 2009; Gruninger, 2003; Tolk, 2006) have identified the need for a flexible configuration of enterprise models as *the umbrella function* capable of providing the meta-structure required for constructing holistic scenarios necessary for understanding enterprise-wide problems. However, most discussions on how these EAs should be revamped to close the gap are instead rigidly focused on improving the state of defining and developing views of technology insertion at the tactical system-level (Bailey, 2011; DoD, 2009; Engelsman, Quartel, Jonkers, & van Sinderenb, 2010; Wisnosky, 2011). It is argued that the mismatch of hierarchical concepts is responsible for incomplete and inaccurate views of strategic requirements from the system of systems (SOS) perspective.

Practitioners that recognize the need for non-traditional approaches that are grounded in soft-systems methodologies (SSM) (Blair, Boardman, & Sauser, 2007; Checkland, 2000; Mitroff & Linstone, 1993) observe the need to demonstrate systemic visualizations of SOS complexity using stakeholder dialog as the vehicle for understanding organizational problems. While these SSM techniques bring to light aspects of organizational issues that *hard systems* engineering methods rarely define, methodologies such as Boardman's *systemigrams*, rely on intensive facilitation from trained practitioners to build the initial rich picture of the owners' SOS, followed by scenario-building, or story-boarding, to capture the follow-on details. In contrast, this study offers an EA approach, namely Reusable Quality Technical Architectures (RQ-Tech), that was created to close the gap in understanding what is needed to visualize and understand the strategic mission and vision of complex, SOS organizations (Hoyland, 2011). It is a balanced methodology poised uniquely between the structure of systems engineering, the standards of the semantic web, and the quest for honest articulation of organizational structure and analysis, as defined by those that must rely on Joint doctrine to work within the boundaries of their Enterprise Systems.

4. Is It Possible to Tease-out EAs from Authoritative Business Documents?

The need for an integrated modeling analogy to characterize the construction of EA models at the strategic level prompted the framework of inquiry for this study. The application of a number of basic systems principles, studied within a structured systemic framework for EAs provides insight into the root cause for failure to achieve enterprise change management. These failures even occur during DoD defense acquisition system projects that strictly adhere to a systems engineering life cycle approach for managing DoD projects. To address the purpose of this study, the research builds upon the existing foundation of systems theory and focuses on answering: *What are the most significant factors to consider when translating authoritative text and rich pictures into semantic models?* A unique RQ-Tech ontology developed specifically for this task provides the basis for how samples of Joint doctrine publications are categorized and validated according to W3C XML standards (W3C, 2004b). Instead of relying on the antiquated factory assembly line analogy, RQ-Tech embodies the mental images associated with collaboration in social networking settings to more accurately depict the required flexibility and unexpected nature of the Joint warfighter's environment.

Joint doctrine is written at a level that is sufficiently general so that it can be used in a wide variety of conditions and to satisfy a vast number of uniquely defined conditions. As such, Joint doctrine authors have tacitly selected their own level of abstraction for using text and the rich pictures of Joint doctrine to convey their intent. Allowing this level of brevity and generalization to also act at the umbrella function of the EA enables users to build their own strategic models in a fashion that requires no further translation into meta-model details required at the operational, functional and technical EA levels.

The Friend of a Friend (FOAF) W3C standards (Brickley, 2000) were adapted and used as a foundation for RQ-Tech’s ontology, shown in figure 1.

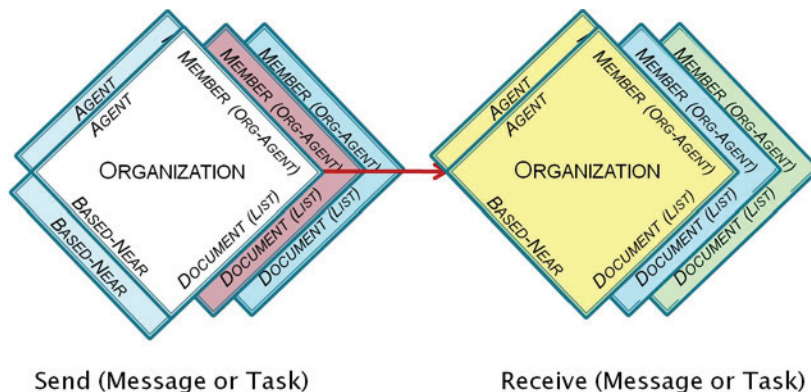


Figure 1: RQ-Tech Ontology

Content analysis was the method of qualitative research used to refine and test the RQ-Tech methodology. A data-tagging schema was invoked on several Joint doctrine publications, with adjustments made for handling the imprecision encountered in categorizing and coding text that had obviously been written by many different authors using various grammatical styles. Subsequently, each publication was parsed into an XML document that when published to the RQ-Tech web server, allows semantic web query and various types of visualization. It was observed that all but the most general descriptions contained in the publications could be represented using the RQ-Tech ontology. The most general descriptions appeared to contain very little, if any, guidance that could be defined as obligatory. Thus it can be inferred that with experience, the majority of Joint doctrine information could be catalogued by individuals competent in employing the RQ-Tech methodology schema.

5. Is it Possible Portray Business Needs using RQ-Tech Semantic Models?

The second research question asks: *To what extent are enterprise models aligned to Joint doctrine useful in representing operational scenarios to illustrate warfighter capability needs?* Considering the authoritative nature of Joint doctrine and its intention to guide vice restrict, it appears that if representations (i.e., models) could be constructed from these documents, they would have the potential to be uniformly accepted as descriptive of the whole enterprise. This research provided the environment that allowed the systems principles and associated systems frameworks to guide construction of a prototype RQ-Tech enterprise ontology method that logically and graphically conveyed capability gaps derived from strategic-level scenario planning, as shown in figure 2.

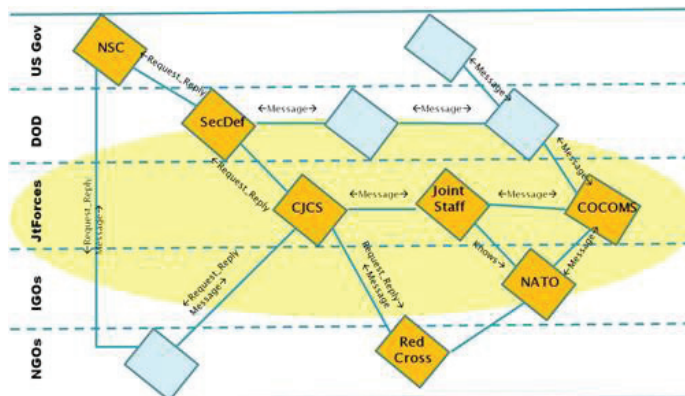


Figure 2: Notional RQ-Tech Semantic Model

This is in stark contrast to the current methods used by project consultants to perform business analysis, i.e., observation of business functions or interviews with workers. Studies have shown that observation changes behaviours and surveys tend to emphasize what workers have on their minds at the time of the interview (Bailey, 2011).

6. Significant Original Contributions

As designed, this research has the potential to make four significant contributions to systems and software engineering, and the SoS methodology:

1. This research develops an enterprise ontology that makes use of current, authoritative, cross-referenced enterprise documentation that defines the rules, guidelines, roles, responsibilities, authorities, and constraints of the enterprise and delivers it to enterprise managers as a dynamic model for the enterprise.
 - Because it is based on *only* the documentation that has been accepted as policy, this model can represent the holistic *should-be* view (Hysom, 2003) for every documented facet of the enterprise.
 - Because this model is based on systems principles, it brings with it the richness of general systems theory, including their metaphors from natural science.
 - Because it is based on both social and technological precepts, it transcends hard systems models and replaces obsolete mechanistic metaphors with those that are rich in social analogy.
2. This research fills the following voids in EA guidance:
 - There is no current way to map and link the scope of the enterprise to systems levels of architectures
 - Lack of formalized, but non-proprietary ways for the user to describe capability requirements
 - Lack of universal EA ontology applicable to all strategic, operational, and tactical levels of EAs
 - Lack of universal EA ontology that conforms to W3C standards and therefore needs no further translation when used with Semantic Web-based technologies, such as RDF/XML and SOA
3. This research provides the EA ontology that serves as guidance to convert current, authoritative documentation into a searchable digital library to:
 - Provide a methodology for unifying disparate documents into one linked organic structure
 - Provide a cross-check of authoritative documentation to ensure consistency and/or identify areas of potential conflict
4. This research provides an EA methodology designed to allow the users to create and update their own EAs. Strategic leaders can access a generalizable and transportable framework that can act as a systems lens for use in assessing and evaluating portfolios of projects against ever-changing strategic priorities.

In summary, this research provides a much-needed SOS Engineering method that has the ability to focus attention on solving the *right* problems in the most effective and efficient way possible (Mitroff, 1998). By starting with a non-proprietary, reusable, holistic framework of required linked organizational descriptions and functions, users who want to describe the undocumented culture of complex behaviors that are the basis of problems or lack of needed capabilities can share the same linked Joint doctrine structure of RQ-Tech to generate and archive scenarios of unique problems they have encountered. Users can be invited to construct specific *as-is* mission threads by following the RQ-Tech Methodology for generating use-cases. In this manner, stove-pipes of singular functionality that result from examining enterprise problems too narrowly can be avoided.

7. Future Initiatives for RQ-Tech Implementation

The RQ-Tech Methodology has the potential to be cost-effective to implement because new versions of Joint doctrine are published on a three- to five-year cycle, so there is time to reap benefit from the effort required to parse and tag each document. However, it can be expected organizational documents will continue to be discovered through cross-references and scenario development. Many of these documents, when parsed into the organizational document library will contribute to augmenting the organization's holistic essence as organizational analysts work

outward toward government and industry standards, policy, lessons learned, education, training and technology that all contribute to the concept of the enterprise itself. It is also possible that as the RQ-Tech methodology matures through use, automated methods for parsing semantic documents will be found that can keep up with changing organizations and all their governing documentation.

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