TOWARDS A SOCIOLOGICALLY-ORIENTED APPROACH TO ENTERPRISE ARCHITECTURE USING THE THEORY OF STRUCTURATION

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DISSERTATION APPROVAL PAGE

This is to certify that the dissertation prepared by Dominic M. Mezzanotte, Sr. entitled: Towards a Sociologically Oriented Approach to Enterprise Architecture Using the Theory of Structuration has been approved by the thesis committee as satisfactorily completing the dissertation requirements for the degree Doctor of Science.

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To Kathryn

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ABSTRACT

TOWARDS A SOCIOLOGICALLY-ORIENTED APPROACH TO ENTERPRISE ARCHITECTURE USING THE THEORY OF STRUCTURATION

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Enterprise Architecture (EA) describes the process of aligning on organization's business vision, strategy, and business-enterprise information technology (IT) systems into a more efficient, effective, and agile organization. EA defines the processes needed to:

- Effect an overall organizational transformation by creating, communicating, and improving the key requirements, principles, and models that describe the enterprise's future state
- Improve operational efficiency, effectiveness, and stakeholder on-the-job productivity

EA frameworks (EAF) provide a conceptual methodology that supports and guides the engineering, design, and construction effort behind EA. The product of an EAF, an EA plan (EAP), details the infrastructure, requirements, and technical specifications needed to align an organization's strategic business plan and operating model with it's information technology (IT) components and capabilities.

Analyzing the philosophy behind today's most popular EAFs (e.g., the Zachman Architecture Framework, The Open Group Architecture Framework (TOGAF), the

Federal Enterprise Architecture Framework (FEAF), and the Department of Defense Architecture Framework (DoDAF)) reveals a purely techno-centric, comprehensive, and disciplined approach to EA design. Each framework focuses solely on satisfying the business goals, strategies, and governance of the EA. However, EA transforms the structure, culture, political, and social environment of an enterprise introducing new processes and technologies into the workplace often with unanticipated and unexpected consequences. The organizational transformation that takes place inevitably alters the roles, duties, responsibilities and organizational position of stakeholders with new processes, procedures, and tasks to be learned. This transformation frequently affects stakeholder behavior that can lead to either acceptance or rejection of EA.

Our analysis of existing EAFs find them to be deficient in that they fail to address the impact EA has on both organizational transformation and to changes in stakeholder behavior. Failure to address and assess these issues from the framework level as an input to, and result of, an EA frequently manifests itself in stakeholder behavior that limits and/or constrains their participation in EA design. As a result, the EA may fail either partially or completely.

This dissertation advances our earlier work exploring three forces that influence EA: organizational transformation, stakeholder resistance to change, and elicitation/use of erroneous EA requirements. We believe each of these issues can be addressed from a sociologically-oriented perspective incorporating ideas from the *Theory of Structuration* designed to remove barriers that limit stakeholder action. This dissertation aims to implement mechanisms that identify early-on potential roadblocks and negative stakeholder input to the design process and define a more holistic and humanistic oriented framework that assists in motivating stakeholder behavior.

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

American National Standards Institute (ANSI) – The U.S. representative to the International Organization for Standardization (ISO) consists of an association of manufacturers, users, and other interested parties that establishes and maintains standards across a wide spectrum of technological and other concerns.

Administration Structure – The visual design for internal users who are responsible for creating and maintaining information such as taxonomy categories.

Agile Software Development – A software development method that breaks the development task into small developmental increments typically involving little planning. The process encourages and takes advantage of a short iterative developmental cycle that includes planning, requirement definition and analysis, and testing. Stakeholder responsibilities include final acceptance testing and typically the development of the documentation for the software

Application Architecture – A solution architecture that in a singular form documents the problems, requirements, and the internal architecture of an application.

Architecture – A top-down description for the structure of the system.

Architecture Development Method (ADM) - A The Open Group Architecture Framework standard defining a process for creating an Enterprise Architecture.

Application Architecture - The interaction between application software, databases, and middleware systems ensuring the suite of software applications used by an organization is scalable, reliable, available, and manageable.

Architect –In Information Technology, an architect is responsible for designing, documenting, and leading the development and construction of an information system that meets the needs and requirements of all stakeholders.

Artifact – An asset that is produced, modified, or used by a process, defines an area of responsibility, and is subject to version control. It may be a model, model element, a document, or a document enclosing other documents.

Architectural Design – The structuring of the system as a whole into a structure of components (i.e., systems and sub-systems) and the interrelationships between those components.

Architectural Framework – A framework which organizes the structure and views which includes the hardware, software, and data standards of an Enterprise Architecture.

Architectural Methodology – A generic descriptive structured approach to solving some or all of the problems related to architecture.

Architectural Process – A defined series of actions or processes that produce either architecture or an architectural description.

Architectural Taxonomy – A classification scheme that organizes and categorizes architectural artifacts.

Architecture – The design and interconnection of the main components of a hardware/software system. The framework and interrelationships of elements of a system. The organization or structure of significant components of a system interacting through interfaces.

Brainstorming – A process designed to solicit a large number of ideas in a short period of time.

Business Architecture – An organizational framework which defines the structure of an organization describing what the business does, its' business processes and information, and how the business functions.

Business Plan – A formal statement of a set of business goals, how they might be attained, and the plan for reaching them. A document that defines a firm's financial and business goals and benchmarks.

Business Process Management (BPM) – A holistic discipline focused on alignment of all aspects of an organizations software capabilities and business expertise through people, systems, and information to accelerate time between business improvements, facilitating business innovation.

Business Process Modeling (BPM) - An activity that seeks to standardize the management of business processes that span multiple applications, data repositories, departments, divisions, companies, or government agencies aimed at improving process efficiency and quality.

BRM (Business Reference Model) – A term defined by the FEA providing a business view of various federal governmental functions.

Chief Information Officer (CIO) – The executive in charge of Information Technology in an organization (corporation, governmental agency, etc.).

CIO Council – Various federal, state, and local government organizations that provide each unique entity with a forum for the development of opportunities that become possible when they work together in developing and using information technology.

Clinger Cohen Act of 1996 – A United States federal law designed to improve the way the federal government acquires, manages, uses, and disposes of information resources and technology.

Common Systems Architecture – A guide described in The Open Group Architecture Framework used for the selection and integration of specific services from the Foundation Architecture to create architecture to build common solutions across a wide number of relevant domains. Examples include: Security architecture management architecture, network architecture, etc.

Commercial Off-the-Shelf (COTS) – Software commercially available from third party manufacturers and vendors. Source code may be available for customization or modification to meet user requirements.

Conceptual Model (CM) – A conceptual model sometimes referred to as a domain model represents entities and the relationships between them and is independent of design or implementation concerns. Various notation schemes such as UML or OMT, among many others, may be used to describe the model...

DA (Data Architecture) – The design of data that defines and describes how data is processed, utilized, and stored in a given system.

DAF (Disclosure, Analysis and Feedback) – A method of documenting the architectural development process implementing a communications path between all project stakeholders.

Dynamic State - Represents an unstable environment being modeled.

EIA – Abbreviation for Enterprise Information Architect. *See Enterprise Architect.*

Endogenous – Related to, caused by, synthesized or produced by factors within the system or business cycle.

Enterprise – A collection of departments, divisions, sub-divisions, or related components of an entire corporation or governmental organization.

Enterprise Information Architect – A person (group of people) assigned the task of linking and aligning the strategic business plan of an organization to its Information Technology (IT) strategy.

Enterprise Architecture (EA) – A rigorous and comprehensive discipline that describes the structure of an organization, decomposing the enterprise into subsystems identifying the interr4elationships between subsystems and the external environment, defining the language and terminology used, and the guiding principles employed in the design and evolution of the organization.

Enterprise Architecture Framework – The methods, disciplines, and processes used to organize data gathered providing the structure, views, and mechanisms for communicating information about relationships that are important to and associated with Enterprise Architecture.

Enterprise Architecture Management (EAM) - In EA, EAM describes the blueprint connecting the business and technology needs of an organization while managing the impact of business-driven change.

Enterprise Architecture Plan (EAP) – The planning process used to define and support the architecture and information requirements of an organization and the method of implementing and managing the architecture.

Enterprise Resource Planning (ERP) - Program/Project resource planning of activities, supported by multi-module application software and processes to help an enterprise manage key parts of its business which may include product planning, maintaining inventories, supply chain processes, providing stakeholder services, human resources planning, etc. It may include any other system involving any kind of resource consumption that can benefit from integration of information across many functional areas.

Enterprise Service – Related to Service Oriented Architecture, a concept of highly-integrated web services combined with business logic and harmonized semantics that can be accessed and used repeatedly to enable end-to-end business processes.

Epistemology – A branch of philosophy that investigates the origin, nature, methods, and limits of human knowledge.

European Committee for Standardization (CEN) – An organization promoting voluntary technical harmonization in Europe in conjunction with standards bodies worldwide and its European partners.

Exogenous – Related to, caused by, introduced or produced by factors outside the system.

Expectations – Represents the desires of the stakeholder that might not prevent the product, process, procedure, or service from working as intended but would cause stakeholder dissatisfaction if not met.

Federal Enterprise Architecture (FEA) – A common methodology for Information Technology (IT) used by the Federal government that guides the acquisition, use and disposal of Federal governmental IT applications.

Federal Enterprise Architecture Framework (FEAF) – An organized structure and a collection of common terms by which Federal segments can integrate their respective architectures into the Federal Enterprise Architecture.

Fishbone Diagram (Ishikawa Diagram) – A graphic representation of both ideas and possible causes are grouped into common categories such as manpower, methods, environment, processes and procedures for analysis and resolution from which possible causes for a problem can be determined and assessed. The fishbone diagram was initially developed by Dr. Ishikawa.

Flowchart – A graphic representation of a process/procedure or a portion of a process/procedure.

Foundation Architecture – A TOGAF description of generic services and functions in which more specific architectures and architectural components can be built.

Federal Segment Architecture Methodology (FSAM) – A step-by-step process using proven best EA practices from across Federal agencies for developing a segmented architecture using templates that expedite architecture development.

Goals – The aggregate result achieved by the implementation of the common features of a key process area signifying the scope and intent of the key process area.

Governance – The planning, influencing, and conducting of the policies and affairs of an organization, The set of responsibilities and practices exercised by management with the strategic goal of providing direction, ensuring that objectives are achieved, risks are managed appropriately, and that the enterprise's resources are used responsibly.

Hard goals - The goal is "fixed" and doesn't change as it is approached. The goal has clear-cut criteria to decide whether it has been met or not.

Hermeneutics - The study of interpretation theory, and can be either the art of interpretation, or the theory and practice of interpretation. That explains, interprets, illustrates or elucidates.

Holistic – Relating to or concerned with whole systems rather than with th4e dissection of a system into separate and distinct parts.

Information Architecture – A set of aids/tools that match information needs with information resources.

International Organization for Standardization (ISO) – A voluntary nonprofit, non-treaty, nongovernmental international standards consortium from participating nations.

Information Flow – Describes how information flows within an organization.

Information Usage Pattern – Describes how information is utilized and flows within an organization.

Institute of Electrical and Electronic Engineers (IEEE) – The leading U.S. authority in electrical engineering and technical areas ranging from telecommunications to aerospace and to information technologies.

Method (see Process) – The way in which a task/work is performed.

Model – In this dissertation, model/modeling defines a predictive process where predictors (variable factors) are likely to influence the outcome or future behavior of an event.

National Institute of Standards and Technology (NIST) – A U.S. agency under the Department of Commerce that promotes and applies, with industry, technology, measurements and standards.

Object Modeling Technique (OMT) – An approach to software development, OMT represents an object modeling language used for software modeling and design.

Ontology – Concerned with what entities exist or can exist, and how those entities can be grouped or cataloged into a hierarchy and subdivided according to similarities and differences. In knowledge sharing, a means of specification or conceptualization.

Performance Measurement – Actual results produced and generated by the implementation of enhanced business and information management solutions.

Process (see Method) – The way in which a task/work is performed.

Requirements – The criteria that describes and defines the operational, functional, design characteristics, traits, and constraints a product, process, procedure, or service must possess in order to function as intended. It represents the performance characteristics, measurability, and acceptability of the deliverable product.

Requirements Engineering – Broadly defined as the subset of systems engineering concerned with analyzing stakeholder specifications, transforming those specifications into functional requirements, tracing, qualifying, communicating, and managing those requirements that define the system at various levels of abstraction.

Return on Investment (ROI) – The financial return for a given outlay, usually calculated in terms of today's present value of money.

Risk Assessment – The process of identifying potential risks, quantifying their likelihood, and assessing their likely impact on the project.

Risk Avoidance – The process of planning activities so as to avoid identified risks using an alternative method or solution.

Risk Management (RM) – A comprehensive framework wherein risks can be managed effectively and financial values placed upon them. The framework provides an organized assessment and control of project risks.

Root-Cause Analysis (RCA) – The analysis of collected data about a problem to determine the true root-cause of the problem.

Segment Architecture Process – In the FEA, a multiple-phase methodology to develop segment architecture work products. Each phase provides an increasing level of architectural detail to support IT investment decision-making and solutions development and implementation.

Sociology - The study of society. It is a social science (with which it is informally synonymous) that uses various methods of empirical investigation and critical analysis to develop and refine a body of knowledge and theory about human social activity, often with the goal of applying such.

Soft Goals – Goals which do not have clear-cut criteria to decide whether the goal is satisfied or not. In contrast to hard goals, soft goals can only be partially satisfied.

Software Engineering – The application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software in a reliable and cost-effective manner and the study of these approaches. The application of engineering principles to software.

Solution Architecture – The architecture for an individual IT system.

Specifications – The subset of the input requirements that the stakeholder puts into the product, process, procedure, or service transaction. Specifications may also be the translation of the requirements into measureable outputs for the purpose of tracking and measuring compliance and governance.

Stakeholder – A stakeholder in an Information system is any person, group of people, or other entity with either a direct or indirect interest in the concerns about the realization of the architecture.

Stakeholder Classes – Stakeholders may be classified according their roles and concerns. Any person or group who is/are a direct user, indirect user, manager of users, top-level management, operations and support staff members, investors, all software, development and maintenance staff including management, auditors, and members from other systems affected by the new development.

Standards Information Base (SIB) – A term used by The Open Group Architecture Framework term referring to an aggregation of information about standards, particularly in the open-source domain.

Static State (SS) – The static state represents the most stable state within the modeled domain.

Structuralism - An approach to the human sciences that attempts to analyze a specific field (for instance, mythology) as a complex system of interrelated parts.

System – A set of distinct elements connected and related in such a way as to perform a unique function not performable by the elements alone. *IEEE Std. 610.12-1990*: A system is a collection of components organized to accomplish a specific function or set of functions.

Technical Reference Model (TRM) – A TOGAF TRM consists of two components: a taxonomy that defines terminology and provides a coherent description of the components and conceptual structure of an information system and an associated TRM Graphic that provides a visual representation of the taxonomy to facilitate and aid to understanding the taxonomy.

The Open Group Architecture Framework - As of this writing, Version 9.0 defines an architectural methodology controlled by a professional enterprise architects called The Open Group.

Transcendent – Exceeding usual limits, extending or lying beyond the limits of ordinary experience, being beyond the limits of all possible experience and knowledge.

Unified Modeling Language (UML) – A graphical language that provides a standard visual way to specify, construct, and document the artifacts of a software-intensive system providing a tool for complexity-management and clear communication.

Use Case Model – A model that describes the interaction between the system and the user. It corresponds in a similar way to a requirements model.

Zachman Framework for Enterprise Architecture – A framework or taxonomy described in a number of cells (30 or 36) with each cell representing the intersection between stakeholders (rows) and different views of the architecture (columns).

Chapter One – Introduction

Enterprise Architecture (EA) describes the process of aligning on organization's business vision, strategy, and business-enterprise systems into a more efficient, effective, and agile organization [39][91]. The process entails the analysis of the enterprise in it's *as is* or current environment to a desired future design or *to be* state from three perspectives [7][91][121]:

- Strategic
- Organizational
- Technological

Underlying the EA process is the analysis, design, and implementation of desired enterprise solutions (i.e., systems) that support the projected strategic business opportunities while taking into account the capabilities of the enterprise [7][109][140]. In addition, it provides an analysis and planning discipline for both large and small organizations that ensures enterprise systems have the agility needed to align with and support changes in business strategy and underlying business capabilities [91][109][140].

Given this definition, the EA process produces several things of value for the organization such as [39][91][109][140]:

- A clear and concise understanding of the strategic requirements of the enterprise and the infrastructure (e.g., hardware, software, resources, tasks, processes, procedures, etc.) needed to support the enterprise.

- Models of the future state ilustrating the viewpoints of what the enterprise should look like in support of the business strategy.
- A plan or "blueprint" for the change initiatives required to reach that future state.
- The requirements, principles, standards, and guidelines that will manage, steer, and govern the implementation of change initiatives and enterprise architectural assets and information.

In this context, EA represents an important useful resource for any organization, large or small, in providing the enterprise-wide view needed to effectively develop and utilize systems and technology for competitive business advantage. As such, the goal of EA is to effect an overall organizational transformation by creating, communicating, and improving the key requirements, principles, and models that describe the enterprise's future state.

The EA process, however, frequently results in a major cultural and structural transformation of the organization that potentially has a significant impact on the design and implementation of EA. However, there is a tendency for information technology (IT) infrastructure projects, such as those fostered by EA, to overlook or minimize the impact human (i.e., stakeholder) behavior has on project outcome [23][95]. This is a mistake.

Humans are purposeful beings that exhibit a will (i.e., behavior) of their own and the capacity to act intentionally or unintentionally for, or at odds, with an organization's structure, character, culture, social, and political environment [46][58][83]. Stakeholders observe, learn, imitate, and vacillate between acceptance and rejection of organizational directives to achieve their own personal goals and objectives, choose their behavior, and decide when and how they will communicate with others in and out of the workplace [46][58]. In effect, the behavior they demonstrate in the workplace is the product of the cognitive aspects of their past and present work and life experiences that together with organizational behavior affect their future capacity to contribute. Put into the wrong circumstances however, their behavior may be contrary to that desired by the organization and thus poses a threat that potentially jeopardizes not only the quality of but also the success of the EA [46][58][83][85]. From an organizational perspective, stakeholders should be viewed as enterprise resources possessing strengths and weaknesses with characteristic skill sets, expertise, and experience that should be considered human capital and likened to organizational assets.

Managers who view EA from a purely technical architectural design point-of-view generally overlook the creative and innovative contributions stakeholders can make to EA and, as a result, marginalizes EA's usefulness and consequently minimizes the potential business value stakeholders can bring to the organization [20][46][58][83][85]. Building an EA consists of multiple complexities requiring multiple competencies. Unfortunately, the tendency of EA management and, to a large extent, that of an Enterprise Information Architect (EIA) is to treat stakeholders in a pathological, single-competency, mechanistic, and utilitarian role seeking efficiency and effectiveness as their sole basis for EA [20][58][87].

This thinking, referred to in management theory literature as *efficiency thinking* [131], reflects the historical influence of Frederic Winslow Taylor (i.e., *Taylorism* [115]) and has influenced the way managers manage and, to a large extent, how stakeholders work. In other words, *Taylorism* states how managers should dictate how people should work [131].

Taylor's theory utilizes typical industrial engineering techniques such as time-motion studies, metrics, and removing people from the process to progress *efficiency thinking* [131]. His theory of *management control* gained popularity in the early part of the twentieth century being initially implemented in industrial settings. His management style persists today permeating management behavior in many settings including the IT world. However, most sociologists today disregard his control mentality indicating it does not have much utility where stakeholder creativity, innovation, and cognition are needed and necessary to create an atmosphere of co-creative contribution, such as in an EA [68][78][83].

As stated previously, EA aims to improve operational performance, efficiency, and stakeholder on the job productivity. By their nature, these artifacts may appear to be likely candidates for Taylor's style of management control and thus lends some credibility to his approach [91]. Unfortunately, these objectives are lost whenever new technology, represented by EA, is rejected and/or modified to suit the parochial self-interests of stakeholders [50][82]. Research into the phenomena of why stakeholders accept, reject and/or modify technology (i.e., information systems) and how stakeholders are affected by new systems can be, and are often, linked to the causal relationships between the perceptions, attitudes, and behavior of stakeholders towards the [58][83][85]:

- Usefulness and ease of use of the technology
- Affect the new technology will have on their roles, duties, and responsibilities
- Perceived benefits they expect to derive from their usage of that technology.

However, the issues and concerns surrounding stakeholder acceptance or rejection and use of EA technology may only scratch the surface of EA and the impact human behavior has on its usage.

IT, represented in its various forms of use such as in EA, is the single most important influence affecting human behavior on the world stage today [20][21][95]. In business, technology can either open up new opportunities for enterprise growth and efficiency or constrain and limit human action by the implementation of new processes, procedures, and subsequent monitoring of human action [20][95]. For example, the manner in which technology is introduced into the organization typically determines whether or not the technology is accepted and used. If the technology is introduced unexpectedly and without any input from or concern about stakeholders it may be accepted or rejected by those involved in the technological transition [39][76][83][85][95].

Business often moves in directions contrary to its stakeholders (e.g., employees, customers, and suppliers) and as each moves in their respective directions, so do the desires of business change and its demands on IT [17][91][141]. Therefore, the behavior of project stakeholders, the human actors needs to be taken into account to mitigate the possibility of stakeholders acting contrary to organizational desires and thus undercut and/or sabotage its policies and procedures [20][39][46][91][95].

1.1 Enterprise Architecture – Background and Context

The term Enterprise Architecture (EA) has often been credited to John Zachman after he published "*A Framework for Information Systems Architecture*" in 1987 and for his continued contributions to the subject [140]. Though the term may have been used by other practitioners between 1987 and 1992, the first appearance of the term does not seem to have existed in print prior to 1992 when Dr. Stephen H. Spewak published his book "*Enterprise Architecture Planning*" [126]. However, the actual modern origins of EA trace back to the beginning of the digital age, around 1940, and use of information processing techniques, such as operations research, to solve complex problems in both the military and industry during World War II. This was followed shortly thereafter by the first use of a high-speed, general-purpose computer, ENIAC, introduced into the business world by J. P. Eckert and J. W. Mauchly in 1946 [111]. The invention and introduction of this new technology was followed by the ascendency of information technology (IT) as an industry unto itself with both profound and unexpected effects on commercial enterprises, people, society, and culture [21][53][95].

Before continuing, and to avoid and side-step questions and ambiguities later in this dissertation, one of the most simple and yet perplexing issues facing the IT industry today is defining the differences between IT and EA. In conducting the research for this dissertation, the definition of EA and IT and the differences between IT, its corollary and derivative, IT strategy (sometimes referred to as IT business strategy), and EA, has become an interesting topic for exploration and discussion. This became extremely important and interesting in determining and assessing EA versus IT failures. However, the definition is soluble.

Separating EA from IT and vice versa is difficult as most literature frequently confuses the two and interchanges the terms as do most industry practioners. Evidence supporting this assertion is reflected [37][39][43][44][74][76][113]:

- In an analysis of the literature written on both EA and IT

- The diverse opinions of the authors
- The actual literature related to IT and/or EA failures

In most literature, the focus of IT and IT business strategy can be interpreted as *What are we going to achieve*. All of the literature recognizes the major by-product of IT to be information systems (IS) or application development. As such, IT and IS are collectively grouped together in this dissertation as IT [39][61][94][106].

Zachman distinguished EA as a separate and different paradigm from IT in his *Enterprise Architecture Artifacts vs Application Development Artifacts* [142]. In this and other literature, EA is all about strategic change planning, organizational transformation, governance of the change process, and ensuring the change occurs without much divergence [30][91][109][141][142]. As differentited from IT, EA represents continual incremental change, high level planning, a circular lifecycle as opposed to a more linear lifecycle for IT, and with EA providing the foundation and low level common building blocks for IT [4][91][109][141]. EA then represents not only the top hierarchical level or superset of IT described in this dissertation it also provides the answer to *How are we going to achieve it*. However, both EA and IT are about stakeholder requirements [33][39][88][91][106][116]. Given this perspective, we can conclude that the major difference between IT and EA is that IT is focused on a specific set of requirements used to build an EA and therefore IT is the process of *doing EA*. This perspective then brings up the next question for resultion: does an IT failure constitute an EA failure or does an IT failure happen as the result of EA failure?

One of the key by-products of both EA and IT are the stakeholder requirements that are to be satisfied [30][91][109][142]. In most cases, either partial or complete failure occurs when these requirements are not delivered with blame typically termed "poor architecture" [37][44][90][113]. Whether EA or IT, at least three arguments can be made that [91][109][142]:

- EA is recognized as a high-level macro abstrction of stakeholder requirements needed to drive IT.
- Specific IT requirements are formulated from and therefore in a macro-sense dependent on EA requirements.
- EA and IT are somewhat/cursorily synonymous and analogous with one another with the success of either each dependent on elicited stakeholder requirements.

This last element presents an interesting question for consideration, essentially a chicken and/or egg scenario: were the stakeholder requirements obtained during the EA process valid when passed to IT development or did the requirements get erroneously translated, miscommunicated, misunderstaood, etc., in the transition and translation from EA to IT development? Literature on this topic does not explicitly or definitely stipulate or adequately define what are really IT and/or EA failures. In fact, the literature for the most part aggregrates the two and as such EA nad IT failures are considered the same in this dissertation. An empirical study separating EA from IT failures is perhaps something for future research considerations

Though literature on the IT, and now EA, subject is extensive, it is also varied in content, context, and in approaches to solving complex large-scale information system problems. The focus of the literature is usually on the technical aspects of IT strategy, design, development, and implementation. The sociological and psychological impact technology has on human behavior is, in most cases, totally ignored or, at most, only cursorily taken into account. Yet, EA has introduced some unintended consequences related to the study of technology and the importance of human behavior.

As the impact of technology on society has grown, the EA industry has continually attempted to develop new and/or improved approaches, techniques, and frameworks that make it easier, faster, and less expensive to design, build, govern, and maintain high-quality EA architecture. Facilitating this process has been the inclusion and use of many IT modeling techniques such as Business Process Modeling (BPM), ArchiMate, Sparx, i*, et al., to verify and validate stakeholder design requirements and specifications [28][110][125][139].

In today's competitive business environment that, in some cases, spans the globe, technology and IT (here defined as the collection of "tasks, techniques, knowledge, and tools" [91]) symbolized by EA are essential to enterprise viability, competitive, and growth. However, we can demonstrate that EA is also inextricably intertwined with and influenced by stakeholder acceptance and usage of that technology [87][95]. From the organizational and technical viewpoint, the forces behind the relevance of this trend are threefold [62][80][106]:

- The high cost of research and development into producing a product that attempts to solve what are often large-scale complex solutions to business problems.
- The organizational transformation that takes place as a result of new technology and the impact this transformation has on the structure, culture, and political environment of the enterprise.

- The risk to enterprise management undertaking new technology to remain competitive in the business world and the consequences of failure.

Putting the topic into proper perspective, EA projects can range from broadly-focused enterprise-wide strategic Information Systems (IS) plans encompassing all aspects of the enterprise's information and technology needs (e.g., the IT infrastructure, software, hardware, people, processes, and procedures) to one directed at a specific IS application [87]. Yet historically, many of these projects fail to deliver the expected high quality solutions with the projects, more often than not, frequently ending in failure [37][106][113].

As a new approach to solving the problem of implementation of large-scale complex business applications, EA emerged in the late 1980s projecting a new image of and ways to explore IT development [91][140]. The frameworks used to develop EA, an EA framework (EAF), continue to evolve such that they now routinely incorporate aspects of enterprise engineering and enterprise modeling previously ignored within the industry.

EA has its own portfolio of techno-centric approaches, frameworks, processes, and procedures all aimed at exploiting the benefits enterprises expect to derive from desired operational efficiencies and effectiveness [91]. Like the historical context of IT methodologies, EAFs are grounded in traditional computer-oriented and computer science theories that illustrate the maturation and aggregation of several IT disciplines such as enterprise engineering, software engineering, systems engineering, requirements engineering, and software development. Together, these disciplines provide a layered "architectural" view of anticipated EA systems and subsystems and desired stakeholder requirements (see Figure 1) [39][89][91][128].

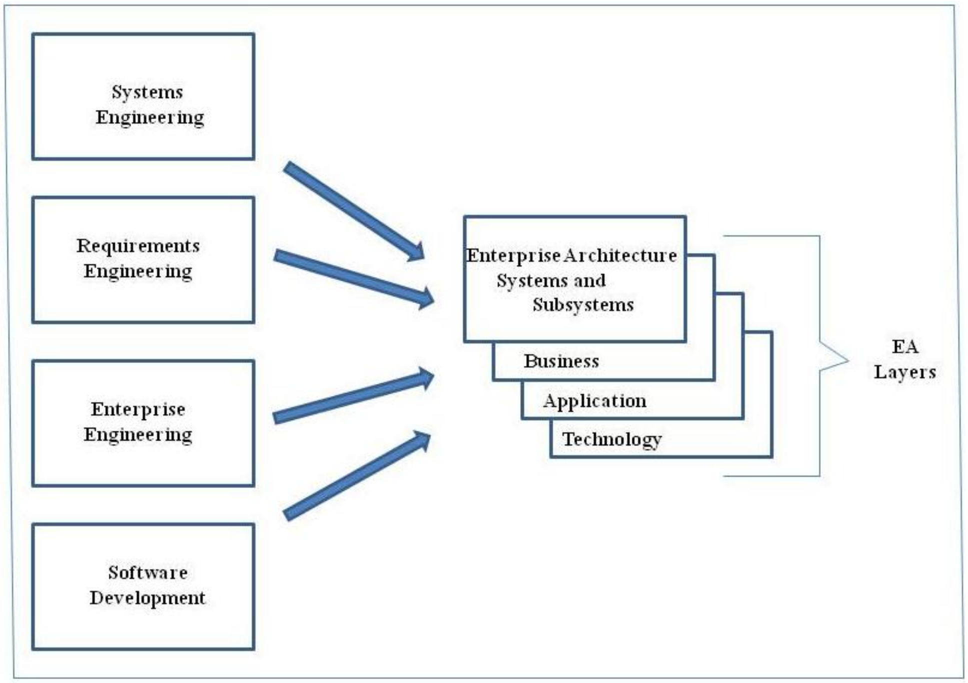

Figure 1. Layered Approach to Enterprise Architecture

Like the definition of architecture in the construction and building trades, EA creates an overview of an organization's structure, business processes, technical support infrastructure, and the supporting detail behind the different aspects, relationships, and domains of EA applications [72]. In essence, EA architectures articulate the structure underlying the technological solution to a particular business problem. In EA, architecture, as defined by the IEEE 1471-2000 / ISO/IEC 42010:2007, is "the fundamental organization of a system embodied in its components, their relationship to each other, and to the environment, and the principle guiding its design and evolution" [71]. Enterprise, on the other hand, can have and frequently does have many meanings.

As it relates to this work, enterprise is any group of organizations or agencies, subsidiaries, divisions, subdivisions and/or people (i.e., stakeholders) who come together governed by organizational rules, policies and procedures, who interact with one another agreeing to coordinate their physical and mental activities, to achieve a predetermined, common set of goals and objectives [20][45][95]. In this context, the EA design process lies at the confluence of stakeholders, organizational policies and procedures, and technology with business strategy, the process input, driving the design with business results, the output and end-product of the process (see Figure 2).

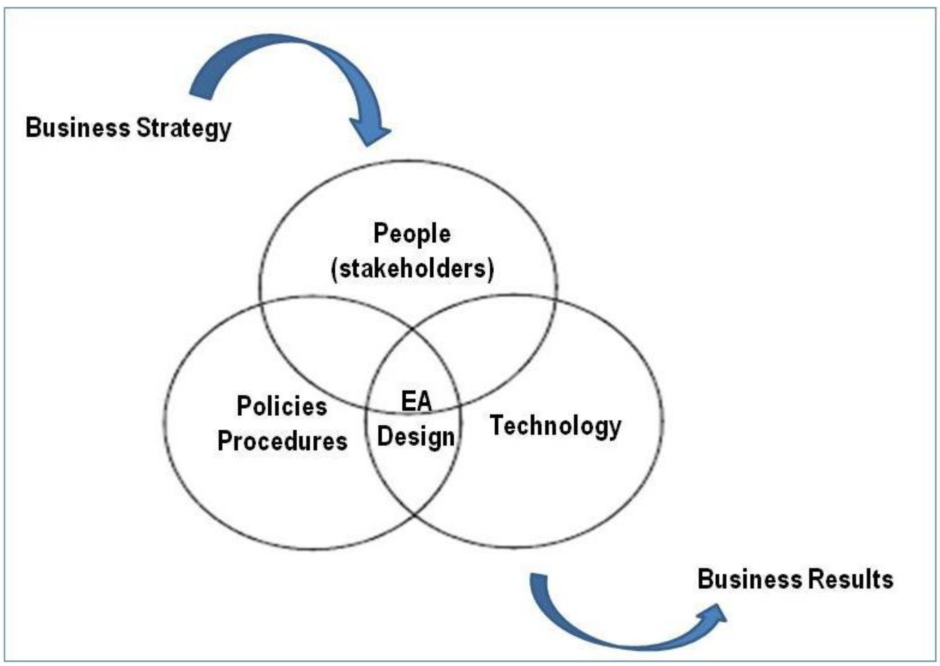

Figure 2. Components of Enterprise Architecture Design

Together, these activities form the foundation for EA, supported by enterprise engineering principles that embody all aspects (e.g., software, hardware, processes, procedures, and technical infrastructure) of IT necessary for constructing an EA. The enterprise engineering principles surrounding these activities aims at researching and understanding the relations and dependencies between enterprise concepts, systems, methods, and enterprise concerns such as business processes, goals, strategy, people (i.e., stakeholders), organization structure, and the supporting systems and technology.

As a vehicle supporting business problem-solving and decision-making, EA represents the extant status and future projection of organizational strategic planning and operating model alignment with its IT components and capabilities (see Figure 2). The tool used in this process, an EAF, articulates the processes and procedures to be followed that provide the requisite logical structure (i.e., an ontology) for classifying (i.e., a taxonomy) EA functional and non-functional requirements to describe the enterprise's systems. The documented perspective of the EAF emphasizes a high-level, macro-oriented abstraction of the requirements needed for the EA [76][77][91]. The end-product of this effort, an EA Plan (EAP), expresses and details the enterprise's schema used to achieve the desired alignment of business goals and objectives with IT [91]. In essence, the EAP is a knowledge-based, intensive "blueprint" with an assigned task and primary responsibility to formally represent knowledge (i.e., requirements) needed to manage, monitor, govern, and progress the EA alignment process. However, EA goes far beyond just developing and implementing a strategic technology centric business plan [20][91].

1.2 Problem Definition and Motivation

One of objectives for Enterprise Architecture (EA) is organizational transformation [76][82][90]. Organizational transformation means changes to the structure, characteristics, and culture of an organization and, at the same time, alterations to the social, economic, and political environment within the enterprise [81][90][99]. As a result of this transformation process, two outcomes for the EA are possible [90]:

- It can be accepted as the new norm for the enterprise, in which case the enterprise simply moves on.
- It can have a negative effect on stakeholders and be rejected and/or modified to meet their personal goals and objectives.

In this latter situation, the behavior of all involved in the process may be altered, and in some cases, it may literally tear the enterprise apart influencing the potential life of the enterprise by introducing factors into business operations that management may or may not be able to cope [83][85]. As a result, the impact of these outcomes can produce behavioral patterns that can jeopardize the viability of the EA ending with the EA being improperly aligned with the enterprise’s strategic business plan and operating model to either being partially implemented or completely abandoned [95]. The question then becomes: why didn’t the changes brought about by EA work?

Research into the literature conducted into these phenomena leading to this dissertation does not address the fundamental impact that EA has on organizational transformation [87][89][90]. Though the interactions of stakeholders and technology from a technical perspective are adequately addressed, the literature does not offer any solutions for handling of the cumulative effect stakeholder behavior has on acceptance and/or rejection of EA and thus poses the potential for failed EA.

These aspects of organizational transformation and stakeholder behavior must be addressed from a sociologically and psychologically oriented and organizational theory perspective in order to mitigate EA failure. This dissertation asserts and proposes a more effective solution to EA that takes into account the impact of EA on organizational transformation and the subsequent affect change has on stakeholder behavior by proffering a more holistic and humanistic approach to EA.

Specifically, this dissertation’s analysis of existing EAFs (e.g., the Zachman Architecture Framework, The Open Group Architecture Framework (TOGAF), the Federal Enterprise Architecture Framework (FEAF), and the Department of Defense Architecture Framework (DoDAF)) shows that they fail to address questions such as:

- What impact will or does EA have on both stakeholder and organizational behavior?
- How will organizational transformation affect stakeholder behavior?
- How can human behavior be managed to better ensure EA success?
- What employee motivational tools might better serve the organization?
- How best can an EA design achieve organizational goals and objectives?

This dissertation examines the current state of existing EAFs while taking into account the affect EA has on stakeholder behavior and organizational change. The intent of this process is to move stakeholder behavior to the forefront of the EAF process as a first-class design principle in EA design. It also proposes an alternative approach embodying ideas from the *Theory of Structuration*. The focus of this dissertation aims to implement mechanisms that identify early-on potential roadblocks and negative stakeholder input to the design process and define humanistic oriented mechanisms that assist in motivating stakeholder behavior.

The motivation for this research is to focus on the behavioral aspects associated with enterprise transformation taking into account the risks to management and the uncertainties inherent and surrounding the design and implementation of technology-centric processes.

This dissertation asserts that a better approach for EAFs is one which also takes into account the behavior of the stakeholders and the organization as a part of the EA development process. This model focuses on the impact of human behavior as an input to the EA as well as how human behavior is affected by the introduction of new or enhanced technology. We examine Giddens' *Theory of Structuration* and its application in the realm of technology [39][91] as it relates to, and can be used for, EA. The theory describes the interactions and interrelationships between human actors (stakeholders) and structures (organizations) and provides the foundation of this paper. Specifically, this dissertation:

- Examines current EAFs for their approach to stakeholder behavior as an input to, and a reaction from, the development of an EA (Section 2).
- Describes the inclusion of a behavioral and organizational theory, the theory of structuration, as a lens by which the development of an EA can be used to understand the importance of stakeholder behavior (Section 3).

The use of the *Theory of Structuration* as a foundation for examining and understanding stakeholder behavior as an input to, and reaction to, EA is necessary to develop models and approaches for their inclusion into EAFs to promote EA success. Most EA projects fail being either partially implemented or completely abandoned [37][43][44][113]. Answering the questions surrounding the failure and providing solutions, however, is more difficult and complex. Researching and investigating many of the recognized forces that influence EA design from a human behavior perspective and provide recommendations that mitigate these negative influences. The motivation for this research is aimed at problem resolution focusing on the human behavioral aspects associated with organizational transformation that occurs as the result of EA and new technology. The risks to management and the uncertainties inherent and surrounding the design and implementation of techno-centric processes will be explored aimed at using practices and processes from disciplines such as organizational theory, sociology, and psychology to better understand the impact of management and stakeholder behavior has on EA.

1.3 Rationale for Research

Information Technology (IT), represented in its various forms of use, is the single most important influence affecting human behavior on the world stage today [20][21][95]. However, in the business arena, business often moves in directions contrary to its stakeholders (e.g., employees, customers, suppliers, etc.) and, as each moves in their respective directions, so do the desires of business change and its demands on IT [17][91][141]. Technology, on the other hand, can constrain and limit human action by implementing new procedures and subsequent monitoring of human action [20]. Thus, the behavior of project stakeholders, the human actors [20][46][91][95], who have the capacity to act, whether intentionally or unintentionally, at odds with the organizational structure needs to be taken into account [39]. Simply stated, human behavior can act within and for the organization or undercut its policies and procedures.

In the case of EA today, the tool used to progress EA design, an Enterprise Architecture Framework (EAF), focuses only on the relationship between technology and the enterprise value without taking into account non-technical factors which impact and influence the organization (e.g., workforce morale, group size, stakeholder roles, environment, technology task, training of staff, etc.) [20][76]. Over the past twenty-five plus years, many paradigms have been proffered that recommend and support the use of various EAFs to define EA [17][32]. Yet historically, many technology projects whether ascribed directly to EA or to IT fail [36][37][43][44][74][113].

As stated above, separating EA from IT is often difficult because of the different perspectives of both authors and EA/IT practitioners responsible for most of the literature written on technology failures. In some literature, EA specifically is assigned as the cause of failure while in other literature failure is attributed to IT or to information systems (IS) (application development.) Accepting two premises that IT, or IS, is *doing EA* and *did EA cause IT failure* from Section 1.1 above, then failures attributed to IT collectively and/or including IS are also EA failures. Therefore the statistics that follow can be considered as EA failures.

For example, the success rate for many EAs remains small with some statistics placing the success rate between 16% and 29% [43][74]. On the other hand, statistics related to EA failure directly place the failure rate between 66% and 82% in the private sector to over 84% in public organizations [37][39][44][102]. The cost estimates for both EA and IT failure ranges annually into the billions of dollars for all types of organizations with some statistics placing the number into the hundreds of billions of dollars world-wide [43][74]. In the United States alone, the annual cost of EA and IT failure is estimated at thirty billion dollars [74]. In the statistics to follow, EA and IT shall be referred to as *projects* with both EA and IT collectively referred to as *failures*.

The reasons cited in surveys completed by users to determine the cause(s) of failure cite [39][102]:

- Insufficient top-level management commitment and support
- Limited stakeholder commitment to adapt and align to the EA
- Inadequate stakeholder awareness of EA requirements
- Failure to recognize internal and external economic and political factors that prevent EA development and implementation
- Lack of adequately estimation of the time required for EA design and implementation

Adding to this list are other studies that cite human behavior in one manner or another as the leading cause of failure. Statistics supporting this last claim finds failure to be related to and characterized by the following issues and concerns [39][43][74]:

- Sixty-six percent of project failures are attributed to poorly defined applications (i.e., miscommunication between stakeholders and IT technical staff).
- Sixty to eighty percent of projects fail because of poor requirements gathering, analysis, and management

An analysis of these failures found that [74]:

- Fifty percent of the projects had to be rolled back out of production
- Forty percent of the problems were found by end-uses
- Twenty-five to forty percent of project cost was wasted on re-work
- Eighty percent of budgets were consumed on fixing self-inflicted problems

This latter group of statistics is staggering and supported by other literature detailing the cause of failure to be directly related to erroneous requirements (organizational knowledge) [37][39][44][113], which we will collectively label hereafter as simply “poor architecture”.

As can be seen, many businesses experience the loss of large sums of money as the direct result of failed EA and/or IT. Unfortunately, technology failures can lead to managerial sinkholes from which some organizations can’t or don’t have the resources from which to recover. In some cases, the failure of EA causes a ripple effect throughout the organization negatively affecting the implementation of other information technology projects.

The existing approach to EA design utilizes tools identifying work-related tasks as *processes* with relevant organizational knowledge (explicit and implicit/tacit knowledge), the foundation providing the input driving task-oriented operational procedures. Included in EA design are the business goals, strategies, concepts, systems, technology, people, and methods that facilitate management and governance of the multiple aspects of the organization [19][39][91][109][141]. The emphasis of the various EAFs focuses on analyzing these components from a mechanistic technical perspective to better understand the cross-cutting relationships between these concerns [4][7][30][109][141]. Herein lays one of the major deficiencies in the current approach to EA – the EAFs used to design the EA and the modeling techniques used to verify and validate EA requirements collectively fail to recognize the importance of human behavior and organizational change in the design process [87][89].

This dissertation asserts that the interactions of the human resources involved in EA (i.e., the stakeholders and their behavior) play a critical and pivotal role in the success or failure of EA, especially in the planning and data gathering (i.e., requirements elicitation) phases of design and development. From this perspective, the impact of EA and technology on human behavior is viewed as an exogenous force which can either facilitate organizational goals and objectives or limit and constrain human action by implementing new processes and procedures and subsequent monitoring of human action [20].

Theorists posit that the interactions of stakeholders and technology results in reactive behavior accompanied with tendencies and moves towards a stable environment. In effect, organizational behavior tends towards an operational state where inputs, outputs, and internal processes are all stable. This behavior can be seen in how [20][39][53][83][85]:

- The parochial self-interests of the stakeholder are served
- People behave in groups
- Individuals behave within the institutionalized organizational environment
- Group members influence each other
- Communication takes place within the group
- Business strategies and structure influence the group
- Organizational objectives serve the group
- Groups can be managed to achieve organizational goals and objectives

These activities influence and reflect the institutionalized policies, rules, practices, and behavior of the organization (i.e., organizational norms) [20][23][95] accompanied by changes in management behavior and attitudes which may be positive or negative in practice [46][53][58][83][84][85].

The new processes and procedures introduced into the workplace by EA typically replace the previously accepted organizational norms with new ones. With this transformation, stakeholders must learn how to interact with the new technology and the assignment of new roles, duties, and responsibilities. The interaction described here between stakeholders and technology is not to be confused with the typical human-computer interface behavior system often described in much of the IT literature but one associated at the human behavior level. Thus organizational transformation, by its very nature, alters the social structure within the enterprise changing the status and/or position of stakeholders [23] in which they may perceive as a diminution of power and influence within the workplace. From this point of view, we can posit organizational change as emerging from an unpredictable interaction between technology, as a result of an introduced EA, with new emotions and feelings (i.e., behavior changes) exhibited by stakeholders who strive to maintain a state of equilibrium and homeostasis in their work [20][21][99].

Where technology is involved, user behavior often reveals itself in the way in which the technology is presented [20][95]. For example, if the technology is introduced unexpectedly and without any input from or concern about stakeholders, it then may be either accepted or rejected by those involved in the technological transition [39][76][83][85][95]. When change is unexpected, user resistance to the technology can be considerable [9]. We can conclude that the manner in which the EA design effort is supported and deployed by a development methodology (in the case of EA an EAF), as well as the design and implementation approach taken by organizational management significantly affects how stakeholders perceive and behave during the EA design process [20][46]. Consequently, user behavior should be viewed as the result of, and due to cognitive processes learned resulting from experiential organizational behavior and their ability to adapt to a changing environment which would in turn affect their respective future capacity for handling and accepting change [20].

The behavior displayed is often in defensive routines and mechanisms such as stakeholder attempts to deceive, manipulate, or distort information during the EA design process [83][85]. Therefore, user behavior becomes a critical and potentially costly component to EA affecting project success and/or failure with a need to mitigate stakeholder and organizational resistance to change and their respective attitudes towards new technology [23][95].

Unfortunately, a balanced or stable state is often difficult to achieve when change enters the workplace. Human behavior may vacillate between planned offensive human action (i.e., resisting change) and reactive moves (providing erroneous information to the EA) to maintain balance [12][17]. Thus, the behavior of project stakeholders, the human actors, who have the capacity to act, whether intentionally or unintentionally, at odds with the new organizational structure must be taken seriously into consideration during EA design. Simply stated, human behavior can act within and for the organization or undercut its policies and procedures by being more interested in their own self interests with their own set of goals and objectives rather than in those of the organization [89]. Given this premise, changes in attitude and behavior towards EA and the organization should not be unexpected or discounted but should be anticipated and therefore planned for.

Assessing the number of EA and subsequent IT failures finds most are directly attributed to some form of breakdown in communication between enterprise stakeholders. It is clear that user acceptance of EA plays a crucial role in successful deployment of EA and therefore must be taken into account during the entire EA lifecycle. Following this line of reasoning, this dissertation explores two critical stakeholder influences on EA:

- They may resist the EA either overtly or covertly by exhibiting their reluctance to follow new norms, rules, and policies established by the enterprise.
- They may intentionally or unintentionally miscommunicate, mislead, and/or provide erroneous requirements as input to and thus sabotage the EA.

In either case, the EA may be jeopardized such that the enterprise reverts to the previous architecture and therefore new approaches to EA are needed that include human oriented and motivational processes to ensure stakeholders "buy in" and are part of the design and decision-making EA processes.

1.4 Scope and Domain of the Dissertation

Enterprise Architecture (EA) lies at the top layer of requirements engineering with the measure of success being the degree to which it meets the purpose for which it is intended [39][72][94]. In the development of an EA, the concentration of work focuses on developing and documenting an EA Plan (EAP) [7][91][109][141]. The EAP details and encapsulates the functional and non-functional requirements at a high-level, macro-oriented abstraction. These requirements then drive the architectural design, alignment, implementation, and deployment of new and/or enhanced technology represented by EA [76][91]. Thus, the elicitation of stakeholder requirements play a critical role in defining EA and it is here where the first fine line between success or failure of an EA is created.

In the same context, organizations invest a significant amount of enterprise resources (i.e., time, money, and people) to progress the work involved in formulating and implementing the EAP [20][58]. EA however, introduces new processes and technlogy into the workplace and as a result causes a transformation of the organization's structure, characteristics, culture, and political environment as well as the surrounding social structure with new roles, duties, and responsibilities assigned to stakeholders [20][23][95]. This transformation frequently causes changes in stakeholder perceptions, attututes, and behavior towards the enterprise and the technology proposed by EA [12][86]. In this setting, stakeholders continually co-evolve, adapting to, and making sense of, the new environment while assesssing and determining their reaction to and their future actions towards change [57][58]. Given this point-of-view, the unpredictable nature of human behavior is frequently demonstrated either intentionally or unintentionally, covertly or overtly in uncertain, indeterminate, and ambiguous actions [23][55][76]. For example, organizational change coupled with new emotions and feelings on the part of stakeholders can be tied to the impact of new technology caused by a perceived diminution of stakeholder influence within the enterprise producing behavioral patterns that may not be in concert with organizational EA goals and objectives [58][83][85]. These behavior patterns can constrain stakeholder action, stifle innovation and creativity, and affect the quality of requirements provided by stakeholders.

Unfortunately, human behavior, is frequently overlooked and/or minimized by both EA management and Enterprise Information Architects (EIA). Yet, human behavior is intrinsically and extrinsically intertwined with the technology introduced into the enterprise by EA [95][97]. Thus, a second line between EA success or failure is created.

This dissertation investigates two issues:

- The elicitation of stakeholder requirements
- The organizational transformation that takes place resulting from new technology, and analyzing the impact human behavior has on each.

The study of EA and the causes leading to failure provide an opportunity to explore other disciples such as sociology and organizational theory to formulate potential solutions to the problems that adversely affect EA design and implementation. Analyzing the effect on human behavior caused by EA poses an issue of high relevance to EA management and in how EIAs do their work [99]. Typical stakeholder questions to be expected are:

- Why do we need to change?
- What kind of change can be expected?
- When will the change occur?
- How will the change affect the stakeholder?
- Will the change take place gradually over time or implemented at one time?

The answers to these questions seem easy, but more likely lie in the manner in which the EA is planned, managed, and governed. The organization of this dissertation defines the scope, boundaries, and the domain of the research as follows.

This dissertation does not provide an in depth analysis of the technical merits of any EAF or modeling scheme as we consider them sufficient to handle the technical aspects of EA. Our research is limited strictly to the value of both EAFs and modeling tools and techniques in recognizing human behavior as it relates to EA design and organizational transformation.

Chapter Two describes the early history behind EA highlighting several of the causal factors related to EA failure. An analysis of existing Enterprise Architecture Frameworks (EAFs) presently used in EA is provided detailing their respective strengths and deficiencies as they relate to human behavior and EA. The current EAF processes vary in their recognition of the significance stakeholder and organizational behavior have in developing the EA Plan (EAP) [116][120]. The EAFs either cursorily address or completely avoid the issue (see Table 2).

Our primary interest, and around which our research is based, is on human behavior and how the impact of technology and organizational transformation affects stakeholder performance and contribution to large-scale, complex information technology (IT) projects. This dissertation asserts that the failure to include human behavior as a key ingredient and input to EA design seriously jeopardizes the probability of the project being concluded successfully. Chapter Three details related research literature to support the theses presented in this dissertation.

Anthony Giddens' *Theory of Structuration* is the supporting catalyst for analyzing human and organizational behavior in EA design and implementation. Chapter Four describes the application of this theory to IT and specifically to EA. Wanda Orlikowski offered the *Structuration Model of Technology* (SMT) incorporating ideas from the

Theory of Structuration providing a cross-cutting link between technology and human/stakeholder/actor behavior. Orlikowski's work addresses technology specifically and contextually in how stakeholders create, use, and modify technology to satisfy their own personal goals and objectives. This dissertation explores the coupling of Giddens' *Theory of Structuration*, SMT, and other sociological, organizational theory, and management behavior principles and practices to either improve existing EAFs or to develop an ancillary process that better ensures EA (and IT) success.

Modeling approaches assist in assessing the veracity of the requirements, systems design, and systems interface issues related to EA. It provides a process that allows the analysis and design of an enterprise in it's *as is* state and it's *to be* state from a strategic, organizational, and technical perspective. Chapter Five examines several modeling schemes to assess their viability, as they are currently constituted in handling an EA design from a human behavior perspective. Like the EAFs analyzed in Chapter Two, a comparison is made between various modeling schemes with one potential candidate identified, i*, that might be applicable to this study. The i* modeling scheme approaches stakeholders from a *dependee* and *depender* perspective and requires more analysis to ascertain its use as a means of addressing human behavior in the EA design process.

Chapter Six explores the use of a sociologically-oriented approach to EA design based on a proposed framework that incorporates a socio-communications channel that fosters and encourages a participative effort for development of an EA. The process includes a mechanism for ensuring verification and validation of design requirements thus ensuring EA design quality.

Chapter Seven concludes this dissertation and preliminary work towards a more holistic and humanistic approach to EA design. Included in this chapter is a brief discussion as to the future work and planned research.

1.5 Dissertation Goals and Objectives

The questions that plague the EA community today are analogous to the questions that initially were asked in the 1950s regarding systems design and software development [3][23][118][127]:

- Why does it take so long to develop and implement an EA?
- Why are the development costs so high?
- Why can't all of the errors be identified and corrected before the EA is implemented?
- Why does the cost to maintain the solution have to be so high?
- Why do we have difficulty measuring progress during EA design and implementation?
- Why was only part of the EA implemented?
- Why did we have to abandon the EA?

Answering these questions is difficult and complex - often surrounded by ambiguities associated with unrealistic deadlines, inadequate technical staff, poor stakeholder training and education, and misunderstood or miscommunicated stakeholder requirements. A more realistic approach investigates all of these issues adding at least one more concern: human behavior.

First, EA has become a large and dominant force in the economics of the industrialized world extending to both the private and public sectors of enterprise [9][15].

Second, the aim of Enterprise Architecture (EA) is the production of quality information technology (IT) architecture, application systems, and subsystems that are delivered on time, within budget and that satisfies stakeholder requirements [109][141]. Third, a variety of techniques and tools, frameworks, have been developed for performing the various architectural production tasks from defining stakeholder requirements and specifications to implementation, deployment, and maintenance [39][47][91]. Fourth, EA embodies the business objectives, processes, and technology infrastructure reflecting the desired incorporation and standardization requirements of an enterprise's operating environment [62]. Fifth, EA represents organizational transformation to improve operational efficiency and effectiveness.

In the case of EA today, the tool used to progress EA design, an Enterprise Architecture Framework (EAF), focuses only on the relationship between technology and the enterprise value without taking into account non-technical factors such as human behavior which impact and influence the organization (e.g., workforce morale, group size, stakeholder roles, environment, technology task, training of staff, etc.) [20][76].

This dissertation suggests a different and/or complimentary approach to EA design that explores and incorporates stakeholder behavior as a significant part of the EA design process. This approach encourages use of an EA framework (EAF) that includes the integration of aspects of organizational theory, management theory, sociology, and psychology with the traditional computer-oriented and computer science theories of enterprise engineering, software engineering, requirements engineering, and enterprise modeling. The projected outcome from this effort includes a more holistic approach to EA design and implementation. Our continued research into the study of human behavior on IT, specifically EA, projects is focused on a more holistic framework that takes into account the:

- Behavior of the stakeholder and the organization as a part of the EA development process
- Impact organizational transformation caused by EA has on stakeholder behavior

The paradigm for the framework model focuses on the impact of human behavior as an input to EA as well as how human behavior is affected by the introduction of new and/or enhanced technology into the workplace.

The work contained in this document is only the beginning of an effort to research and work towards a better way to progress EA design and implementation. It contains portions of earlier research into the formulation of a more holistic EA framework that takes into account human behavior as a key element guiding EA design [87][88][89]. The expected outcome from this dissertation establishes, as a first step, the preliminary elements that will be used to build and define a more effective Enterprise Architecture Framework (EAF). The proposed framework is threefold and includes the use of:

- Sociologically-oriented principles and practices
- Aspects of organizational theory as it relates to organizational transformation and behavior
- Traditional technically oriented software engineering and requirements engineering methodologies

We believe the use of an interdisciplinary EA framework potentially negates adverse stakeholder behavior towards organizational transformation and thus reduces the likelihood of erroneous design requirements entering and affecting the overall design of the EA. The expected benefits to be derived from this approach are:

- A reduction in time, effort, and resources expended to accomplish the EA
- Stakeholder acceptance and ownership of the EA
- Increases in stakeholder productivity and organizational efficiency brought about by the EA and subsequent organizational transformation
- Alignment of the organization's IT component and capabilities with its strategic business plan and operating model

EA uses a number of tools such as EA frameworks to identify and define work-related tasks or *processes* predicated on organizational knowledge obtained from enterprise stakeholders [87][91]. The definition and refinement of those requirements over the EA and subsequent IT development life-cycle form the foundation and the input upon which EA task-oriented operational procedures are developed and implemented [30][41][59]. Included in EA design are the business goals, strategies, concepts, systems, technology, people, and methods that facilitate management and governance of the multiple aspects of the organization. The emphasis of the various EAFs focuses on analyzing these components from a mechanistic technical perspective to better understand the cross-cutting relationships between these concerns [4][7][109][141]. Herein lays one of the major deficiencies in the current approach to EA – the EAFs used to design the EA and the modeling techniques used to verify and validate EA requirements collectively fail to recognize the importance of human behavior in the design process [87][89].

Stakeholders play a vital and pivotal role in the success or failure of EA. The behavior and the interrelationships between stakeholders becomes especially important in the planning and data gathering (i.e., requirements) phases of EA design and development. If we accept the premise that IT is *doing EA* then the output from EA design is crucial to IT, and consequently IS. This dissertation asserts that the impact of EA and technology on human behavior represents a force that can either facilitate organizational transformation or limit and constrain human action And therefore must be recognized and planned for in the EA design process [20][89][95].

Chapter Two – Enterprise Architecture

The primary aim of Enterprise Architecture (EA) is to organize into a single, easy to understand, coherent, and neatly documented EA plan (EAP). The EAP then describes the systems, subsystems, resources, and infrastrcuture that provides easily accessible information to the right people with processes and information system (IS) applications at the right time throughout the enterprise [9][22][92]. The purpose and intent of this effort is to align the enterprise's strategic operating plan with its information technology (IT) capabilities [91][109][141].

However, in the world of IT of which EA is a part, a perfect world does not exist. In fact, the complexities and intricacies associated with EA development crosses many interdisciplinary boundaries of IT with ambiguous and conflicting knowledge used to focus on selective aspects of technology at the expense of others [20][95]. As a result, many EAs fail in one manner or another causing an inordinate expenditure of enterprise resources in correcting partially implmented solutions and/or, in the worst cases, either abandoning or completly reworking the project.

The causal reasons for EA failures are many, ranging from complexities found in the interactions of technology to the tools (i.e., frameworks, models, software, processes, etc.) used to transform collected data into information [36][71][95]. However, part of the problem lies in the non-technical factors underlying EA, such as stakeholder behavior and their interaction with and reaction to technology [20][95]. The strictly techno-centric approaches existing EA frameworks (EAF) take in progressing EA design fail to take into account, and plan for, the impact technology has on human behavior and the organizational transformation that inevitably follows the introduction of an EA into the enterprise. Stakeholder behavior, in this context, may be either positive or negative and exhibited by stakeholders either overtly or covertly throughout the EA effort. This dissertation's analysis of existing EAFs shows that they fail to answer questions such as:

- *What impact will or does EA and new or enhanced technology have on both stakeholder and organizational behavior?*
- *How can human behavior be managed to better ensure EA success?*
- *How best can an EA design achieve organizational goals and objectives?*

The answers to these questions form the basis and foundation for the research discussed in this and the following two chapters in this dissertation.

In this chapter, the continuing emergence of EA that began in the late 1980s and continuing through today is described, focusing on several popular EAFs used to develop the EA design plan (EAP). This dissertation specifically examines the existing EAFs to assess those non-technical issues and concerns related to human behavior that might negatively affect EA design and implementation and thus potentially jeopardize the EA. This dissertation looks at non-technical issues such as the misunderstandings and miscommunications that frequently takes place between stakeholders and technical staff and the organizational structure, culture, politics, and social issues,that affect EA development [23][95]. The focus of the work in this chapter is on the impact of and the interaction of human behavior with technology and how existing EAFs deal with the complexities associated with stakeholder behavior.

2.1 The Emergence and Evolution of Enterprise Architecture

From its earliest beginnings in the late 1980s, the impetus behind Enterprise Architecture (EA) has been to formulate and postulate a unified approach to information technlogy (IT) design and implementation (i.e., standardized hardware and software systems) across an enterprise and all of its divisions, subdivisions, subsidaries, and any other enterprise entity that share the financial interests [91][140]. The premise of EA is to establish an organizational and IT strategic business plan and set of objectives, practices, rules, and policies that promotes the standardization, resue of existing IT assets, and common processes and procedures that align business goals and objectives with organizational IT capabilities (see Figure 3) [7][30][91][109][142].

Since its emergence, EA design has focused on the use of techno-centric processes and procedures encapsulated within a framework, an EAF, to produce a plan, an EAP, or "blueprint" that embodies and describes an "architectural view" of the business objectives, processes, and technology infrastructure needed to support organizational business operations [78][91][140]. In IT, EA represents two apsects of the organization [9][39][91]:

- The "*as is*' or existing technology and organizational environment
- The "*to-be*" or target architectural solution that translates business strategy into efffective and efficient organizational transformation

Progressing this theme, ANSI/IEEE 1471-2000 defines the standard for the "architectural view" for both business and IT systems as "'the fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution" [127].

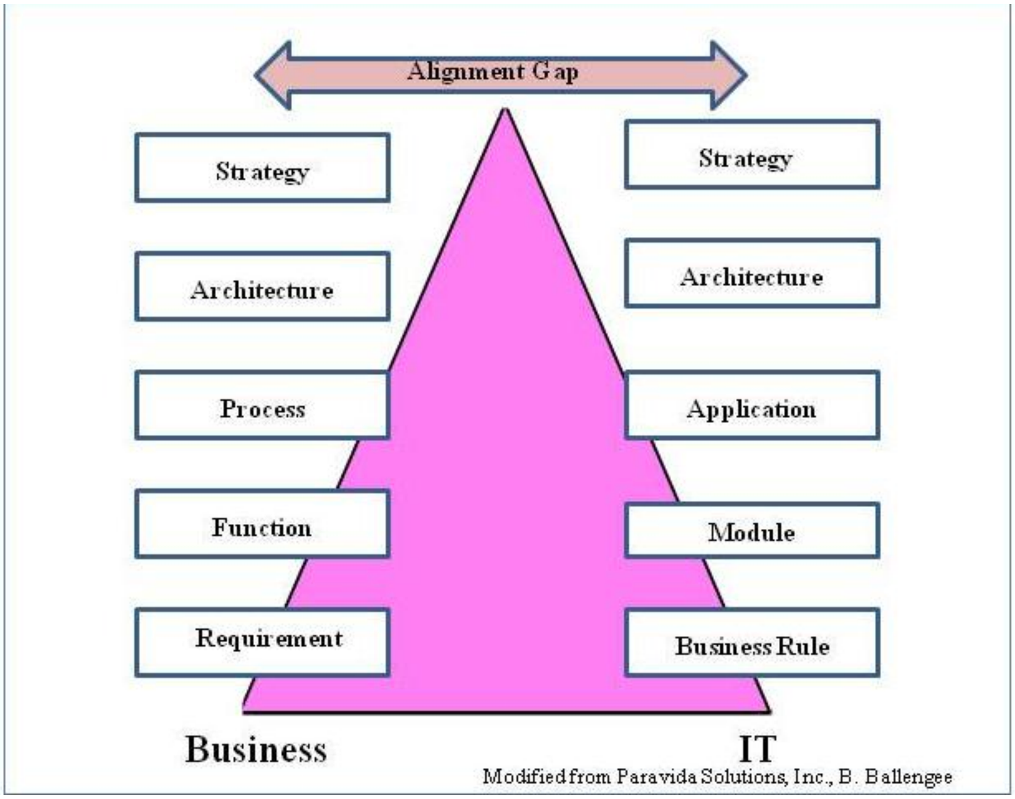

Figure 3. The Business and Information Technology Alignment Process [18]

Most literature on EA development typically focuses on the technical aspects of design, describing software engineering and requirements engineering conceptualizations for enterprise engineering schema and engineering models to achieve EA design and implementation goals and objectives [38][61][71]. This usually means defining the hardware, software, and infratrsucture (i.e., platforms, support, resources, tasks, procedures, etc.) required for the project [18][30][91][117]. Collectively, the EA process aims to develop and integrate consistent business and IT systems that work together, collaborate, and cooperate where and, when appropriate, providing the impetus for productive activities in the organization [8][22][61]. From the stakeholders perspective, the desired product of EA is usefulness and ease-of-use [20][30][88]. However, the process is grounded in a disciplined regimen of computer science and computer-oriented technical theoires, concepts, principles, and practices from the past extending back to the 1960s [23][89][95].

2.1.1 A Historical Perspective of Enterprise Architecture

Early software engineering principles and practices originated in the early 1960s, first with formalized processes and procedures advocated for systems design and analysis [118]. Peter Naur followed in 1968 coining the term *software engineering* at a NATO conference in Garmisch-Partenkirchen where he pointed out that software development should follow the engineering paradigm [118][128]. In 1972, E.W. Djikstra introduced “structured programming” followed by a plethora of other literature on programming and design methodologies and database implementation [41][116][127]. Literature published in the mid-to-late 1970s introduced project management, user requirements, requirements engineering, and description methodologies into and enhancing the IT design and development world. Literature in the early 1980s introduced prototyping and various schemes to model software with the ISO and Bell Labs promulgating industry standards for software development [14][28][47][61]. Into this mix in 1987, Zachman introduced an early form of Enterprise Architecture with his article “*A Framework for Information Systems Architecture*” [140].

From this beginning, EA continues to evolve such that it now has become the de facto standard for the abstraction and documentation of the top hierarchical layer of design and implementation requirements used to develop large-scale complex IT business solutions (i.e., projects). In it’s simplest form, EA postulates a methodology for capturing knowledge about and documenting an organization’s plan to implement new and/or enhanced information technology (IT) [120]. Usually ascribed to large-scales complex IT applications, the scope and magnitude of an EA project may range in size from an enterprise-wide strategic information system (IS) erncompassing all aspects of the organization's information and technology needs to one limited in scope and directed at a specific domain and IS application [87][91]. When it works well, the benefits derived finds a more effetive utilization of technology and therefore is an invaluable organiztional asset. When it doesn't, which is more often the case than not, it becomes a drain on organizational resources with the potential to seriously jeopardize organizational stablility and business operations [36][43].

Defining an EA is a complex process, regardless of the scope and magnitude as its introduction impacts on and transforms the character, culture, and structure of the entire organization [20][90][95]. Today, EAs are simply technical "bluerints" for systematically and completely defining enterprise artifacts and information, platforms, software applications, and business and strategy that describe an organization's current baseline or "*as-is*" and its desired target or "*to-be*" environment [11][77][91][128]. As a high-level form of requirements engineeering, EA depends upon the elicitation and validation of design requirements/artifacts provided by stakeholders. However, EA goes far beyond just developing and implementing a strategic techno-centric business and IT plan in an organization [20][91]. It also changes the organizational character, structure, and culture of the enterprise [20][90].

More important, and yet often forgotten in the process, is the impact of techology on the social and political structure of the enterprise with changes to stakeholder roles, duties, and responsibilities. These changes coupled with new technological processes and procedures transforms the overall operating environment of the enterprise and as such affects how stakeholders are motivated towards and committed to acceptance of the EA [80][88]. These issues are addressed in depth in Chapter Three as they are the focus of this research.

2.1.2 The Causes of Enterprise Architecture Failure

Historically, many large-scale complex IT projects, such as EA, fail often being delivered both late and over-budget [18][33]. The causal factors usually center on one or more information system's (IS) failure to deliver what was expected, needed, or desired by stakeholders [43][74]. As a result, the IS(s) is/are never used to their full potential effectiveness for the purpose(s) they were intended and therefore fail to meet organizational goals and objectives establisehed for the project [44][74][113].

Though a simple single answer and solution to these problems is tragically not available, we know, based on the preponderance of reseacrh literature available, that a major contributory factor points directly at the requirements provided by stakeholders as input to the EA [74][113][127]. Table 1 contains our analysis of the roles stakeholders play in defining EA requirements extraccted from and based on the following EA and IT literature [8][39][41][60][91][106][116]. The table highlights several non-technical issues and concerns (factors) that underlie the dynamics associated with the process [88][95]. First, EA is about deliverables. This includes assets such as: business information plans; assessment of existing application systems (the "*as is*" environment); pricniples, practices, and standards of the IT component; application migration plans (the "*to be*" target environment); business process analysis; business and application process models; etc., must be clearly defined and described at various layers of abstraction (see Figure 1). At each layer, the requirements must define, in understandable language, the services that are to be delivered and the constraints the organization is to expect as a result of EA [4][7][91][106]. Common problems and risks associated with these types of requirements are [39][41][127]:

- They do not reflect the real needs of the stakeholder. From a technicians technical perspective, the stakeholder doesn’t know what they want.
- They are inconsistent and frequently incomplete. Technicians and stakeholders don’t speak the same language. Non-technical stakeholders express their requirements in their own terms while technicians lean more towards bits and bytes.
- There are conflicting requirements between stakeholders. Different sstakeholders have their own set of requirements that may differ from other stakeholders. This highlights the need to negotiate and compromise.
- The target keeeps moving. Governmental regulations and compliance demands and/or changes caused by economic conditions or business competition requires design requirements to be re-worked. This requires proper requirement management and control processes be implemented.
- The misunderstanding and miscommunication that takes place between non-technical and technical stakeholders (e.g., Enterprise Information Architect(s) (EIA), Project Managers, Systems’ Analyst, Programmers, etc.).

Second, EA represents the alignment of the strategic business plan and operating model with the organization’s IT capabilities and IT component(s) (see Figure 1) [91][109].

Stakeholder	Influence on Project	Rationale
Top-Level Management	Responsible for the business entity. Top-Level decision-maker. Final sign-off on EA deliverables.	Establish organizational goals and objectives. Define Strategic Business Plan.
Middle-Level Management	Responsible for day-to-day business operations, Sign-off and acceptance of stakeholder requirements.	Provide input to Strategic Business Plan.
End-User	Describes System/Subsystem Design requirements. End-user of EA applications. Resistance to change.	Organizational knowledge. Explicit and tacit system and subsystem requirements. Usefulness of technology and ease of use.
CIO/IT Management	Responsible for organization's IT facility.	Plans alignment of organization's strategic business plan and IT capabilities.
Enterprise Information Architect (EIA)	Responsible for overall project direction and project deliverables.	Business acumen and technical knowledge. Overall project delivery.
Project Manager	Responsible for system and subsystem project management .	Project team and project assignment supervision.
Systems Development Staff	Responsible for completing system and subsystem software development.	Detail system and subsystem design. Software development, requirements validation, and implementation.
Technical Support Staff	Responsible for infrastructure (hardware, platforms, etc.) maintenance and installation support.	Knowledge of technical capabilities.
Operations Staff	Responsible for performing IT operations.	Operational efficiency, ease of use, and effectiveness.

Table 1. Stakeholder Influence on Enterprise Architecture

The reality of this effort finds projects taking longer than expected to complete and/or being either partially implemented or completely abandoned. The consequence of this reaction to EA often times affects the development of other IT projects, a ripple effect throughout the organization. These issues include:

- The cost to change misunderstood and/or miscommunicated requirements after they have been agreed-upon by stakeholders is expensive.
- The method of managing and controlling requirement change processes is difficult to implement.
- The time to make a change after the requirement has been agreed-upon, designed, and developed delays project completion.

Third, the complexitites of a single application and/or the integration of and with multiple systems and subsystems, size of applications, the organizational culture and environment, and the moving target of business underlie the factors influencing EA design [9]. These factors focus on:

- Changes in organizational structure, business environment, and organizational politics.
- Requirements that change both during the analysis process and over the life cycle of the project.
- Changes to and/or new stakeholders may change system requirements.

Unfortunately, mitigation and management of these aspects of EA have remained primarily technically oriented with little or no attention paid to human behavioral issues related to EA. Literature on the topic posit solutions predicated on various technical approaches to software engineering, requirementes engineering and other related IT engineering frameworks and modeling disciplines [22][41][106][127]. The recommended solutions in the literature seek to augment and enhance existing EA frameworks with new techno-centric automated solutions for design, development, and implementation of enterprise-wide business software solutions [25][47][63][78].

In today's economic environment, organizations recognize technology as driving business and allowing it to function competitively in its industry and, in some instances, in a larger global economy [32][61]. However, technology can also tear apart a business by transforming the structure of the organization, changing its behavior as well as that of its management, stakeholders, and thus altering the way it reacts to changes in business and to changes in the larger global world-wide economy [17][20][95].

2.2 The Rationale for Enterprise Architecture

Enterprise Architecture (EA) reflects an approach towards the desired incorporation and standardization requirements of an enterprise's operarting environment [91]. The target aims to achieve optimal performance of its core business processes with an efficient, enterpirse IT architecure [11][62]. In this context, EA defines the overall form and function of business and information technology (IT) systems across an enterprise [91][109][140]. As such, enterprise consists of organizational divisions, subdivisions, subsidiaries, and other entities that share the same financial bottom-line providing an "architectural view" and a framework with a set of standards and guidelines for systems development [90].

The process allows EA to be decomposed into fundamental architectural elements or components from which IT application systems and subsystems (collectively systems) can be constructued and deployed [7][41][127]. Given this perspective, EA then depends upon the type of system to be designed and developed and the design artifacts and requirements used in the process. Viewed from an architectural perpsecitve, EA is the top hierarchical layer leading to IT development. EA at this level is purely structural constituting the knowledge infrastructure of the enterprise [142].

EA literature differs somewhat on the strata the makes up EA [6][8][91][109]. However, all of the literature include views of EA based on at least four primitives: business, data/information, technology, and application [91][109]. From this top kayer, other layers, levels, or views such as a Domain and Application (i.e., solution) of abstraction can be developed from which design "viewpoints" [109] can be abstracted to simplify the complexity of the EA solution process [5][7][109][141].

Literature on this topic typically focuses on a top-down or hierarchical structure that resides at three primitives or layers of abstraction and design (see Figure 4) [78][106][127]. In the literature, the name assigned to each layer varies and therefore we shall describe the layers for the purpose of this dissertation as:

- An Abstract Enterprise View (AEV)
- A Domain View
- An Application System and Subsystem View

Each layer (view), beginning at the top and continuing down, refines the requirements artifacts and abstractions from the layer above moving towards the desired EA design [61][106][127]. Acronyms on this aspect of EA varies in much of the literature available depending on the source and/or author. Therefore, the acronyms as defined in the following paragraphs will be used thorughout the remainder of this dissertation.

At the Abstract Enterprise View (AEV) (in [7] this view is referred to as the *Enterprise Architecture Level*, in [78] it is referred to as the *Project-Level Architecture*, and in [106] it is called the *world view*), a conceptual model of the complete system is defined where major components of the EA are represented. At this level the scope of EA is directed at the organization/agency providing a macro or low level of detail focused on strategic outcomes [7]. At this level, artifacts such as data objects, processing functions, and behavior, not to be confused with human behavior but that specifically that of the human-computer interface and software behavior, are detailed without regard to the lower-level system components [7][61][106][127][142]. It is at this layer where the general conceptualization model of the EA is defined. This layer would also detail the non-functional (NFR) requirements for the EA such as: security, scalability, reliability, maintainability, etc.

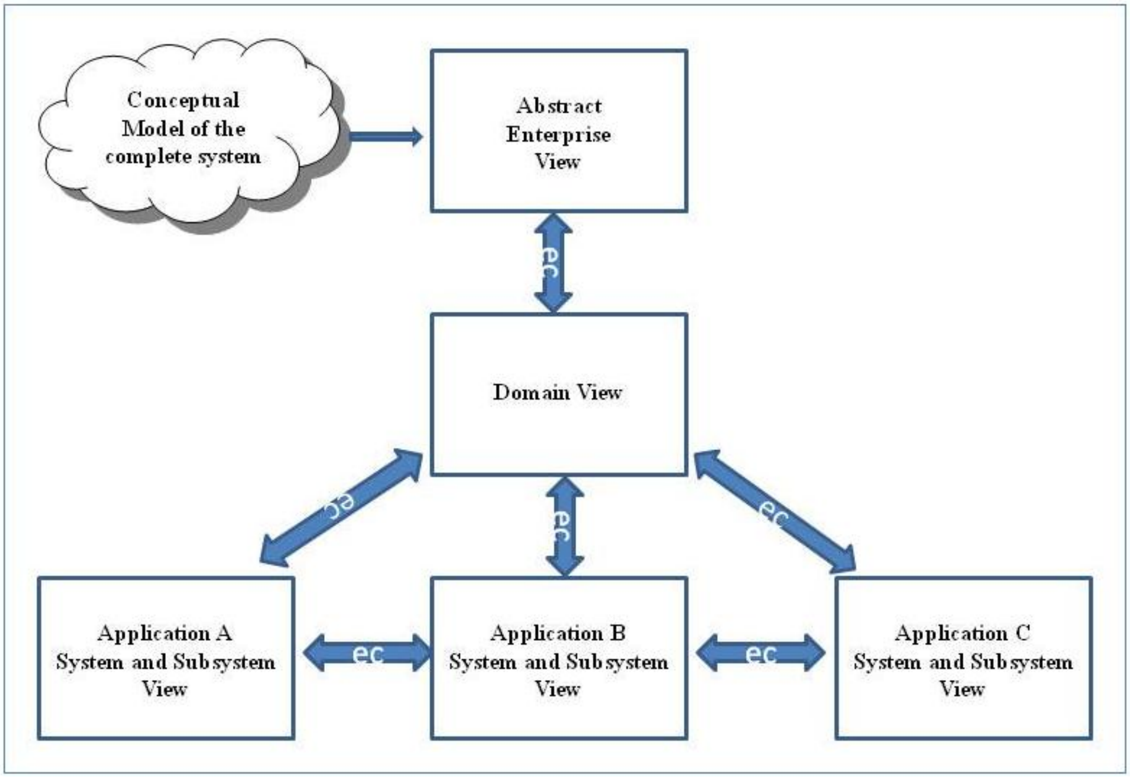

Figure 4. The Three Views of Enterprise Architecture

At each of the subsequent two layers, the Domain View (in [7] this is referred to as the *Segment Architecture*, in [106] it is referred to as *product line engineering*) and the Application Systems and Subsystem View (in [7] this layer is referred to as the *Solution Architecture*), the degree of detail becomes more specific with the Application Systems and Subsystem View transforming the requirement and describing it as a technical specification for software development [78][106][127].

For example at the AEV, requirements set out and describe the essential and, perhaps, desireable properties of the EA at a macro and high-level of abstraction (low-level of detail) [7][61][91][127]. The scope of the Domain View is directed at the specific line of business and reuses domain knowledge to define how system and subsystem behavior, interfaces and integration will be handled [7][30][61][106][128]. At the Application System and Subsystem View, the scope is directed at the functional processes and the high-level of detailed requirements/specifications needed to support application software development [7][61][106][128]. Though not profferred in any available literature, we believe some EAs may have to defined in a fourth, fifth, or sixth layer of abstraction depending on the complexity, scope, and magnitude of the project.

Given this perpsective, EA approaches the alignment issue from two diverse and distinct points-of-view [91][109][141]:

- Business strategy, goals, and objectives
- IT strategy, goals, objectives, and capabilities

Traditional approaches to business strategies, goals, and objectives often use a top-down view of the enterprise in terms of people, groups, entities, and resources [121]. In this context, resources and entities represent the available pool of organizational skills and capabilities the organization can or is willing to contribute to the EA. People and groups on the other hand, specifically stakehoders, explicity or implicitly establish the shape and direction of EA providing the requirements first for the AEV and then the latter Domain and Application Systems and Subsystem Views [22][28][118][127]. Thus stakeholders make or direct the fundamental feasibility, characteristics, functionality, operation, and eventual structure of the EA.

It follows that if an EA does not meet stakeholder expectations providing usefulness, ease-of-use, and desired deliverables, it cannot and will not be considered a success no matter how well it conforms to good design practices. Putting this into proper perspective, EAs are created specifically to meet and satisfy stakeholder needs. However, IT strategy, goals, objectives, and capabilities are contained and typically constrained within software development methodologies and software engineering principles and practices which tend to focus on the specific technical functionality required to automate a task [32][50][78]. From a strictly technical perspective, the existing approaches to EA are comprehensive from this point-of-view. The processes, interactions with other systems, and business strategy are considered more important than the human behavioral aspects of EA are considered less important [78].

2.3 Enterprise Architecture Development and Frameworks

Enterprise Architecture (EA) primarily focuses on a macro-oriented, high-level abstraction of design artifacts and stakeholder requirements, as defined in Section 2.2. It represents “the organizing logic for business processes and IT infrastructure reflecting the integration and standardization of requirements of the company’s operating model” [80][91]. Towards the desired operating efficiency and efffectivesess, EA serves as the first step in a continuing process of collecting organizational knowledge about an enterprise’s [4][7][42][142]:

- Structure
- Business practices and models
- Business processes and software applications
- Systems, integration requirements, functional and non-functional requirements, and supporting infrastructure necessary for information systems design and implementation

In today's economic and competitive business environment, EA illustrates a living and continually evolving dynamic process aimed at improving operational efficiency and effectiveness which are indispensible if an organization plans to remain competitive [91].

In EA, architectures define the structure underlying the technological solution to a particular business problem. The tool used to arrive at an architecture, a framework or EAF, describes and defines how to organize and catalog the structure, requirements and design perspectives (i.e., views) of the EA. EAFs act as component-driven, technical-centric processes used to identify the standards, specifications, and technologies needed to support the delivery of IT services to the organization [7][7][39][91]. EAFs break down EA into components called "domains" allowing Enterprise Information Architects (EIAs) to describe an enterprise from several perspectives, views, or viewpoints corresponding to a set of architecture principles. Some EAFs may reference their methodologies in different forms and terms however, they follow similar perspectives such as a [91][108]:

- Business View – a set of business principles such as strategic maps, goals, corporate policies, business capabilities, etc.
- Data/Information View – as an asset, information architecture, metadata, data models, etc.
- Application View – as independent of specific technology, inventory of software applications, diagrams, interfaces between applications, etc.
- Technology View – only in response to business needs, hardware, servers, platforms, operating systems, etc.

The EAF documents the artifacts and requirements in the context of a disciplined methodology and layered approach leading to the creation of a reuseable functional structure. The final product, the EA plan (EAP) includes the infrastructure, various hardware and software components, integration and interface schemes, processes, and procedures [91][141].

Frameworks enforce consistent design patterns reflective of both the architecture and of the creational and behavioral characteristics of a system, subsystem, or component [91][109][140]. A framework must therefore include the following characteristics:

- Provide the mechanisms to make working with complex technologies easier
- Tie together discrete components into something more useful
- Implement system components in a consistent manner
- Ensure flexibility in integration of system components

In EA, gains in organizational efficiency, effectiveness, employee productivity, and the alignment of an organization’s strategic business plan with its information technology (IT) capabilities are lost if the information (i.e., specifications) needed to qualify and quantify design requirements is inadequate for the EA [33][39][91].

The sole purpose of an EAF is to produce the EA plan (EAP). The EAP illustrates a conceptual view of the technology needed within the enterprise [91][109][143]. Typical EAPs describe the role of information systems (IS) in the overall conduct of business operations while formulating a set of guidelines that lead the organization from planning the EA through to implementation [91]. It becomes the potential plan (see Figure 3) for an enterprise to evaluate its performance, *where an enterprise is* or the *as is*, and it’s potential, *where it wants to go* or the desired *to be* [91]. Several standards-making entities such as the ISO (15704, et al.), ANSI, IEEE, NIST, and CEN maintain and publish standards with recommended procedures and practices related to EA design [91].

In order to improve business operations, the EA plan (EAP) must include, describe, and formalize both the functional and non-functional requirements (collectively requirements) that drive EA [28][50][91]. The process focuses on the technological/engineering architectural design, alignment, implementation, and deployment of new and/or enhanced technology [76][91]. Given that the EAF instantiates and provides the requirements for the EAP, we believe that this is the area where EA is most vulnerable and where the first seeds for EA failure are sown. Simply stated, if the requirement elicitation process breaks down for any reason, the result may introduce erroneous requirements into the EA. This action may be the direct result of stakholder behavior either intentional or unintentional, covert or overt, and may be designed to sabotage the EA. From this perspective, we believe EA depends upon stakeholder participation and acceptance of EA which we will approach first from a requirements engineering viewpoint.

As most requirements engineering projects develop, the technical structure of the process defines the following attributes [39][73][106]:

- A set of goals and objectives
- Business strategies to be followed
- Business change requirements
- Information requirements
- Technology requirements
- Solution requirements

The goals, objectives, and business strategies to be followed typically describe the overall high-level, macro-oriented, esoteric abstractions to be achieved by the EA. The remaining attributes however are the crux of EA and define *what* the EA is to achieve and *how* it will be achieved. Herein lies the major obstacle to successful EA.

2.3.1 Enterprise Architecture Requirements Engineering

EA design requirements are predicated on gathering, analyzing, and validating organizational/institutionalized knowledge learned and used by stakeholders to do their work. In the list above, the first two attributes affects and sets the atmosphere and tenor for the EA and is dependent upon how the EA is introduced into the organization [39][76][83][85][95]. We will address this aspect of EA in more detail below and in Chapter Three. However, the remaining attributes depend entirely upon stakeholder input to the process and as such reflects the willingness of stakeholders to share information and participate in the EA process [20][23][88][99].

The foundation for EA design requirements is the total knowledge base of the enterprise [61][106][127]. It therefore plays a major, and perhaps the most critical and salient, role in EA success or failure. We consider this information to consist of two categories:

- Explicit - that which is documented and known throughout the organization.
- Tacit - that which is usually undocumented and known only to a select individual or group of people.

Together, explicit and tacit knowledge defines the necessary components needed to determine the functional and non-functional requirements needed for EA [28][91][128]. The critical role of this knowledge in EA design changes the significance in evaluating the elicitation process and thus poses a dilemma in determining how stakeholders create, process, produce, and provide organizational knowledge as input to EA design. We believe the failure to properly capture and validate collectively this knowledge is the major contributor to “poor architecture”.

Without belaboring the point, we believe requirements engineering (RE) to be somewhat analagous and useful in EA. First, the product of RE is a requirements document that communicates system requirements to all categories and classes of stakeholders such as end-users, developers, and management [127]. This document is very similar to the EAP used for the same purposes in EA design and implementation. Like the EAP, the requirements document is not initially a detailed design document but one that focuses on *what* is to be done without specifying *how* it should be done. Therefore, the methodologies, from a technical point-of-view, used for RE are like those used in an EAF.

Second, in RE like EA, eliciting stakeholder requirements is a prime concern in developing the requirements document. Both RE and EA function in a recursive manner that reconceptualizes organizational knowledge in that the quality of that knowledge can be directly linked to stakeholder and organizational behavior and the enterprise’s environment [23][95]. This is where we will discontinue the RE discussion and focus solely on EA by stating: if stakeholders are committed to EA, the elicitation process will yield legitimate design requirements. If they are not, the EA has a good chance to fail. Thus, this link emphasizes the importance of human behavior and social structure recognizing both as significant drivers in the acquisition of requirements needed for EA.

2.4 Existing Enterprise Architecture Frameworks

The first documented EA framework (EAF), the Zachman Framework for Enterprise Architecture (Z|AF), is a taxonomy-oriented framework for development of large, complex systems and uses a matrix to classify EA design requirements based on stakeholder roles and expectations [141]. This framework was followed shortly thereafter by other ontological-oriented EAFs such as The Open Group's Architecture Framework (TOGAF) [106][107], the Federal government's Federal Enterprise Architecture Framework [7][30], and the Department of Defense Architecture Framework [4][122].

Existing EAFs are each comprehensive and designed to handle large volumes of complex and interdependent system and subsystem requirements from a technological perspective with the end-product and EA Plan (EAP) [91][106]. State-of-the-practice EAFs formulate an EA aimed at maintaining business continuity and aligning an organization's strategic business plans (i.e., goals, vision, strategies and governance principles), business operations (i.e., business vocabulary, organizational structure, people, processes and information), with its IT infrastructure (e.g., hardware, software and processes) and resources [39][52]. The approaches within EAFs follow a macro-oriented, high-level abstraction of EA design artifacts and requirements.

Conversely, the inherent weakness of each EAF centers on the techno-centric solutions they formulate towards producing a desired set of technical deliverables for the EA [39][91]. This satisfies the high-level abstraction needed for an EA with the strategic EAP identifying in detail the proposed organizational structure, business processes, desired information systems, design requirements, implementation plan, and associated IT infrastructure. However, the processes discount the importance of the intersection of technology with human behavior and their respective effect on the quality of the work effort, the EA design requirements.

For example, the key element around which all design activity takes place in TOGAF Version 9.1, the Application Development Method (ADM) [108][109], describes a comprehensive step-by-step approach to develop EA [109]. It provides for the identification and management of key stakeholders from a purely technical perspective. Stakeholder roles, responsibilities, and contribution to EA are identified through TOGAF's ADM based on what is termed *Stakeholder Management*. The process consists of four concepts: Stakeholders, Concerns, Views, and Viewpoints. The process essentially identifies who will be involved and who is needed in EA design [109]. The process asks several questions regarding stakeholder role(s), decision-making, resource control, etc. Though these questions by themselves are relevant, the process itself fails to ask questions that would improve good decision-making and problem-solving such as "why?" and "why not?".

In assessing various EAFs, several interesting attributes come to light. The first attribute is that, at least in the beginning, the EA can be easily changed, replaced, or ignored. However, once selected, architectures are difficult to change or replace [90]. In effect, they become embedded and institutionalized in the EA design process. As a result, they become an intergral part of the organizational landscape and you're stuck with them. Second, EAs require a dynamic conceptual methodology, a framework, that serves to support and guide the engineering, design, and construction effort [7][30][92].

This second attribute, an EAF, describes a techno-centric methodology for developing and implementing an EA [109][121][141]. The methodologies typically propose taxonomy, ontology, and a paradigm to view and analyze the organization's current information architecture and operating environment. The purpose is to focus and guide an organization on how best to use and align technology with the organization's business plan [91] as a way to improve organization performance and efficiency [9]. In effect, the EAF methodology represents a tool for the Enterprise Information Architect's (EIA) use in advancing the organization's EA plan. The role of the EIA is critical in progressing an EA and is described in more detail below. One easily drawn conclusion can be ascertained in this process: if the EAF is flawed or deficient in any way, it may adversely affect the EA.

2.4.1 An Analysis of Existing Enterprise Architecture Frameworks

There have been many EAFs proposed for use in EA design and implementation over the past twenty plus years. For example, the Zachman Enterprise Architecture Framework (Z|FA) [17] [18] [19], The Open Group Architecture Framework (TOGAF) [13] [17] the Federal Enterprise Architecture Framework (FEAF) [3] [17], and the Department of Defense Architecture Framework (DoDAF) [4], are each unique, disciplined, and regimented towards a particular apporach to EA. Within these distinct and unique EAFs there are a set of processes and procedures that provide the methodology which defines an EAP.

The strengths of the various EAFs are that each imposes a regimened set of step-by-step guidelines and processes for design and implementation of the EA [91]. The weakness of current EAF processes is that they concentrate on developing and implementing the EA plan only from an objective technical point-of-view. For example, if we accept that stakeholders are an integral part of defining and describing the requirements needed for, then their willingness to participate and contribute plays a major role in the success or failure of the EA.

In analyzing the literature available for each framework, we found that collectively each fails to take into account the stakeholder's subjective view of the new technology and how human capacity for change might be affected by past and present experience and future expectations at any given momen. Our analysis of the frameworks is detailed in Table 2. This work was published in our paper, "*On Applying the Theory of Structuration in Enterprise Architecture,*" and presented at the IEEE/ACIS 9th International Conference on Software Engineering Research in Yamagata, Japan in August, 2010. Our analysis of the existing frameworks find them as leading to a failure to capture contextual variations in stakeholder perceptions within and across departments/agencies within an organization, and an assumption of objectivity and structural uniformity of organizational work flows, procedures and information needs that may not quite be the correct representation of reality.

Another potential weakness of existing EAFs is that they try to represent complex processes and systems that characterize an organization through the use of objective rules and assumptions [91]. This is perhaps too constricting and discourages the use of more innovative and creative approaches to problem-solving. The processes reveal an inherent weakness in that each approach fails to address and take into account the human behavioral aspects within an organization when formulating an EA.

Architecture Framework	Framework Characteristics	Stakeholder Role	Extent of Consideration of Stakeholder Behavior
Zachman Architecture Framework (Z|FA)	Described as a framework, in reality it is more of taxonomy than a framework or process. The process provides a means to categorize architectural artifacts creating the design documents, specifications, and models for data and functionality.	The taxonomy considers the interrelationship of stakeholders only, in terms of the role of the stakeholders and the flow of information between stakeholders.	The Zachman AF considers stakeholder interrelationships only regarding the flow of information, the "Why" of the framework. The assumption is that such a flow of information is objective and its logic predicated solely by the requirements of the work flow. Such an assumption implies a sense of uniformity of behavior that may be erroneous, because it does not take into account the behavioral differences that may lead to variation of use and impact of the flow of information between different individuals.
The Open Group Architecture Framework (TOGAF)	A methodology featuring a process more than a framework, TOGAF features a process called "Architectural Development Method" (ADM) to design an EA. The process is complete with a step-by-step approach to creating an EA.	Within the TOGAF ADM Business Architecture View, an Organizational View considers stakeholder roles, capabilities and the business units of the organization from a perspective of management of those business units. The aspects and role of the stakeholder role is defined in several forms used by the process.	TOGAF recommends the creation of a "Stakeholder Map Matrix" and similarly related forms that depicts their usage only in the context of information flow similar to Zachman. The process does not identify any potential failures that could/can result from negative stakeholder behavior It also fails to capture individual variations that may occur because of situational/behavioral context.
Federal Enterprise Architecture Framework (FEAF)	The framework satisfies two facets of EA: it may be used in the context of an implemented EA or as a methodology to create an EA.	FEAF promotes the sharing of information throughout the Federal Enterprise, across Federal agencies, and between governmental and commercial institutions.	Like both Zachman and TOGAF, the social interrelationships and behavior of stakeholders are not considered in this framework. As in the other frameworks, FEAF does not take into consideration inherent variations in information that may result from behavior of the stakeholders both in the creation and within an implemented EA.

Table 2. Relationship of EAF Methodologies and Stakeholder Behavior

communication) which are essential to handle human behavior and the subsequent organizational change. Any such effort should be predicated upon an approach that recognizes human behavior, the impact of technology and the actions and relationships of those entities on and within the social structure of the organization. The mechanisms must provide for both vertical (i.e., up and down the organizational hierarchical structure) and horizontal (i.e., peer-to-peer) communication between stakeholders. In effect, a socio-communicative process that provides an effective line of communication between all project stakeholders. The effect of such a feedback mechanism provides a means of maintaining a state of homeostasis offering a channel for stakeholders to exchange ideas, know-how and knowledge benefitting the organization.

2.4.2 The Zachman Architecture Framework

Described as a framework, the Zachman Framework for Architecture Framework (Z|AF) is, in reality, more of a taxonomy than a framework or process [122]. The framework, in its current state, describes a generic classification scheme establishing and implementing a common vocabulary accompanied by set of perspectives that provides descriptive representations of design artifacts for complex objects [91][122][141]. Zachman's initial architectural methodology, "*Framework for Information Systems Architecture,"* evolved from older architectural disciplines rooted in such areas as architecture/construction and engineering/manufacturing aligning aspects from each discipline to information systems [122][141]. Referred to simply as the "Zachman Framework," the framework has become the de facto industry standard for developing enterprise architecture providing taxonomy to classify and organize design artifacts of an organization. For example, other frameworks such as The Open Group Architecture

Framework (TOGAF) support inclusion and take advantage of the Zachman Framework's classification and organizational perspectives within their own processes [108][109].

In its present state, the Zachman Framework consists of a six-by-six matrix of rows and columns with the intersection of a row and column defined as a cell [143]. However, the first iteration of the framework considered only three columns and six rows [143]. The initial columns were labeled: *What, How*, and *Where* with the rows labeled: *Scope (Planner), Business Model (Owner), System Model (Designer), Technology Model (Builder), Components (Sub-Contractor),* and *Working System (Functioning Enterprise)* [143]. Three additional column interrogatives were added to complete the taxonomy as it used currently: *Who*, *When*, and *Why* [143]. Each cell of the two-dimensional matrix supports the access, integration, interpretation, development, management, and changing set of architectural representations of the organization (see Figure 5). These elements are referred to as *artifacts* in the Zachman Architecture Framework and describe a holistic model of an enterprise's information infrastructure [91][141].

The columns provide a means to model and describe various abstractions of the enterprise with the rows describing various perspectives/viewpoints from which the abstractions can be described. The intersection of a column and a row, a cell, represents a high-level abstraction of the enterprise from a given perspective/viewpoint [141][143]. Zachman considers two basic points in his framework [140]:

- Architecture is an enterprise issue and not a systems issue
- EA is defined on an older precedent related to architecture/construction and engineering/manufacturing

The top row represents the most generic perspective of the organization with each descending vertical row describing successively more concrete perspectives. The intersection of a column and a row, a cell, represents an aspect of the enterprise that can be modeled from a given viewpoint and perspective [143].

As derived from earlier artifact classification and organization structures, the framework template (see Figure 5) depicts design artifacts that form the intersection between the various roles in the design process [42][122][141][143]. The columns of the matrix can be arranged in any order, perhaps to facilitate object-oriented design [91], and represent different abstractions to reduce the complexity of any single model built. For example, cell content consists of deliverables, business goals and strategy, and stakeholder perspectives [143].

The two-dimensional matrix can be further extended to represent a multi-dimensional framework by applying the framework model to separate divisions, sub-divisions, etc., within the enterprise thereby producing a complete organization-wide system [91][141]. The intersection of the rows and cells describe the design process in terms of *Owner*, *Designer*, *Builder*, *Planner*, and *Sub-Contractor*, and the product abstractions the *What (material)* it is made of, *How (process)* it works, *Where (geometry)* the components are relative to each other, *Who* does the work, *When* do things happen, and *Why* are various choices made [141][143].

The framework yields architectural and design artifacts (such as descriptive representations, product descriptions, and engineering documentation) from which to create the design documents, specifications, and models for data and functionality [140][141]. Zachman defines the design artifacts as *primitives* or descriptive artifacts that constitute the knowledge infrastructure of the enterprise [142]. The primitives are horizontal and vertical design artifacts that facilitate software development but are not intended as such at the enterprise level [142]. The classification scheme is a generic process that facilitates a focused concentration on selected complex aspects of an object without losing sight of the contextual or holistic perspective aimed at the audience for which it is intended. The process produces the artifact constructed with an abstraction classified by content or subject focus of the artifact [141]. The taxonomy considers the interrelationship of stakeholders only, in terms of the role of the stakeholders and the flow of information between stakeholders.

In his documentation [141][142][143], each cell represents a detailed model at both the horizontal and vertical intersection (cell) providing a composite and potentially enterprise-wide view of EA design artifacts [142]. It does not explicitly provide for a "stakeholder" perspective with the matrix cells serving to only describe deliverables and the business from a high-level functional/organizational structure.

An analysis of Zachman's documentation found no references to human/stakeholder behavior related to the introduction of new or enhanced technology resulting from EA design. Zachman considers stakeholder interrelationships only regarding the flow of information, the "*Why*" of the framework and does not directly take into account the roles and responsibilities of users from a behavioral perspective which potentially can lead to failure in capturing the tacit knowledge needed from stakeholders to ensure EA design success. The review and analysis of Zachman's documentation illustrated in Table 2 above found no references to human/stakeholder behavior related to the introduction of new or enhanced technology from EA design. Our analysis also finds

Zachman deficient in assessing and/or addressing tsakeholder behavior related to organizational transformation.

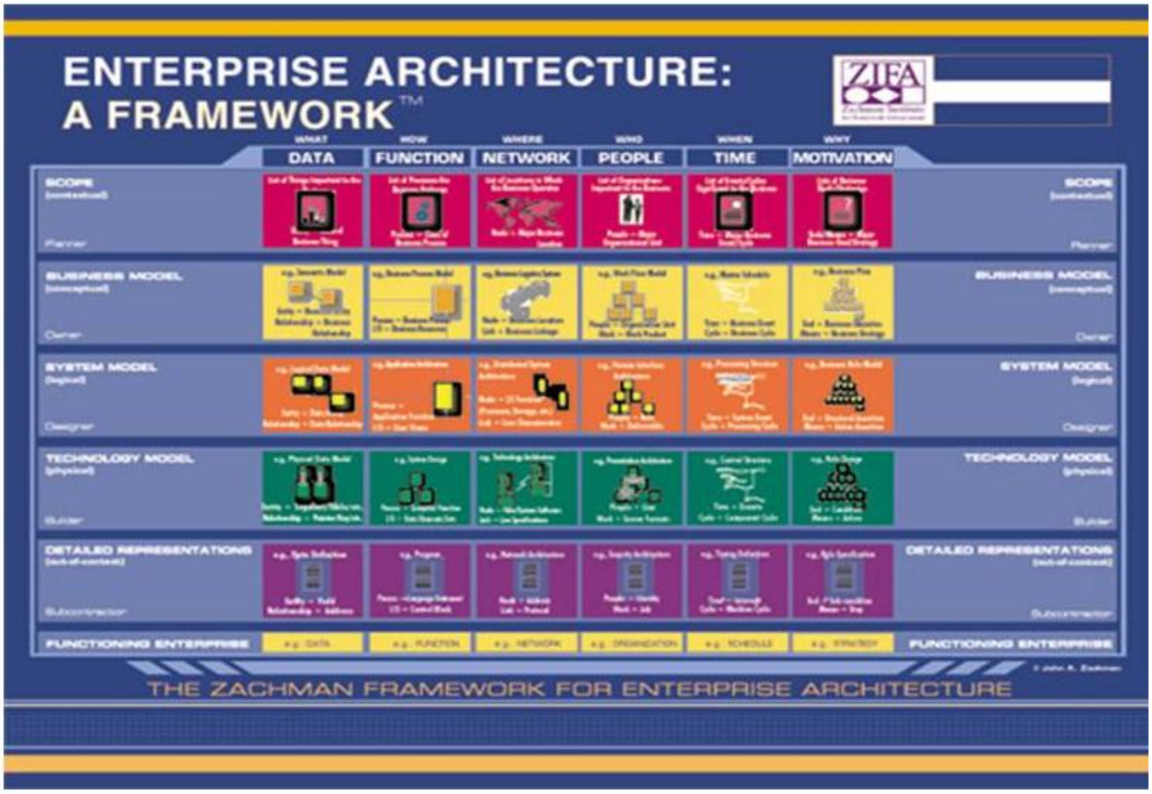

Figure 5. The Zachman Architecture Framework Matrix [141][143]

The framework's assumption is that the flow of information collected is objective and its logic predicated solely by the requirements of the workflow [91]. Such an assumption implies a sense of uniformity of behavior that may be erroneous because it does not take into account the behavioral patterns that may lead to variation of use and impact of the flow of information between different individuals. Zachman considers the framework a logical structure and extension of EA for classifying and organizing the descriptive representations that are significant to the enterprise's management and the development of the enterprise's systems [141].

2.4.3 The Open Group Architecture Framework (TOGAF)

The latest version of The Open Group's Architecture Framework (TOGAF) Version 9.1 became available on December 1, 2011, with the Open Group recommending a number of upgrades/changes to Version 9 [109] (members of the Open Group work within the Architecture Forum to maintain and develop TOGAF). According to the TOGAF documentation, EA design is now divided into several phases with the upgrades/changes implemented in Version 9.1 backward compatible through earlier versions of TOGAF such as Version 8 and Version 9 specifications and certifications [109].

In its present iteration, TOGAF Version 9.1 has the following main components [108][109]:

- An Architecture Capability Framework (ACF) which defines the enterprise's processes, skills, roles, and responsibilities while detailing a set of reference material on how to establish an architecture function and including a set of comprehensive guidelines to support the key activities in EA design.
- An Architecture Development Method (ADM), both the core of TOGAF and generic in nature which allows it to be used in a wide range of industries, consists of stepwise cyclic iterative approach to EA design. The ADM provides a series of steps and processes for both the enterprise and the Enterprise Information Architect (EIA) to use to develop the EA.
- An Architecture Content Framework which divides EA into four closely interrelated architectures, the:
    - Business Achitecture

   - Data Architecture
   - Application Architecture
   - Information Technology (IT) Architecture
- An Enterprise Continuum (EC) which illustrates the generic aspects of TOGAF and describes how architectures are developed across a wide range, or continuum, of architectures from foundational architectures, through common systems architectures and industry specific architectures, to one designed specifically for the enterprise's individual requirements. The EC leverages relevant architectural assets and assists in moving the EA through different layers of abstraction. The Enterprise Continuum consists of several reference models such as the:
   - Technical Reference Model (TRM)
   - The Open Group's Standard Information Base (SIB)
   - The Building Block Information Base (BBIM)

TOGAF focuses on the complexity of developing an EA defining what it advertises as "best practices" to identify both present stakeholder needs/requirements and providing for the future business needs of the enterprise [109].

At the heart of TOGAF lies the Application Development Method or more commonly the ADM (see Figure **6**). The ADM integrates various components of TOGAF to develop the EA describing available architectural assets to meet business and IT requirements. For example, the ADM identifies at relevant places where any assets are available from the EC should be used. The ADM acts as an iterative process over the entire architectural development cycle. It requires a fresh decision to be made at each iteration asking questions related to the [91][109]:

- Breath of enterprise coverage to be defined
- Level of detail required
- Overall and intermediatetarget time lines involved
- Architectural assets to be leveraged

In its generic form, it serves and can be applied in wide and diverse vertical industry group. It can also be used with other frameworks such as Zachman, FEAF, DoDAF that define deliverables to specific industry.

The ACF, in its present form, is not intended to be used as a comprehensive template for operating an architecture capability (see Figure **7**). The ACF outlines an architectural vision for the EA with one of several criteria defined within its process to "identify stakeholders and their concerns, business requirements, and architecture" [108][109]. The ACF works in concert with the ADM providing the governance for the process. This step establishes the first high-level definition of the baseline and target environments from a business information systems and technology perspective. Within the TOGAF content description of its framework, the ACF includes a structured meta-model for architectural artifacts, the use of re-usable architecture building blocks, and an overview of EA deliverables [109].

The Enterprise Continuum (EC) typically includes an Architecture Repository that contains reference architectures, models, previous architecure patterns used within the enterprise, and any architectures developed before the current process [109]. The EC essentially categorizes the enterprise's architectural source and reference material, relevent available reference models and standards in the industry. The ADM again drives the EC allowing the EIA to consider which, if any, architectural assets for the Architecture Repository should be included in the latest EA iteration [109].

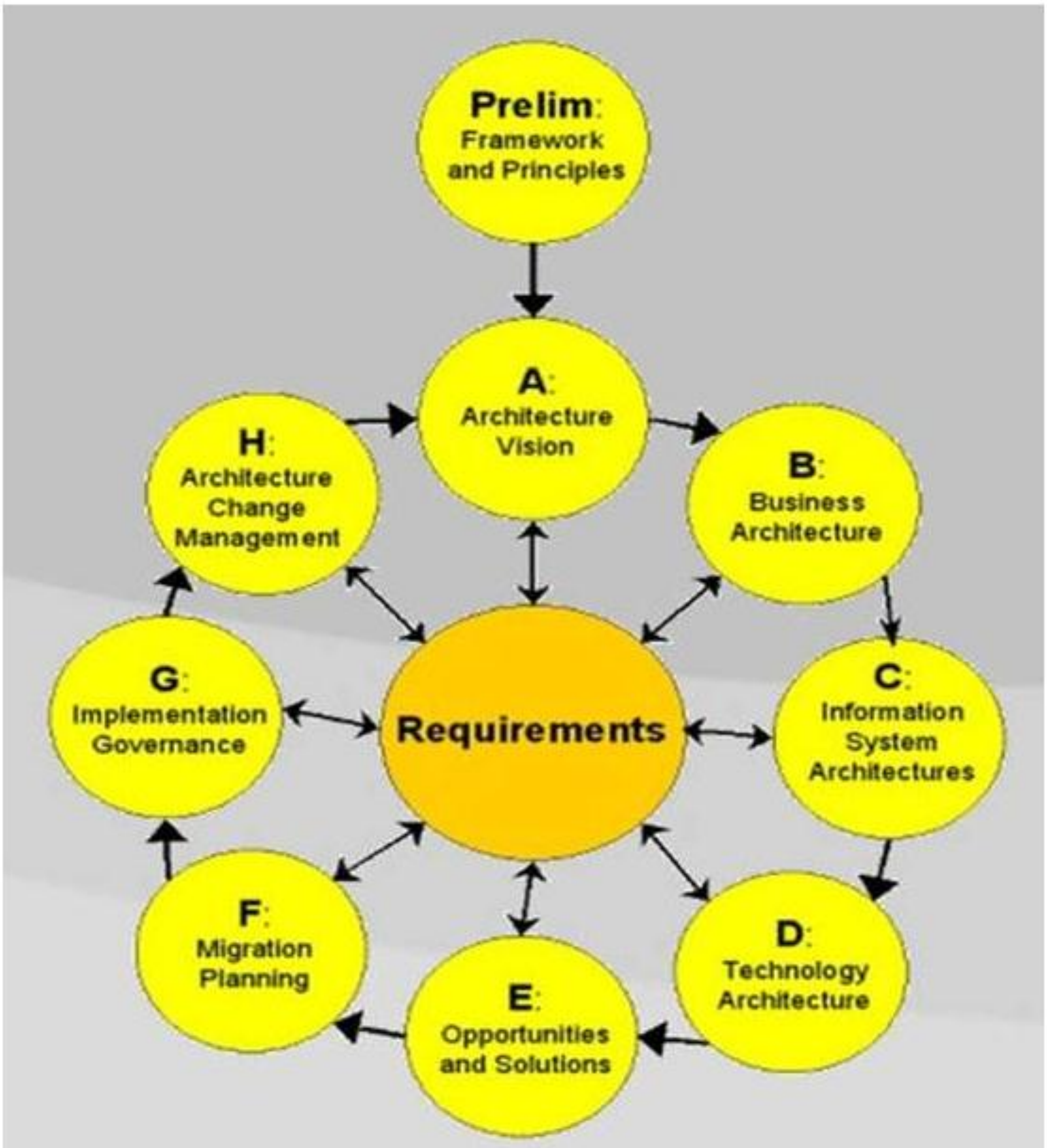

Figure 6. The TOGAF Application Development Method - TOGAF Version 9.1 [109]

One aspect of TOGAF is the Foundation Architecture (FA) where the ADM assists in defining the business requirements, reusable common models, policy, and governance definitions. Requirements defined at this component are restricted to the overall concerns of the EA and thus are less complete than for a specific enterprise [109].

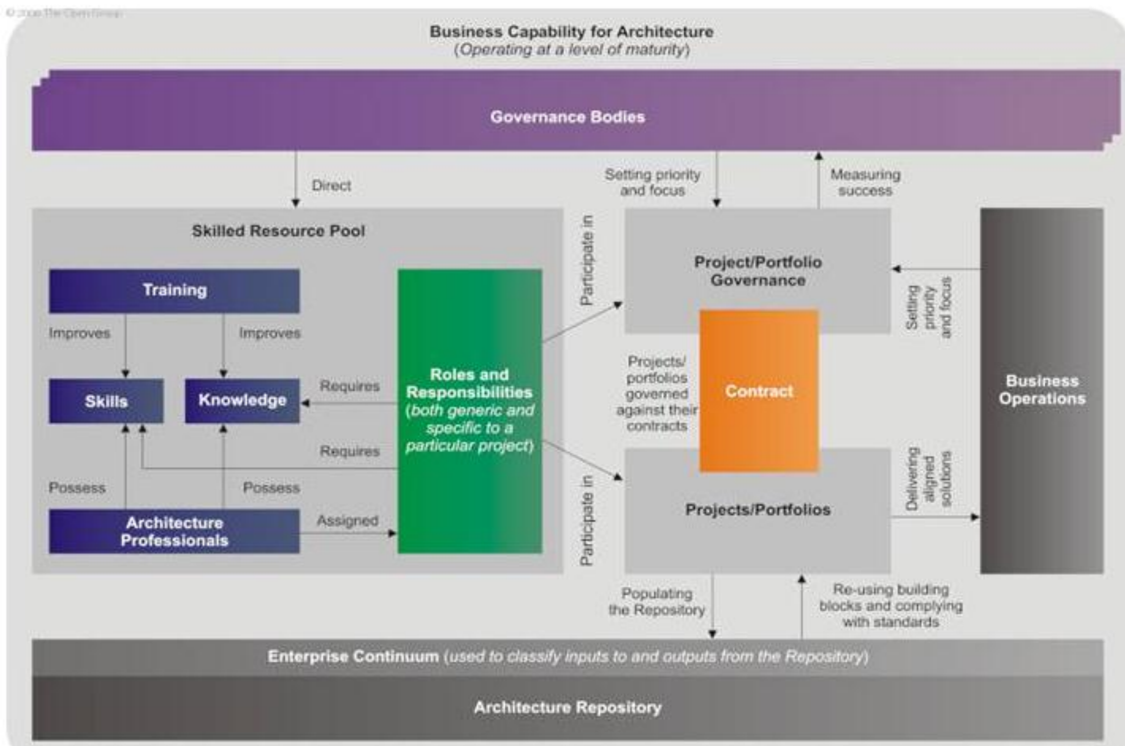

Figure 7. Arhcitecture Capability Framework (The Open Group Version 9.1 [109])

Within the TOGAF and ADM Business Architecture View, which essentially is an Organizational View, stakeholder roles, capabilities and the business units of the organization are defined, described, and considered from a management perspective of those business units. The aspects and various roles of the stakeholder are defined in several forms related to the organization and their respective functionality within the organization [108]. TOGAF, specifically Version 9.1, recognizes the importance of stakeholder involvement in the architectural process in their documentation as described in "Stakeholder Management" [109]. It recommends identification of those individuals and groups who will contribute to the EA development. Specifically, stakeholder roles are referred to in the documentation for the ADM as:

- Stakeholders
- Concerns
- Views
- Viewpoints

TOGAF documentation recognizes the significance of and places identification of “key” stakeholders throughout the EA process indicating stakeholders may come and go.

TOGAF recommends the creation of a “Stakeholder Map Matrix" and the maintenance of a “Stakeholder Analysis” document within the ADM to record ratings and actions to be taken during the design, keep “key” stakeholders informed and satisfied, noting stakeholder roles and responsibilities on the EA [109]. In conjunction with these documents, a chart, the “Stakeholder Power Grid,” describes what is referred to as the level of interest of stakeholders. The assessment of stakeholder impact considers the following questions [108]:

- Who gains and who loses from this change?
- Who controls the change management processes?
- Who designs new systems?
- Who makes the decisions?
- Who procures IT systems and who decides to buy?
- Who controls resources?
- Who has the specialist skills the project needs?
- Who has the influence?

While these questions are needed and relevant in EA design, the framework does not address other questions that may be more important such as:

- Who is not involved in the process and why?
- Who could potentially adversely affect process performance and why?
- What impact will new or enhanced technology have on both stakeholder and organizational behavior and why?
- Is the data and information collected to ensure the specifications and requirements for the EA valid and verifiable and why?
- Are the deliverables and expectations the right deliverables and expectations and why?

These questions are paramount to EA design and are, often times, overlooked and are consequently reflected in negative human behavior. A review of the TOGAF Version 9.1 documentation, as well as Versions 8.1 and 9.0, contains no references to stakeholder behavior and the impact of behavior on the organization in the framework and consequently does not identify any potential EA outcomes that could/can result from either positive and/or negative stakeholder behavior.

2.4.4 The Federal Enterprise Architecture Framework (FEAF)

The United States government has spent over six hundred billion dollars over the past decade in Federal information technology (IT) [8][11]. Unfortunately, most the IT projects remain unfinished as a result of a lack of [11]:

- Integration standards
- Common data governance processes
- Common data management standards

The case for a more cohesive, comprehensive, and disciplined approach to Enterprise Architecture (EA) can be found in the large number of failed IT projects which have cost taxpayers billions of dollars [43][44][74]. Documentation compiled from audits of Federal Agency IT projects by the Federal government's General Services Administration (GSA) Office of Audits support these claims. This documentation does not separate EA from IT though the thrust of Federal technology frameworks focus on EA with IT the product of EA. Therefore, again in this dissertation EA and IT are considered together with IT the end-product of EA. Two recent examples are:

- Audit of the Federal Acquisition Office's (FAO) Information Technology Solutions Shop (ITSS) replacement acquisition system, GSA Preferred [1]
- The FBI's Upgrade That Wasn't [37]

In both examples, the new software systems failed to deliver the functionality desired and the projects were abandoned.

The conclusions drawn by the General Accounting Office (GAO) are that the IT systems developed and deployed by Federal agencies are both inefficient and uneconomical [11]. The reasons cited by the GAO state that the independent nature of each agency is a major factor as current policies allow it to operate without any centralized IT oversight and/or adherence to common information architecture (IA) policies, practices, or principles [7][11].

The Clinger-Cohen Act of 1996 assigned the Federal Chief Information Officers Council (CIO) the responsibility to develop consistent IT architectures (ITAs). The primary purpose and intent of the Act serves to improve Federal Agency practices in the design, modernization, use, sharing, and performance of Federal information resources

[30]. The purpose, scope, and audience of the Federal Enterprise Architecture Framework (FEAF) as defined in federal documentation is to provide a set of guidelines directed at all federal agencies for initiating, developing, using, and maintaining an EA [11].

As promulgated, FEAF promotes and facilitates the implementation of top-level enterprise architecture for the Federal Enterprise using a five-layered model (see Figure 8) authored by the National Institute of Standards (NIST). The NIST process is a segmented approach to EA design and development [7][8]. FEAF [7] was developed by the Federal Architecture Working Group (FAWG) under the strategic direction of the Enterprise Interoperability and Emerging Information Technology Committee (EIEITC) of the Federal Chief Information Officer [11].

The segmented approach used in FEAF for EA design is appropriately labeled the Federal Segment Architecture Methodology (FSAM) and uses what are described as proven *best-practices* for EA development from across the spectrum of Federal agencies [7][8][10]. The expected output from the process is the production of segmented architectural work products that bridge enterprise planning and the development and implementation of solution architecture(s) [7]. FSAM is a collaborative, step-by-step process that conforms to the NIST Enterprise Architectural model. The five layers of the NIST EA model serves as a recursive and iterative process consisting of the following architectural viewpoints:

- The Business Architecture, which drives the
- Information Architecture, which prescribes the
- Information Systems Architecture, which identifies the
- Data Architecture, which is supported by the

- Delivery Systems Architecture (hardware, software, communications)

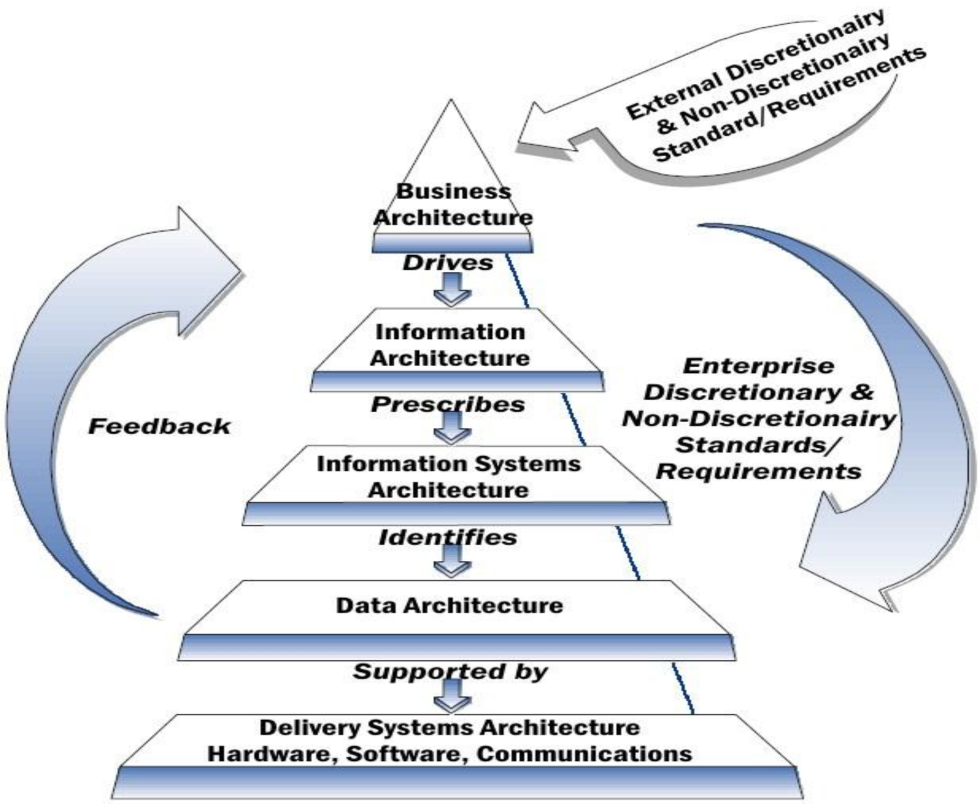

Figure 8. NIST Enterprise Architecture Model (The FEA Framework [30])

The NIST model (see Figure 8) illustrates the interrelationship and recursive nature of enterprise business and information environments [8][10]. FEAF diverges somewhat from the NIST EA standard segmenting the EA process into three artifacts [7][8]:

- The FEA Reference Model
- The Federal Transition Framework
- An Assessment Instrument (Office of Management and Budget (OMB) EA Assessment Framework)

Though the NIST model acts as the set of EA standardized guidelines for all federal agencies, it does allow the agencies to modify the framework to accommodate any unique requirements the agency might have.

The Federal Enterprise Architecture (FEA) represents a strategic information asset base defining the business, information needed to operate the business, technologies to support the business, and transitional processes for implementing new and/or enhanced technology [30]. FEAF consists of a comprehensive toolkit of suggested analytical techniques such as prototyping/pilot, laboratory implementation, initial field implementation, and complete implementation to describe the system development life cycle (SDLC) for Federal EA design [30]. It postulates federal architectural requirements by satisfying two facets of EA:

- As the context of an implemented EA
- As a methodology to create an EA

One of the primary design principles of FEAF promotes the sharing of information throughout the Federal Enterprise, across Federal agencies, and between governmental and commercial institutions.

Like both the Zachman Framework and TOGAF, FEAF documentation does not take into account the social and political interrelationships and behavior of stakeholders. In addition, it also does not take into consideration inherent variations in information that may result from behavior of the stakeholders both in the creation and within an implemented EA. For example, in a report to Congressional Committees on Enterprise Architecture, the GAO found missing architecture content and limited stakeholder input constrained usability of the EA developed by the Department of Homeland Security (DHS) [5]. In a planned EA for NOAA’s National Weather Service, one reference to stakeholder involvement was found and that reference was only to capture NWS users and stakeholders as customers and partners [64]. In both of these examples, the failure to ensure stakeholder involvement and participation in the EA design were cited as major factors contributing subsequent human behavioral reaction to and rejection of project implementation. Though these two examples represent only a small portion of Federal EA design efforts, others can be found to support that the FEAF architectural process does little to ensure that explicit and especially tacit knowledge is captured to ensure the adequacy of architectural specifications and requirements.

2.4.5 The Department of Defense Architecture Framework (DoDAF)

The Department of Defense Architecture Framework (DoDAF) acts as a comprehensive framework and conceptual model used by the Department of Defense (DoD) to support and guide the DoD Chief Information Officer (CIO) in developing and maintaining architectures as required under the Clinger-Cohen Act [4][7][8]. While conforming DoDAF to these mandates to fullest extent possible, it serves as the principle vehicle and guide for development of integrated architectures, data collection and presentation, and is intended to enable the sharing and reuse of architectural data [4].

DoDAF, like FEAF, follows the architectural process described and detailed by the NIST EA model (see Figure 8) [4][7][8] augmented with specific DoD components conforming to DoDAF requirements for developing defense related architectures within the department. The DoDAF process ensures reuse of information and those architectural artifacts, models, and viewpoints that can be shared with common understanding [4].

The latest version of DoDAF documentation, Version 2.0, was released in May, 2009, replacing earlier versions of the framework. The intent of DoDAF enables development of architectures, including support of and development of net-centric services across the DoD and multinational boundaries. The major emphasis in this release focuses on data-centric processes designed to provide DoD managers with quality decision-making information rather than one aimed towards product-centric processes [4]. In this regard, the vocabulary of Version 2.0 has changed from earlier versions of DoDAF, For example, the term *products* in earlier versions of DoDAF, such as Version 1.5, has been replaced with the term *views* or *viewpoints* (see Figure 9). In this context, *views* represent specific types of presentation of architectural data and derived information with *architectural views* being organized into *viewpoints* providing a broad understanding of the purpose, objectives, and the components, and the *capabilities* represented by the *individual architectural views*. In addition, linkages to FEAF are also described and defined in this release [4].

In addition to defining the functional requirements for an EA, a systematic approach is described in DoDAF's Technical Architecture for Information Management (TAFIM) to address non-functional requirements such as system reliability, accuracy, flexibility, expandability, and interoperability [7][8]. The process focuses on data rather than on developing products [4]. The documentation describes and formulates the modeling methodologies, DM2, to be used across the frameworks spectrum to verify and validate DoDAF architectures.

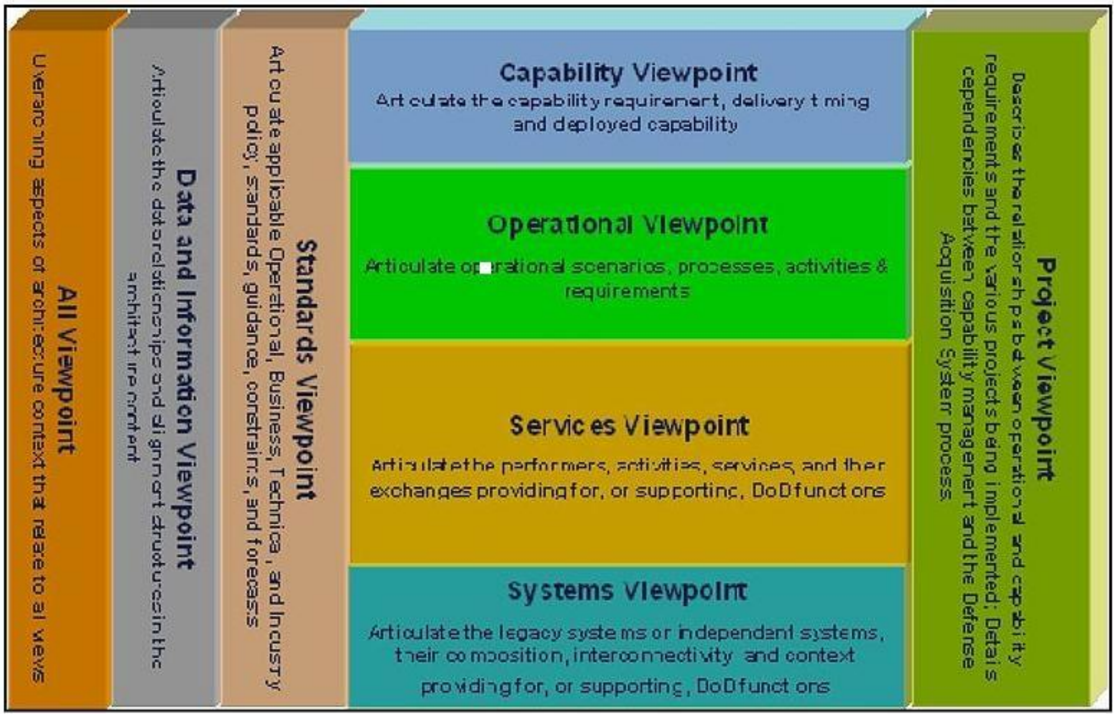

Figure 9. DoDAF Version 2.0 Viewpoints [4]

The U.S. Undersecretary of Defense for Business Transformation's DoDAF Working Group administers and is responsible for maintaining DoDAF. It is designed especially for large systems and to systems-of-systems with complex integration and interoperability concerns. DoDAF Version 2.0 also supports the use of other frameworks within the DoDAF design such as Zachman, FEAF, NAF (the NATO Architecture Framework), and TOGAF. The logo for DoDAF stresses what it refers to as "Fit for Purpose" defined and described in Volume 1 of the DoDAF documentation as an Architectural Description consistent with specific project or mission objectives [4].

A detailed review of DoDAF Version 2.0 documentation which at present consists of three volumes found stakeholder references throughout the new release highlighting the need to acquire stakeholder specifications that conform to their desired expectations. However, references to stakeholder and/or human behavior were not found. The material is strictly technically oriented and does not address the impact of new or enhanced technology. The framework also fails to provide any motivational tools to mitigate or to recognize negative behavior in the EA design. Therefore, though both behavior and stakeholders are referenced, DoDAF Version 2.0, like Zachman, TOGAF, and FEAF can be better improved by providing a means that takes into account the impact of new technology on the behavioral patterns of stakeholders and implementing behavioral modification schemes that mitigate negative stakeholder behavior relative to the EA.

2.5 The Role of the Enterprise Information Architect

Like the evolution within the field of information tchnology (IT), people with a wide range of technical skills refer to themselves as either Enterprise Architects. Enterprise Information Architects, IT Architects, and/or Software Architects [89][91][106][128]. Regardless of the job title, they all do the same work, perform those tasks using the preferred Enterprise Architecture Framework (EAF) to design and implement an Enterprise Architecture (EA). In this work, the term Enterprise Information Architect (EIA) will be used to collectively refer and define all of these job titles.

Today, the requisite skill set for an EIA traditionally consisted of a practical knowledge of both business practices and technology [89][91]. The role of the EIA takes:

- An enterprise's strategic business plan and operating model
- Defines and describes the requirements, resources, and infrastructure needed to align the proposed information technology (IT) systems architecture
- Implements the business and IT strategic EA plan to support the EA

To satisfy these goals, the EIA must therefore understand the enterprise's business and be able to describe and define the technology infrastructure necessary to support the enterprise [71][76][91].

The Institute for Enterprise Architecture Developments (IFEAD) places EA and system construction in the same context as constructing a building with similar roles assigned to an EIA. Their Enterprise Architect stipulates and requires a skill set far surpassing those of software engineers "with a flair for design to build the huge, complex infrastructures of the information revolution" [119]. To avoid confusion and to differentiate the role of a Project Manager and that of an EIA, a Project Manager (PM) focuses on developing "working software" [47] while EA and the EIA focuses on planning and describing the overall strategic technological solutions and infrastructure which map to the current and future operating model of the enterprise [76][91]. The scope of the EIA's work, therefore, must be wider and include skills related to business acumen as well as sociological and psychological *soft people* skills to be effective. Confusing the two activities almost always results in misdirection of effort and a reinforcement of misunderstanding on the part of stakeholders leading to EA failure.

Much of the available literature on the role of an architect follows many of the processes used by PMs though the magnitude of responsibility far exceeds that of a PM. For example, PMs typically handle a single project focusing solely on producing "defect-free" software developed through applying some form of project management model [47]. An EIA, on the other hand, thinks about the alignment problem along with people, structures, processes, and the techniques and tools needed to solve business problems [18][91]. Where PMs focus on delivering software, EIAs target business deliverables such as:

- Business system plans
- Assessment of application portfolios

- IT principles and practices
- System and/or migration plans
- Analysis of business processes
- Modeling shcemes for business process and EA

Therefore, the EIA needs to have a broad wide-rangin of skills beyond just those of IT such as [39][92]:

- A knowledge of business processes, principles, and practices
- A knowledge of how technology can be applied to the business process

In addition, the EIA must know how to communicate between IT and business people in an easily understood language. However, what all of the literature fails to define are the skill sets required outside of the technical and business knowledge needed to manage and motivate stakeholder behavior. Lost in traditional stakeholder management processes are conceptualizations of:

- A communication strategy to specifically address stakeholder interests
- Mechanism to assist in predicting stakeholder behavior
- Processes to measure and analyze the impact of the EA on stakeholder behavior
- Motivational tools to assist and resolve stakeholder resistance to organizational change brought about by EA

2.6 Summary

The adoption and use of EA in large enterprises and development of complex, large-scale systems now places it at the forefront of IT and organizational business strategy [39][77]. The process aspect of EA is inclusive in its approach formulating a design and implementation plan for the project. The methodologies used in existing EAFs to describe the EA typically propose ontology for both viewing and analyzing the enterprise's current information architecture and operating environment. The focus of this effort is on how best to use technology and align it with the enterprise's strategic business plan and operating model [91].

The responsibility for developing the EA design has been that of an Enterprise Information Architect (EIA). Until now, the requisite skill set for the EIA typically consists of a practical knowledge of technology and business practices [91]. Today, possessing just these skills alone are not enough to address a workplace environment where stakeholders no longer accept change without question but more routinely question the need for EA and the organizational transformation it brings about. We illustrated the importance of the EIA in our work "*Applying the Theory of Structuration to Enterprise Architecture Design*' published and presented at 2011 World Conference in Computer Science, Computer Science and Applied Computing, International Conference on Software Engineering Research and Practice, IEEE/WorlsComp 2011, SERP 2011, in Las Vegas, Nevada, in July, 2011. In this work, we highlighted stakeholder use and abuse of technology manifesting itself in two ways that the EIA must plan and allow for:

- How the solution may be either abused or used properly
- Designing the solution such that it identifies and handles abuse.

These two elements move the EIAs skill set to include principles and practives from sociology, psychology, organizational theory and management behavior.

Of the many EAFs used since EA's inception, four stand out as de facto standards within the industry: the Zachman Enterprise Architecture Framework (Z|FA)

[140][141][142], The Open Group Architecture Framework (TOGAF) [108][109], the Federal Enterprise Architecture Framework (FEAF) [6][8][30], and the Department of Defense Architecture Framework (DoDAF) [4]. Each of these EAFs feature distinct and unique approaches to EA design embodied with their own set of processes and procedures. In some cases, taxonomy defines the EAF (e.g., Z|AF) process while in the others listed above ontology describes the process [122]. Regardless of their methodologies, the strengths of the frameworks are that each imposes a disciplined regimen of processes and procedures guiding documentation of the EAP [89]. However, our analysis of existing EAF documentation contained in Table 2 above reveals the weaknesses of current EAFs in that they fail to take into account [20][46][83][85]:

- The cultural effects on human behavior caused by the environment of the enterprise and the cognitive aspects of stakeholder behavior.
- The behavior and influence an individual has singularly or on and within a group.
- The social change within the enterprise resulting from the EA.
- The changes to the enterprise's political and economic systems caused by the EA.
- The social conflict that might result from the EA.

Each of these forces plays a significant role in stakeholder behavior and thus influences their capacity to contribute to the EA. In Table 1 above, we illustrated the influences different groups of stakeholders have on EA. Using both Table 1 and Table 2 we can draw upon the different effect of and the factors that influence stakeholder behavior and the weaknesses of an EAF to better assess and handle human behavioral issues in EA design. For example, if we examine the cultural environment of an enterprise, stakeholder behavior mirrors organizational behavior learned over time and manifests itself based on their past and present work experiences within the enterprise [46][83]. Continuing, group behavior cannot be understood solely as the aggregate behavior of an individual though an individual may significantly influence the group's behavior or be influenced by the group [83][97][85].

Social change, on the other hand, is evolutionary and can occur in two opposing fashions: opened or constrained and is internally the by-product of technology and/or change in the political structure of the enterprise. External forces can also induce social change but are beyond the scope of this document at this time.

Systems of coordinated and controlled activities result from work embedded in complex networks of technology-centric relations and boundary-spanning exchanges. Giddens, in his *Theory of Structuration* [46], addresses how relationships between human agents and structures can be both beneficial and at odds with each other with individuals having the ability to act in ways other than those that support the existing organization or social structure. Orlikowski [95] identifies and highlights the impact of technology on human behavior and organizations further postulating Giddens' theory and providing more insight into the human behavioral aspects of introducing new technology in the organization. Both Giddens and Orlikowski theories are addressed in Chapter Four.

In an EA, the forces that affect social change are twofold: technology including the new processes introduced by the technology, and the new roles, duties, and responsibilities assigned to stakeholders [95]. These forces alone usually result in the transformation of the enterprise's political and economic structure. This force singularly can induce several salient, potent and counter-productive possibilities in that it can:

- Evoke conflict within the enterprise [46][83][85]
- Resistance to change [20][58]
- Create stress within the workforce [83][85]

As can be seen, EA alters stakeholder perceptions of the enterprise and as such changes their behavior which can seriously jeopardize the EA.

Given this perspective, this dissertation concludes that the techno-centric methodologies espoused by existing EAFs are deficient in neither providing mechanisms that recognize human behavior in their approach to EA nor contain any tools or processes that would mitigate adverse behavior in EA implementation [87][89][95]. Thus, the aggregation of these forces on EA elicits behavior that constricts, discourages, and limits stakeholder action and, at the same time, stifles their capacity to offer more innovative and creative approaches to problem-solving [87]. The EAFs fail to address issues such as:

- The need to involve users in all aspects of the analysis and design phase
- The necessity to distinguish between technology-oriented design and human-oriented design
- The elicitation of tacit stakeholder knowledge
- The need to provide for comprehensive humanistic-based EA control and governance

A better approach would focus on EA design in a more holistic and broader scope by not only considering the technical, business, solution architecture but inclusive of both stakeholder and organizational behavior aspects of EA design. These aspects would include the kinds of humanistic based principles and practices such as communication, education, and training programs we believe essential to deal with stakeholder relationships, interactions, and behavior.

Chapter Three – Human Behavior, Organizational Transformation, and Enterprise Architecture

The study of human behavior coupled with research into the impact management theory and organizational theory in an industrial setting has been the subject of debate and an ongoing topic of discussion for many decades [27][53][55][56]. The modern emphasis on the topic extends back to the early 20th century with Frederick Taylor's *scientific management* (*Taylorism*) theory, a form of industrial engineering postulated early in the twentieth century introduced to and used on the Ford assembly line [131].

This approach to management was followed in the 1920s with the Hawthorne Experiments and the beginning of group studies of human behavior in the workplace [15][131][136]. Today, *Taylorism* has diminished as a favorite management philosophy in many circles though it persists in some industries and there are conflicting opnions on the benefits of and on what the Hawthorne Experiments revealed [70]. However, the study of human behavior in conjunction with aspects of organizational theory, management behavior, sociology, and psychology is gaining more credibility and acceptance in assessing the impact of and the interactions of human behavior and information technology (IT) [20][53][58][99].

Other theories such as Herzberg's *Motivtion and Hygiene* [58], Mazlow's *Hierarchy of Needs* [83], and MacGregor's *Theory X* and *Theory Y* [85] have been widely written on and used to progress a more humanistic approach to motivate workers. Today, Giddens' *Theory of Structuration* [46] and Orlikowski's *Structurational Model of*

Technology [95] are now being recognized and seriously considered as potential influences in assessing the impact technology has on human behavior [87][89].

This chapter explores the interactions of human resoures involved in Enterprise Architecture (EA) design by examining the role that stakeholder behavior plays in the success or failure of EA. The motivation for this research focuses on organizational transformation brought about by EA and the subsequent behavior demonstrated by stakeholders involved in the change process. This dissertation examines and analyzes organizational transformation from three points-of-view:

- Stakeholder reaction to organizational change
- Stakeholder acceptance, rejection, and/or modification of new technology
- Management evaluation of risks caused by the uncertainties inherent and surrounding the design and implementation of technology-centric processes

This dissertation considers these aspects of human behavior to play a critical and pivotal role in the success and/or failure of EA and therefore must become a part of the EA development process.

3.1 Early Contributions to Human Behavior in the Workplace - An Introduction to Organizational Theory

Depending on the literature, the definition of organization takes on various meanings. For the purpose of this document, we have taken the liberty to consolidate several definitions into the following: “organizations consists of groups of people working together within a social structure made up of various elements that contribute to the whole and collective functions organized for a particular purpose” [27][86]. Organizations instantiate structure. In this instance, structure typically acts as a hierarchical framework within which an organization that [45][53][57]:

- Arranges its lines of authority
- Delegates and assigns roles, power, and responsibilitties
- Controls and coordinates communication and the flow of information between various levels of both management and staff
- Allocates rights and duties

Organizational structure generally takes two forms [20][55]:

- Centralized – decision-making power is concentrated in the top-level of management.
- Decentralized – decision-making and a degree of autonmy is distributed among organizational department, division, and subdivisions.

In either form, management and its behavior sets the environmental tone by establishing the rules, policies, and control mechanisms it feels are necessary to achieve defined objectives. Theories, on the other hand, are built from abstractions known as concepts based on phenomena of interest [55].

The phenomenon and academic research into the study of the interactions of human behavior and organizations, simply organization theory (OT) is too complex for a simple precise explanation. Human behavior is predominantly unpredictable in all organizations and in human interactions except in those organizations and situations that are tightly controlled and constrained by governance processes, rules, and policies that enforce and mitigate nonconforming stakeholder behavior [20]. Given this exception however, OT is the study of organizations and the role of stakeholders within the organization aimed at problem solving and improving operational efficiency and productivity [55].

An extensive analysis of the literature surrounding those related human behavior and organizational pathologies does not assign exact values or any formulae to explain much of the human action that occurs in the workplace [17][82]. For example, human action may be the result of an action by another person, group of people, the environment, or to some other stimuli. Their reaction to the event might then be intentional or unintentional, overt or covert, objective or subjective to which the acting individual attaches meaning and might therefore be difficult to define [46][58][68]. On the other hand, reliance on techniques such as statistical probablility, metaphors and analogy, and, in some cases, understanding and appreciation provide a variety of, and perhaps better, ways from which to draw upon to explain human behavior [27][58][83][85].

The relationship between information technology (IT) and OT currently consists of research performed by academicians from several disciplines and interdisciplinary specialities such as organizational theory, management science, sociology, psychology, and information science. Within these disciplines, each practioner posits their own preferred theories, concepts, and theoritical biases attempting to explain and answer the question “why do we do the things we do?” [82].

From its early beginnings in the first half of the twentieth century, classical organizational theory (OT) continues unabated to evolve. Though somewhat limited in scope, the ramifications of how people work and how managers manage those that work began to shape the culture and social environment during the 1920s and 1930s.

3.1.1 Scientific Management Theory

Frederick Winslow Taylor developed his "*Scientific Management Theory*" called "*Taylorism*" and stipulated "the principle object of mamagement should be to secure the maximum prosperity for the employer, coupled with the maximum prosperity for each employee" [131]. The theory analyzed workflows aimed at improviing operational efficiency and employee productivity. He popularized his theory by using financial incentives as a motivational tool to reward employees who exceeded peoduction measured against predetermined standards.

An interesting facet of his work found that some workers [131]:

- Were more talented and perhaps more intellignet than others but they were often unmotivated
- Were faced with performing repititive tasks performed those tasks at the slowest rate that went unpinished

Though popular through the 1910s, other prominent theorists in organizational theory and management behavior such as Elton Mayo (1880 – 1949) theorized that economic incentives only partially explained individual motivation and satisfaction [84]. His contributions have been criticized in recent years because his efforts were directed towards the work group and the labor-management cooperation while ignoring or belittleing topics directed on industrial relations. However, his participation with Fritz Roethlesberger and William Dickson formulated theories concerning factors that increased human motication and satisfaction.

3.1.2 The Hawthorne Experiments

No study of human behavior would be complete without referring to the Hawthorne Experiments conducted at the Western Electric Company at the Hawthorne Works in Chicgo, Illinois between 1924 and 1932 [70][84][103]. Considered as groundbreaking in human relations within the workplace, research teams from the National Research Council (NRC) and the Harvard Business School conducted a series of tests that initiated a major shift in the study of management from a scientific to a multi-disciplinary approach [15][103]. Ths experiments introduced various foms of stimuli into the work environment each producing an increase in employee productivity. Analysis of the studies reveals the art and science of this seminal behavioral study with questions and theories related to the relationships between employee (i.e., stakeholder) productivity and the needs that motivate those stakeholders [84][103].

The Hawthorne Experiments consisted of three separate and independent tests, the [84]:

- Illumination Tests
- Relay-Assembly Tests
- Bank-Wiring Tests

Conduced over a period years, the Hawthorne Experiments examined various aspects of the workplace to evauluate working conditions and employee attitudes towards the work.

The first test, the Illumination Test, was to primarily determine and assess illumination and worker productivity. The test fund that though illumination was one factor that increased worker productivity it was not ther most important. The researchers concluded that human factors outside the study were more significant. Unfortunately, the human factors were not part of the test and as such were not controlled, and were therefore unidentified [70][84].

The Relay-Assembly Tests were designed to measure and evaluate the effects rest periods and hours of work would have on efficiency and to determine why employee productivity declined in the afternoon [84]. The conclusions drawn by the test researchers found that a complex battery of attitudes influenced by outside factors such as conditions at home or within the community, pror life experiences, as well as the worker's social situation at work influenced their behavior [84]. Of interest is the recognition of the cognitive aspects of human behavior in the workplace at this point in industrial history. This lends support to our belief that stakeholder behavior is affected by their cognitive experiences and thus their ability to contribute [89][90].

The researchers also found that changes in pay, working conditions, and supervision alone could bring about desired change. It's interesting to note at this point that Herzberg in his Motivational Theory came to this same conclusion [58]. However, employees felt more positive about the work environment when an interviewer or listener showed interest in their activities. This supports our claim that the behavior and attitudews of management plays a significant role in EA propject success or failure [87][88][90].

The final experiment, the Bank-Wiring Test, was designed and intended to study the Bank-Wiring Unit as a functioning entity and observe its behavior [84]. The test was to oberve and study the social relationships and social structures within the bank-wiring group [84]. The wiring work itself was repititive, requiring workers to stand for long periods of time, and therefore tiring. An intersting aspect of the study found that the observers were met with resistance by the wiring shop foreman resulting in the work being done outside the wiring area [70][84]. The literature did not provide any rationale for the foreman’s behavior but it would not be unreasonable to conclude that two factors may have influenced what appears to be autocratic and dictitorial behavior. The foreman:

- Was not interested in participating in the study
- Was concerned more with meeting production schedules rather than devising motivational mechanisms and improving the work environment

The study findings confirmed the complexity and importance of group relations, the importance of what and how workers felt about one another, and that group expectations were more important over that of an individual.

The Hawthorne Experiments, or as it sometimes referred to the “Hawthorne Effect”, describe early research into worker attitudes recognizing the need to understand what motivates workers and their behavior. It identified supervision and formal group work and behavior as esential components to organizational objectives and efficiency Considered as the most important study of social behavior in the workplace, it has its detractors [70][103].

The study has been criticized by some economists, sociologists, and psychologists who seem to want to defend their respective areas of expertise rather than defining assessable flaws in the study. For example, Mayo has been criticized for his conservtive views while others such as Daniel Bell focused on the exclusion of unionized workers [70]. Other sociologists cite the influence and pressure form corporate management as factors in what they term “bad science” with the management influence on researchers deemed “servants of power”.

3.1.3 Abraham Maslow and the Hierarchy of Needs

Abraham Maslow is best known for his *Hierarchy of Needs* which he based on the needs of creative people who used all their talents, potential, and capabilities (see Figure 10) [21]. His hierarchy crosses many disciplines including business, technology, education, hospitals, and his primary field psychology. The hierarchical nature of his theory divided a needs structure into two categories:

- Basic needs – phsyiological needs which include water, food, and sleep, and psychological needs such as affection, security, and self-esteem.
- Metaneeds – “being needs” or growth needs which include justice, goodness, beauty, order, unity, etc.

Maslow identified *human motivation* as the need and basis for people seeking fulfillment and change through personal growth [21][83].

Maslow‘s work focuses on what he refers to as *self-actualization*, a state all people are capable of achieving but that only few ever do. In this contect, self-actualization refers to the need for personal growth that is present throughout a persone’s entire life [83]. According to Maslow, all people are always “becoming” and never remain static. He assigned fifteen characterisitcs to *self-actualized* people that include their ability to:

- Percieve reality efficiently and to handle uncertainty
- Accept themselves and others for what they are
- React spontaneously in thought and action

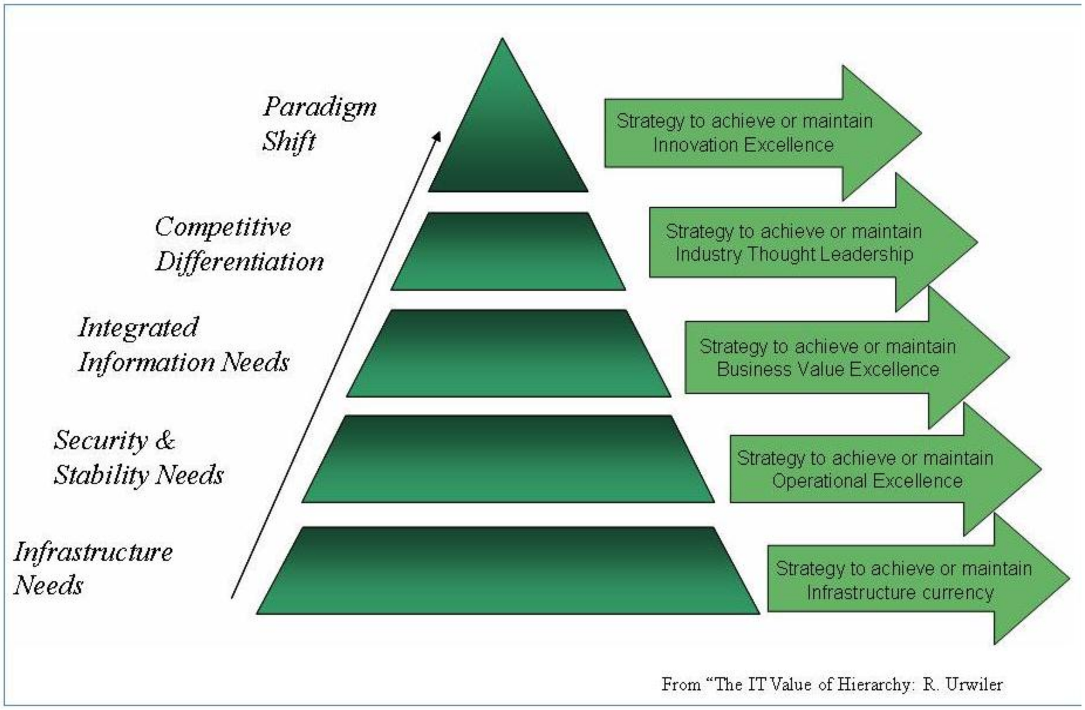

Figure 10. Maslow's Hierarchy of Needs Pyramid and IT Value [133]

- Be problem-cenered without being self-centered
- Have an unusual sense of humor
- View life objectively
- Be highly creative
- Demonstrate a concern for the welfare of others
- Appreciate basic life experiences
- Establish ninterperesonal relationalships with a few people
- Peak experiences
- Desire privacy
- Exhibit democratic attitudes
- Maintain strong ethical and moral standards

The behavioral characterisitcs find that self-actualizers:

- Experience, absorb, and concentrate on life like a child
- Try new things rather than sticking to safe
- Evaluate and listen to their own feelings rather tha to those of tradition, authority, or others
- Avoid pretense or "game-playing" and being honest
- Are prepared to be unpopular if their views do not coincide with those of the majority
- Take responsibility for ther actions and work hard
- Try to identify their defenses and yet are willing to give them up

The above reflect Maslow's theory concerning self-actualization which he believes all people strive to achieve. Maslow identified the familiar hierarchy of prioeities for human needs staring with the base level those physiological needs: air, water, and clothing. Next is the need for safety and shelter and so on up the hierarchical chain. Implicit in the hierarchy is that each need must be fulfilled in order to progress to the upper layers of the pyramid [19][83]. For example, Mazlow's theory states that the higher needs of humans only become the focus of attention after the lower needs are satisfied [83].

Literature on Maslow's *Hierarchy of Needs* and its application to technology is somewhat limited. However, our research into and the anlaysis of available literature ties Mazlow's hierarchical pyramid to technology, especially systems development and management, to the various pyramid layers [19][133]. One such example is shown above in Figure 10. Though useful in bringing a sense of order to understanding the unpredictable nature and chaos of humen behavior, Maslow fails to fully reflect the social aspects needed by humans such as collaboration and social connection. An interesting perspective presented in [133] equates the needs of an organization with those of humans. In this context, the higher technological needs of the enterprise become the focus of ambition once the fundamental needs of the organization are satisfied.

Given the premise that technology is a tool for accomplishing some work/task, Maslow, by recognizing human needs from the bottom up, allows us to observe behavior as not necessarily reflective of what we unconsciously do but rather to map social behavior to human survival. This facilitates a sense of belonging and social connectivity and survival that contributes to:

- Collaboration and teamwork
- Reciprocal and trusting relationships
- Social identity and validation
- Group competence and an enhanced attachment to the group

In implementing new technology, recognizing and addressing these factors during EA better ensures a participative environment for stakeholders.

3.1.4 The Motivational Theories X and Y

Douglas McGregor, a noted American socialogist, proposed his two theories of management style in the 1960s labeled Theory X and Theory Y [85]. Each theory defines a particular type of management style still viewed today as salutary and a reminder of the natural roles of management behavior towards people. The theory refers to and is based on the Psychological Contract between employers and employees addressing the concerns and concepts of mutual expectations of inputs and outcomes [85].

The Psychological Contract proposed by organizational and behavioral theorists Chris Argyris and Edgar Schein is usually seen from the standpoint of feelings of employees as the fairness and balance between:

- How the employee is trated by the employer
- What the employee puts into the job

MacGregor's Theory X defines an authoritative management style with Theory Y a more participative form of management (see Table 3) [85]. The behavioral characteristics of the Theory X manager include traits such as being:

- Results and deadline driven to the exclusion of everything else
- Intolerant, fact, and figures oriented
- Unresponsive to or have an interest in human issues
- A one-way communicator and poor listener
- Autocratic and dictatorial in issuing work instrcutions, etc.

Theory Y, on the other hand, ecourages a participative work wnvironment often sharing in decision-making and fostering feelings of teamwork.

A recent theory proposed by William Ouchi, Theory Z, is frequently referred to as the "Japanese" management style [100]. The difference between MacGregor's Theory Y and Ouichi's Theory Z are where MacGregor focuses on management and motivation from the manager's perspective, Theory Z places more reliance and responsibility on the attitude and responsibilities of the worker. Table 3 represents our compilation of the significant aspects of characteristics of MacGregor's Theory X and Y and Ouichi's Theory Z [85][100].

Theory X	Theory Y	Theory Z
The average person dislikes work and will avoid if he/she can	Effort in work is as natural as work and play	Incorporates all of Theory Y
Most people must be forced to work towards organizational objectives	People will apply discipline and self-control in the pursuit of organizational objectives without external influences	Places a lot of freedom and trust with workers
The average person must be directed to work	Commitment to objectives is a function of rewards associated with their achievement	Assumes workers are loyal and desire working within organizational teams
The average person wants to avoid responsibility	People often seek and accept responsibility	Places more reliance on the attitudes and responsibilities of the worker
The average person is unambitious	Using a high degree of imagination, ingenuity, and creating in problem solving is widely distributed within the organization	Focuses attention on worker behavior to provide motivation towards organizational objectives
The average person wants security above all other needs	The intellectual capacity of people in industry is underutilized.	

Table 3. A Comparison of Management Theory X, Y, and Z

The application of both Theory Y and Theory Z in developing what is essentially knowledge-based technology depends on stakeholders willing to invest and put at risk the information they hold. In this context, stakeholders hold claim to a legitimate role in shaping organizational objectives that are consistent with their interests and values. Today, the relationships between stakeholders and organizations are inextricably intertwined such that management and management education needs to take a longer-term and more sustainable approach in dealing with professional and organizational standards, ethics, and norms.

3.1.5 The Two-Factor Theory

Frederick Herzberg, a clinical psychlogist, addresses management ethics and the well-being of people in the workplace. His primary study, a survey of 200 engineers and accountants in Pittsburg utilized a technique considered unique at the time of based on “open” questions. Open questions requires more discussion from the interviewee than “closed” questions that require only a yes/no resonse or the selection from an extent-based multiple-choice question. As a result, more meaningful results were obtained by exploring several perspectives/factors that affect job satisfaction [58]. These perspectives/factors are associated with “job enrichment” and include:

- Job satisfaction and dissatisfaction referred to and labeled respectively to as motivators and hygienes (hygiene factors)
- The effects and duration of high and low feelings/atitude
- Separation of these factors into a first level or main casual fators and second level factors such a those derived from probing further during the interview process
- The interrelationship between factors

His theories attempt to bring more humanity and caring into the workplace focusing on how to manage people properly to improve organizational performance. His studies focused on motivation and attitudes of the worker to determine which factors influenced their behavior: satisfaction (motivation) and/or dissatisfaction. Six factors factors ranked from high to low are illustrated in Table 4.

The implication dereived from Herzberg’s theory are that management must ensure:

- The job should have enough of a challenge to utilize the full ability of the emplyee.
- Employees who demonstrate increasing levels of ability should be given increasing levels of responsibility.

- That if a job cannot be designed to use an employee’s full abilities, then the firm should consider automating the task or replacing the employee with one who has a lower level of skill. If a person cannot be fully utilized, then a motivation problem exists.

Dissatisfaction	**Satisfaction**
• Company Policy	• Achievement
• Supervision	• Recognition
• Relationship with the boss	• The work itself
• Work conditions	• Responsibility
• Salary	• Advancement
• Relationship with peers	• Growth

Table 4. The Herzberg Hygiene Theory

Herzberg’s research does not include many assumptions preferring to target “critical incidents” provided by study respondents. His open question approach to interviewing respondents gleaned more information for analysis than the conventional closed qusetions requirng simply a yes or no answer.

His use of the following phrase "We can expand ... by stating that the *job satisfiers* deal with the *factors involved in doing the job*, whereas the *job dissatisfiers* deal with the *factors which define the job context*" helped explain that factors which motivate workers are different to but not simply the opposite factors that dissatisfy. According to Herzberg, huamn beings have two sets of needs [58]:

- One as an animal to avoid pain
- The second to grow psychologically as a human being.

While focusing on the Psychological Contract, Heerzberg understood well, like Maslow, the importance and relevance of ethical management, social responsibility, fairness, justice, and compassion in the organization [58]. Though there are weakneses in the Herzberg theory, it endures because it recognizes that motivation comes from the person.

3.1.6 Sociological and Psychological Theory and Stakeholder Behavior

In analyzing the impact of technology and specifically EA, the lack of stakeholder acceptance and use of technology has long been recognized as an impediment to the success of new information technology [27][33][41]. In fact, stakeholder acceptance is often considered the pivotal factor in determining the success or failure of an IT project [33]. There are many theories ascribed to manage and motivate human behvior in the workplace.

Given this perspective, the Hawthorne Experiments provide an understanding into group behavior in the workplace and the influence various forms of stimuli have on increasing stakeholder on-th-job performance. The sociological theories describe various ways of managing and ways to motivate and treat stakeholders. The information gathered from this research provides a perspective on human behavior to be taken into account during EA design.

3.2 The Human Side of Information Technology

Most people today recognize human behavior as a means in identifying our existence as social beings who live out our lives in the company of other humans. As social beings, we organize into social groupings such as countries, cities and towns, clubs, and the places in which we work. As such, the forces that influence our behavior in these various settings may be either internal or external to the setting and are affected by and can come from many sources such as [58][83][85]:

- Genetic inheritance

- Past and present life and work experiences
- The behavior of others that surround and influence our daily lives
- Changes in the environment in which we function

In effect, these forces form the basis for the cognitive aspects of human behavior upon which we rely shaping the way we develop and grow and thus influence our future capacity to contribute (see Figure 11) [89][95]. This allows us to study human behavior from a variety of cultural, political, economic, socialogical, and psychological perspectives [21][27][46][131] and thus facilitate our ability to analyze human behavior and its effect on organizations where change is iminent such as that which occurs when new technology is to/will be implemented.

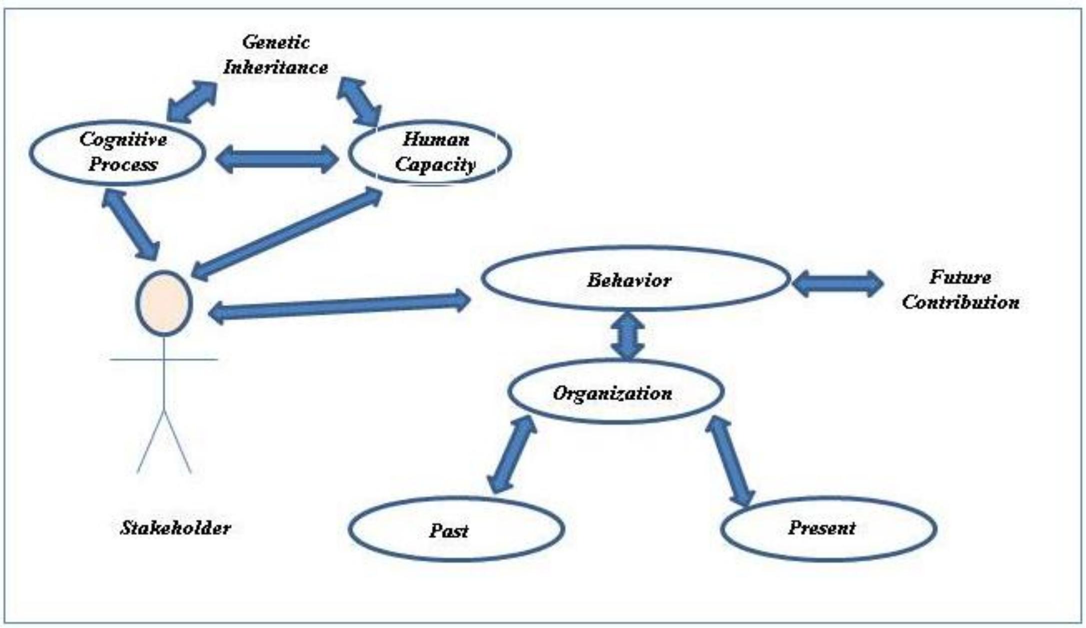

Figure 11. The Cognitive Nature of Stakeholder Behavior

Cultural effects on behavior begin at birth predicated upon the social and cultural context of our environment. With the passage of time, these life experiences either stimulate or inhibit as well as constrain and/or limit cultural growth impacted by the surroundings in which we live and function. For example, our interactions with other people, our learning experiences encountered such as reward and punishment, ways of making a living, and social roles are based on our collective life experiences. We must also recognize that these behavioral patterns can be different depending upon the circumstances and the environment in which the stakeholder is exposed. Similarly, the introduction of new technology affects the social structure of an organization and is significant in how stakeholders are motivated and committed to the inevitable organizational transformation and their new status, roles, duties, and responsibilities within the new organization [20][83].

In today's business climate, an EA represents a continuously evolving architecture aimed at improving operational efficiency and effectiveness. In the development of an EA, an EA Plan (EAP), documents the requirements that drive EA focusing on the architectural design, alignment, implementation, and deployment of new and/or enhanced technology [76][91]. EA requirements are predicated on gathering, analyzing, and validating explicit and tacit organizational knowledge. Thus, the EA focuses on the information technology (IT) processes, related artifacts, platforms, software applications, and business and strategy to support and accomplish IT operations [77][91][128].

However, the implementation of an EA poses several potential problems requiring organizational management and an Enterprise Information Architect (EIA) to address and resolve: EA redefines the way and manner in which an enterprise functions [95] and, therefore, affects either positively or negatively stakeholder behavior.

First, EA changes the enterprise's structure, characteristics, culture and political climate of the workplace [20][95]. As a result of this transformation process, two outcomes for the EA are possible:

- It can be accepted as the new norm for the enterprise, in which case the enterprise simply moves on.
- It can have a negative effect on stakeholders and be rejected and/or modified to meet their personal goals and objectives. In this situation, the behavior of all involved in the process may be altered, and in some cases, it may literally tear the enterprise apart influencing the potential life of the enterprise by introducing factors into business operations that management may or may not be able to cope [83][85].

Second, the impact of these outcomes can produce behavioral patterns that can jeopardize the viability of the EA ending with the EA being improperly aligned with the enterprise's strategic business plan and operating model to either being partially implemented or completely abandoned [95]. The question then becomes: why didn't the changes brought about by EA work?

Answering this question is difficult as causal factors differ. However, most literature attributes failure directly to erroneous requirements (i.e., organizational knowledge) [39][43][44][113], which we will collectively label hereafter as simply "poor architecture". However, we look at the problem and resolution from a different point of view: human behavior and the impact technology has on that behavior. From this position, EA can be defined as being influenced by two separate and distinct perspectives which we will categorize as: 1) the context or environment in which EA functions; and, 2) the processes it symbolizes.

EA context is made up of sociological, organizational, and psychological elements such as stakeholder attitudes and behavior, and organizational norms, policies, politics, standards, and resources. EA frameworks (EAF), on the other hand, take on the more techno-centric aspects of EA design that consist of methods for developing the EA [39][91]. Yet, the interactions between the context of EA and its process are dependent. However, if not properly managed, they can pose a conflict in EA design in deciding the weight that should be apportioned to either context or process, potentially jeopardizing the success of the EA.

EA focuses on engineering principles and practices as a means to synchronize organizational activities and engineering modeling schemes to develop and test the architecture. The reality here lies in the fact that stakeholder requirements drive EA design [39][91][116][127]. However, the EAFs used to do the work are formulated around highly techno-centric processes and procedures based on the modalities of traditional computer oriented and computer science theories [71][77][106]. Existing EAFs aim at solving business problems from a purely technical perspective and do not include stakeholder behavior as a significant influence on EA design.

Given this perspective, each enterprise has its own characteristics, culture, and social structure which the enterprise information architect (EIA) must understand and include in the development of an EA. For example, stakeholders are expected to adapt to new environmental conditions imposed by the EA. This influences stakeholder behavior with the assignment of new roles, duties, and responsibilities which, in some cases, they are expected to assimilate unquestionably [20][23][95]. This works well in enterprises that routinely function in a tightly controlled environment, it will not in others [46][83][85]. In most cases however, stakeholders typically perceive these changes as a diminution of influence within the enterprise.

Therefore, the lack of continuity between EA context and process has the potential to cause conflicting views of the EA, altering the previously known stable state most enterprises and stakeholders strive for in the workplace. From this, the integration of sociologically-oriented principle with the existing techno-centric EAFs becomes a viable solution to EA design. Failure to implement such an approach leads to negative stakeholder behavior which may be observed in one of two ways [20][46]:

- They may resist the EA either overtly or covertly by exhibiting their reluctance to follow new norms, rules, and policies established by the enterprise.
- They may intentionally or unintentionally miscommunicate, mislead, and/or provide erroneous requirements as input to and thus sabotage the EA.

In either case, the EA may be jeopardized such that the enterprise reverts to the previous architecture. Reversion to the previous state is detrimental in that more efficient and effective technology is subverted and therefore enterprise growth is inhibited.

3.3 Organizational Theory and Enterprise Architecture

Inevitable with the introduction of Enterprise Architecture (EA) comes organizational transformation [90]. Organizational transformation, on the other hand, changes the character, culture, environment, and social structure of the organization often times resulting in the change taking on an undesireable form [68][81][95]. In some cases, it is used to restructure an enterprise to hide inefficiencies in management practices and eliminate employees that are no longer needed [81][85][98]. Researchers have adopted a myriad of of approaches to assess mechanisms which allow projects such as an EA and organizational transformation can be handled, managed adequately, and controlled. The dimensions and extent of EA, its implementation, and its affect on the organization depends upon a variety of factors. These factors, in many csaes, are not related to technology but more often than not associated with non-technical issues such as stakeholder behavior, management practices, oranizational structure as well as the competitive, macro-environment, and internal politics and power structure inherent in most enterprises [20][81][90][95].

The concept of Organizational Theory (OT) is an abstraction based on the phenomena of unpredicatable human behavior, except in tightly controlled and constrained environments. Examining conceptualizations of linking IT and OT extends several decades into the past to the 1950s where an abundance of literature has been produced citing the influence of human behavior has on IT projects. With the recognized emergence of EA in the 1980s, the earlier research into IT and human behavior has been extended into the EA world.

Several views of the literature focus on quantitative and qualitative aspects of IT, and thus EA, and OT reseacrh illustrating various approaches to research. These studies include conceptual, empirical, theoritical, and analytical applyication of both theory and grounded observtion using case studies to explain and foster sollutions to complex behavioral concerns [23][44][86][97]. However, the literature does not provide any guidelines or potential solutions to dealing with EA and organizational transformation.

There is little question that the human relations movement evolved as a result of difficult authoritarian management pricatices. However, EA tests the boundaries of human behavior perhaps requiring new approaches to EA design and implementation that include OT as well as principles and practices from the fields of sociology, psychology, and management behavior.

3.4 Summary

Enterprise Architecture (EA) and the introduction of new and/or enhanced technology into an organization often results in a sociological and a political change in the hierarchical structure of the enterprise. This is evidenced by a dynamic shift in internal and perhaps external perceptions of the organization. Stakeholder roles and responsibilities invariably change because of new rules, policies, procedures and processes introduced by technology into the organization. The result of these changes is frequently met with stakeholder resistance to change often followed by rejection and/or modification of the technology.

To manage and control the complexity of an enterprise requires the coordination and control of activities embedded in the complex networks of techno-centric relations and boundary spanning exchanges. Therefore, the manner in which the EA design takes place can seriously affect acceptance and/or rejection of the EA by different stakeholders. This depends upon stakeholder participation in the EA process. In examining the factors associated with EA failure, we find several of the causes to be [90]:

- Poor communication
- Lack of leadership
- Lack of top-management support and sponsorship

- Underestimating the importance of change and change management
- Lack of technical and business knowledge
- Poor project management

These factors are counter-productive yet they can be minimized and mitigated by providing an environment where stakeholders are involved with and are active participants in and are receptive to change. Such an environment fosters collaboration and information sharing where stakeholders communicate both horizontally (i.e., peer-to-peer) and vertically (i.e., up and down the hierarchical organization chart) whenever and however they need to in order to solve problems and exchange knowhow and knowledge (see Figure 12) [87].

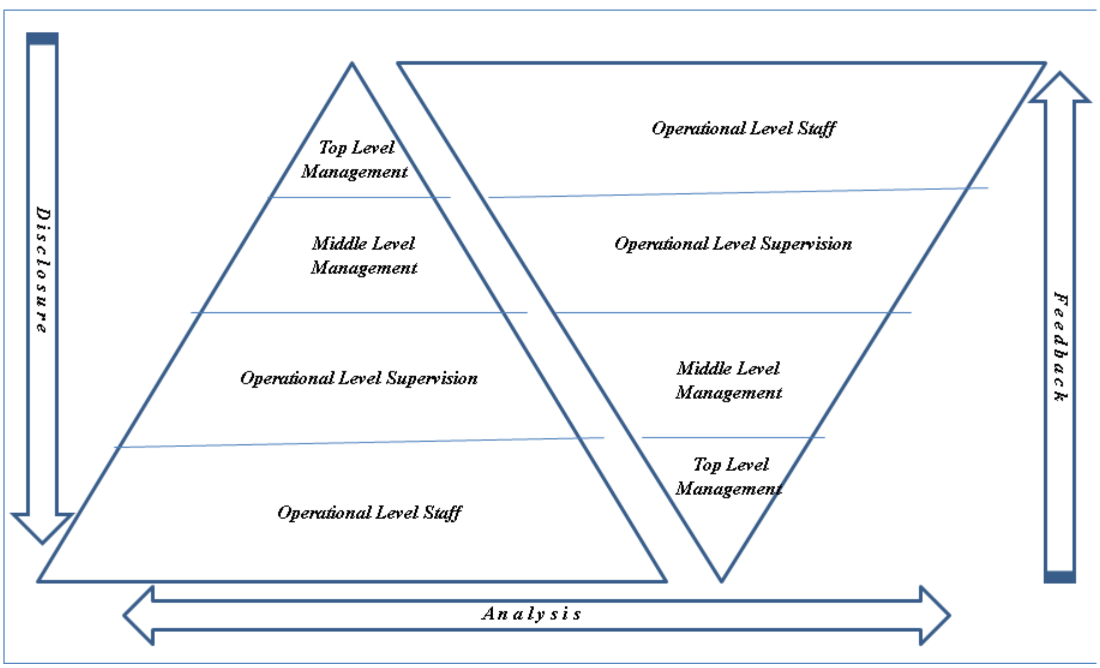

Figure 12. A Socio-Communicative Communication Channel

There is much that can be learned, extracted and used from the theories and writing from notable sociologists and psychologists such as Mayo, Maslow, MacGregor, Ouichi, and Herzberg to better understand and explain the effects of technology on human behavior. We plan to advance our work into human behavior and the influence it has on EA either positively or negatively to provide a better platform to manage and govern the design process. Aspects of organizational theory, sociology, psychology, and management behavior will be expanded to pursue development of an EA framework and comprehensive modeling scheme that better ensures EA quality.

Chapter Four – Enterprise Architecture and Applying the Theory of Structuration

The development of complex, large-scale information technology (IT) systems planned for in Enterprise Architecture (EA) expect changes to take place in organizational design aimed at improving operational efficiency and effectiness [95][104]. The traditional approaches to EA typically requires the use of a wide-range of diverse, techno-centric information technology (IT) disciplines and frameworks to accomplish the work [9][39][91]. The disciplines embrace all aspects of software engineering, requirements engineering, and systems design and analysis [39][47][91][127]. The EA frameworks (EAF) include those proposed by Zachman, The Open Group, and the federal government (FEAF and DoDAF) [4][30][109][141]. Over the years, the nature of both the disciplines and the frameworks remains a technically-oriented process [23][32][41]. Forgotten, for the most part, are the changes made to stakeholder roles, duties, and responsibilities brought about by organizational transformation and the impact these changes have on stakeholder behavior [20][90][99]. We identified these factors in our research and published and presented our findings in the following two papers:

- "*Applying the Theory of Structuration to Enterprise Architecture Design*.", 2011 World Conference on Computer Science, Computer Engineering and Applied Computing, International Conference on Software Research and

Practice, IEEE/WorldComp 2011, SERP 2011, Las Vegas, Nevada, July, 2011 (acceptance rate 22%)

- "*Enterprise Architecture and Organizational Transformation: The Human Side of Information Technology and the Theory of Structuration*.", 2012 World Conference on Computer Science, Computer Engineering and Applied Computing, International Conference on Software Research and Practice, IEEE/WorldComp 2012, SERP 2012, Las Vegas, Nevada, July, 2012 (acceptance rate 28%)

These papers concluded that any EA initiative needs to incorporate a dynamic, behavior-driven view of an organization that enables an EA to be aligned with an objective such as Giidens' *Theory of Structuration* [46].

Our research and analysis found that current EA processes rely solely on an EAF which, in turn, depends on the epistemological characteristics, culture, and policies of the organization to develop the EA plan (EAP) [76][95]. However, the interactions, goals, objectives, and behavior of stakeholders involved in the development of the EAP are often at odds with the strategic plans of the enterprise resulting in the EA being either partially implemented or completely abandoned [44][89][113].

From this position, EA can be defined as being influcenced by two separate and distinct perpsectives which we will categorize as:

- The context or environment in which EA functions
- The processes it symbolizes

In EA, context is made up of sociological, organizational, and psychological elements such as stakeholder attitudes and behavior, and organizational norms, politics, standards, and resources [20][23][90][99]. EA frameworks (EAF), on the other hand, take on the more techno-centric aspects of EA design, the processes that consist of methods for developing the EA [39][91]. Yet, the interactions between the context of EA and its process are dependent and the reality of EA [90]. However, if not properly managed, they can pose a conflict in EA design in deciding the weight that should be apportioned to either context or process, potentially jeopardizing the success of the EA. Anthony Giddens' *Theory of Structuration* provides a solution and an explanation to dealing with complex organizational processes involved in EA design.

This chapter explores the behavioral patterns exhibited by both the organization and stakeholders during EA. It considers stakeholder and organizational behavior as a multi-faceted, complex system/entities that together recursively affect the design, implementation, and use of enterprise-wide information technology. It asserts that a better approach for EA design and implementation is one in which principles from the fields of sociology, psychology, organizational theory, and management theory are integral components of the EAF landscape. This work believes that the behavior of stakeholders and the organization are a significant part of the EA development process.

Our model focuses on the impact of human behavior as an input to the EA as well as how human behavior is affected by the introduction of new or enhanced technology. We examine Giddens' *Theory of Structuration* and its application in the realm of technology [46][95] as it relates to, and can be used for, EA. The theory describes the interactions and interrelationships between human actors (i.e., stakeholders) and structures (i.e., organizations) and provides the foundation that allows us to:

- Examine current EAFs for their approach to stakeholder behavior as an input to, and a reaction from, the development of an EA.
- Describe the inclusion of a behavioral and organizational theory, the *Theory of Structuration*, as a lens by which the development of an EA can be used to understand the importance of stakeholder behavior.

The use of the *Theory of Structuration* as a foundation for examining and understanding stakeholder behavior as an input to, and reaction to, EA is necessary to develop models and approaches for their inclusion into EAFs to promote EA success.

4.1 The Impact of Stakeholder Behavior on Enterprise Architecture Design

Formulating an effective Enterprise Architecture (EA) plan (EAP) depends on the quality of design requirements elicited from stakeholders [30][91][127]. In this context, EA represents a significant investment of enterprise resources and, if successful, serves as the instrument leading to a major change or shift in the structure, character, and culture (i.e., structure) of the organization [20][90][95]. The change in organizational structure, however, frequently is met with resistance from stakeholders who are reluctant to change and accept and use the new technology afforded by EA [50][57]. Resistance to change is not atypical human behavior. Stakeholders frequently characterize changes in their behavior to changes in an organization’s structure and its behavior [20][45][65][95]. This behavior is usually attributed to that caused by changes in management behavior [4][46][83][85]. However, we will examine this issue and its resolution from a different point of view. Resistance to change may be the result of:

- The desire for both individuals and organizations to trend towards a stable environment and a state of equilibrium [76].

- New stakeholder behavior caused by a perceived diminution of influence within the enterprise manifesting itself in behavioral patterns that are not aligned with achieving organizational goals and objectives [20][23][95].

In either case, individual, and consequently organizational, resistance to change may result in work intentionally being sabotaged either overtly or covertly thus allowing the organization to revert to the known equilibrium of the past [83][85].

People (i.e., stakeholders) view technology from different perspectives, reacting to it accordingly, and for several legitimate reasons [81][83][88]:

- Fear of job loss and job security
- A perception of loss of status, roles, duties, and responsibilities within the organization
- A feeling of disempowerment
- The need to learn new procedures and processes
- Belief and feeling that the employer no longer cares about the employee

These behavior patterns can constrain stakeholder action, stifle innovation and creativity, and affect the quality of requirements provided by stakeholders [87][95].

In the past, stakeholders have accepted the infusion of technology (e.g., hardware, software, and processes) solutions into their daily lives without question [45][55]. That is no longer true today. Stakeholders frequently question, either covertly or overtly, new or enhanced technology in relation to how it might affect the environment in which they function [95]. This change in human behavior poses a topic of high relevance to EA management and in how Enterprise Information Architects (EIA) do their work given that technology can be accepted, rejected, or modified to fit the roles and personal goals and objectives desired by stakeholders [23][90][95]. From an analytical perspective, these personal goals and objectives may:

- Be contrary to those of the organization
- Represent the self-interests of the stakeholder
- Limit stakeholder innovation and creativity
- Include the perceptions and be influenced by the behavior of other group members
- Affect their capacity to act within and for the organization or to undercut its policies and procedures
- Pose an influence on and perhaps a major threat to EA success [46][58][85]

It also raises questions about how EIAs must evaluate the quality of the elicited design requirements and how the unanticipated use of technology might affect EA design throughout the EA design effort [95]. Stakeholder use of technology therefore manifests itself in two ways:

- How the solution may be either abused or used properly
- Designing the solution such that it identifies and handles abuse

If we consider the elicitation of stakeholder EA requirements as knowledge creation, simply organizational knowledge held by stakeholders, as the intersection and interaction of technology and stakeholder behavior, then how stakeholders create, process, and provide that knowledge as input to the EA becomes a recursive process directly related to organizational behavior and environment. This knowledge is then a dynamic recursive re-conceptualization of organizational knowledge creation that directly affects the quality of EA design while providing a paradigm for effective EA.

Historically, social theorists have asserted that top-management behavior permeates through all layers of an enterprise influencing the organization's work environment, culture, and social structure [20][23][58][85][95]. From this perspective, the enterprise, represented by its management behavior (i.e., its attitudes, rules, and policies) maintain a deeply ingrained mechanistic view of technology. This view stems from a utilitarian economic emphasis on improving operational efficiency coupled with a desire to increase stakeholder productivity [20][33][54]. Stakeholders, on the other hand, are purposeful beings which exhibit will - stakeholder will may act in concert with or oppose enterprise goals and objectives. The addition of technology to the equation thus [20][83][85][95]:

- Compels stakeholder action to accept, reject, or modify potential EA solutions
- Influences stakeholder behavior and attitudes towards the organization
- Affects the feedback loops and selection mechanisms for managing, monitoring, and governing EA design activities

Therefore, we can conclude that the interactions and behavior of all stakeholders involved in EA design play a critical role in the success or failure of EA.

4.1.1 Introducing Technology into the Enterprise

Where technology is involved, user behavior often reveals itself in the way in which it is presented. For example, if the technology is introduced unexpectedly and without any input from or concern about stakeholders, it then may be either accepted or rejected by those involved in the technological transition [39][76][83][85][95]. In some cases, stakeholders may also modify the technology to suit their own personal goals and objectives [87][95]. The behavior displayed is often in defensive routines and mechanisms consisting of a continuous sequence of actions that is continually being reproduced by the stakeholders involved and is based on their personal or group to which they belong values and beliefs [40][46]. Where gathering stakeholder information (i.e., requirements) is essential to EA, this behavior may result in stakeholder attempts to deceive, withhold, manipulate, or distort information during the EA design process [83][85]. Therefore, user behavior becomes a critical and potentially costly component to EA - affecting project success and/or failure with a need to mitigate stakeholder and organizational resistance to change and their respective attitudes towards new technology [95][98].

The major EA framework (EAF) methodologies described and used today to progress EA (Zachman Architectural Framework [140][141], TOGAF [108][109], FEAF [8][30], and DoDAF [4]), the view of user and organizational behavior varies from being either cursorily considered or completely avoided in developing the EAP [116][120]. Literature typically recognizes stakeholders and the need to gather information but the elicitation effort acts primarily from a techno-centric perspective. Yet, any discourse regarding technology should be inextricably linked to the social context of its formulation and use. EA can be defined as being influenced by two separate and distinct points-of-view which we will categorize as: 1) the context or environment in which EA functions; and, 2) the processes it symbolizes.

EA context is made up of sociological, organizational, and psychological elements such as stakeholder attitudes and behavior, and organizational norms, policies, politics, standards, and resources. EA frameworks (EAF), on the other hand, take on the more techno-centric aspects of EA design that consist of methods for developing the

EA[39][91]. Yet, the interactions between the context of EA and its process are dependent. However, if not properly managed, they can pose a conflict in EA design in deciding the weight that should be apportioned to either context or process, potentially jeopardizing the success of the EA.

Given this premise, technology, if taken singularly and in isolation, can be easily constrained resulting in limited stakeholder innovation, creativity, participation, interest, and commitment when designing and implementing the new EA procedures, tasks, techniques, tools, user knowledge requirements, roles, and responsibilities without considering their impact on human behavior [46][83][85][87]. For example, user resistance to the technology can be considerable [76].

From this viewpoint, we can conclude that each enterprise has its own characteristics, culture, and social structure which the enterprise information architect (EIA) must understand and include in the development of an EA. For example, stakeholders are expected to adapt to new environmental conditions imposed by the EA. This influences stakeholder behavior with the assignment of new roles, duties, and responsibilities which, in some cases, they are expected to assimilate unquestionably [20][23][95]. This works well in enterprises that routinely function in a tightly controlled environment, it will not in others [58][83][85]. In most cases however, stakeholders typically perceive these changes as a diminution of influence within the enterprise.

Therefore, the lack of continuity between EA context and process has the potential to cause conflicting views of the EA, altering the previously known stable state most enterprises and stakeholders strive for in the workplace. From this, the integration of sociologically-oriented principles with the existing techno-centric EAFs becomes a viable solution to EA design. Consequently, the manner in which the EA design effort is supported and deployed by a development methodology (in the case of EA an EAF), as well as the design and implementation approach taken by organizational management significantly affects how stakeholders perceive and behave during the EA design process [20][46]. As a result, user behavior should be viewed as the result of, and due to, cognitive processes learned resulting from experiential organizational behavior and their ability to adapt to a changing environment which would in turn affect their respective future capacity for handling and accepting change [20].

4.1.2 Consequences of Stakeholder Behavior on Enterprise Architecture

The failure of many EA projects can be traced to the multi faceted sides of human interaction with new technology [40][82]. This frequently results from either a lack of knowledge about the new processes and procedures being implemented or the by-product of negative human behavior interjected into the design and implementation of EA [12][17][45]. In either case, human behavior plays a pivotal role and, therefore, a better framework for EA should include processes to better understand and deal with the societal, organizational, and personal contexts caused by the introduction of technology and the development and implementation of enterprise-wide information systems (IS) [23][39]. Today, one of the most influential social theories describing organizational structure and human (i.e., actor/agents) behavior is Giddens' *Theory of Structuration* [46].

For example, organizational behavior reflects the tone and management style of it's leadership [20][55][57]. Contemporary studies into human behavior, including those aimed at organizational management and other stakeholders, describe a seminal intent to provide for a more effective and efficient organizational environment [91][95]. However in reality, this does not always occur and is frequently either an abstruse concept or overlooked. However, organizations must respond to competitive and shifting environmental demands by changing their existing operating environment and replacing it with one focused on the use of technology [77][91]. The resultant organizational transformation requires stakeholders to willingly or unwillingly accept and adapt to new ways of doing work which in turn changes their perception of the environment in which they function [20]. As stated earlier, new rules, policies, standards, processes and procedures dictated by management to be followed and used by stakeholders typically results in new stakeholder behavioral patterns [58][83][85]. In many situations, organizational transformation is difficult to achieve because of these new behavioral tendencies. From a negative point of view, we can explore the effect of two candidates that can seriously affect and influence the success or failure of change [83]:

- Stress
- The need for users (stakeholders) of EA to learn, adapt, and accept something new

Stress is nothing new in any organizational setting to either stakeholders or the organization. However, it can take on a life of it's own where technology is the prime motivation for change.

Stress caused by change is evident and easily recognized in stakeholders by their actions and behavior. Both stakeholders and organizational behavior tends toward a point where inputs, processes, and outputs remain stable with change viewed as a potential threat to the equilibrium and known state of the enterprise. Giddens defines agency as the period of day-to-day life occurences of intentional actions which may have unintended consequences and, as unitended consequences, may systematically feed back to unacknowledged conditions of further acts [46]. If we consider EA to exist within a significant social context resulting from the interaction and intersection of human actors/agents and technology, then structuration as a general social theory is applicable to the various phases of EA development and human behavior can then be addressed from a structurational perspective.

4.2 The Theory of Structuration and Enterprise Architecture

Beginning in the late 1970s, British sociologist Anthony Giddens began writing what was to finally culminate in 1984 with his book titled *The Constitution of Society* coining the phrase *Theory of Structuration* [46]. Giddens' work received a significant amount of attention primarily because it deviates from tradtional and challenges established theoretical positions regarding social life [31][65].

In social science, the relationship between *agency* and *structure*, the basic tenets/constructs of the *Theory of Structuration's duality of structure*, is among the most difficult and pervasive aspects in how the actions of individual agents are related to societal structure [40][46][65][95]. Human agency, in Giddens' formulation, is the "capacity to make a difference" (also known as "transformative capacity") [46]. In this context, human agency can be defined in terms of action, whether intentional or not. Agency is intimately connected with power - in fact this is one of its defining characteristics, since the loss of the capacity to make a difference is also powerlessness.

In practice, human agents almost always retain some transformational capacity - though it may be small. From this, we can consider Giddens' *Theory of Structuration* as a better and appropriate theoretical lens that enables it to be aligned with an EA [46]. In Giddens' theory, structure is understood to be an abstract property of social systems and in this context is not something concrete, situated in time and space, but lacks material characteristics. Structure does not and cannot exist apart from the human actors who enact and interpret its dimensions existing only in a virtual state. People, however, readily allow their actions to be constrained and limited by these shared abstractions of social structure suggesting that behavior can be strongly influenced, and sometimes tragically, and induced even by vague simulations of authority relationships and other organizational settings. The ability of organizational structures to elicit compliance and conformity in the absence of material constraints attests to the power of those socially constructed abstractions.

Given this perspective, the *Theory of Structuration* articulates a process-oriented theory that treats structure (institutions) as both a product of, and a constraint on, human action. Giddens attempts to bridge the gap between the deterministic, objective and static notions of structure, on one hand, and voluntary, two realms of social order and focusing attentions on the subjective and dynamic views on the other, by positing points of intersection between these two realms. Giddens termed these as the *Institutional Realm* and *Realm of Human Action* [46]. The former represents the existing framework of rules in an organization derived from a cumulative history of actions and interactions. Such a framework of rules is characterized by dimensions of signification, domination and legitimization. Signification schemes are modalities for communication within an organization and constitute organizational structures of signification. Structures of significance represent organization rules that define and inform interaction. Resources are modalities through which power (i.e., domination) is exercised in an organization and may be authoritative (extending over people) or allocative (extending over material/property). Norms are modalities that define appropriate behavior and constitute organizational structures of legitimization using which a “moral order within an organization is articulated and sustained through rituals, socialization practices and tradition” (see Figure 13) [46].

On the other hand, the *Realm of Human Action* refers to the social interaction of the humans under the aegis of the institutions. The institutions’ properties are encoded into the human actor’s stock of knowledge through the modalities of interpretive schemes, resources and norms, and influence how people communicate, enact power and determine what behavior to sanction and reward. The crux of Giddens’ theory, though, is that this relationship is not directional but recursive. Organizational structural properties (i.e., the Institutional Realm) are drawn on by humans in their on-going interactions (i.e., Human Action) even as such use in turn reinforces or modifies the institutionalized structures. Such a recursive relation is termed as the *duality of structure*.

The *Theory of Structuration* does not merely provide a means to understand the natire of an organization but can also be applied to gain insight on the impact of technology as proposed by Orlikowski in [95] which we will discuss in Section 4.3. From the organizational perspective, institutional properties influence humans in their interaction with technology, through and by constituting: professional norms, rules of use – design standards and available resources (i.e., time, money and skills). There is, however, a consequence of the institutional interaction with technology. They are manifested by impacting the institutional properties of an organization through reinforcing or transforming structures of signification, domination and legitimization that characterize the institutional realm.

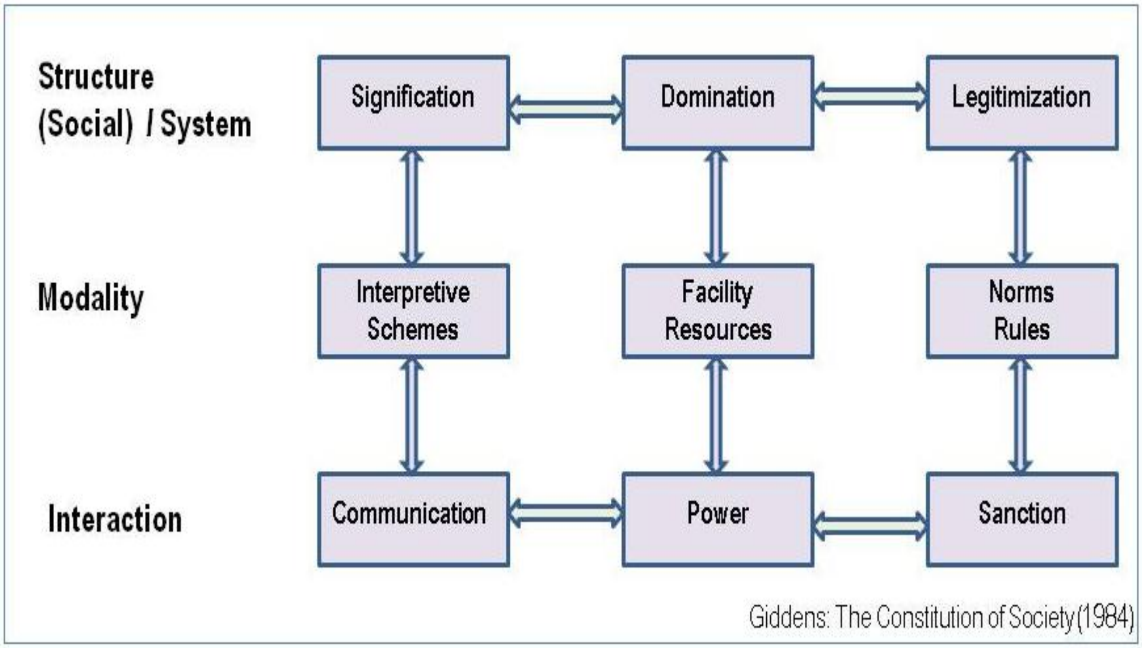

Figure 13. Giddens' Theory of Structuration

The *Theory of Structuration* in its' original formulation pays little attention to technology [65]. It does, however, provide a wide-ranging framework for understanding social situations in terms of social structure and human interaction. As such, the theory articulates a macro perspective, the structure aspects of the organization, and a micro view, the agency, through its *duality of structure* that can be used in the context and process of EA development, especially in handling social factors such as sanction and power.

In dealing with technology, the transition to something new forces stakeholders to learn new ways to do work: processes, procedures, software, and other IT artifacts [23][95]. In most situations, this is accompanied with assignment of new roles, duties, and responsibilities [20][95]. This relearning process, in many cases, is simply beyond the day-to-day ability of some stakeholders to accept and adapt. Their tolerance level and threshold for change is limited. This results in a loss of productivity and, more importantly, negative changes in their behavioral patterns. When the change is involuntary, and imposed by internal and/or external forces (e.g., management), the change becomes emotional with stakeholders feeling a sense of disempowerment and loss of control, all adding to their feeling of stress [83][85]. As can be seen, these factors must be addressed by incorporating a dynamic and behavior driven approach to EA.

Applying *The Theory of Structuration* in this instance considers humans as “knowledgeable agents” operating in a specific context [46] and almost totally neglects technological artifacts and abstractions. It is more a general or meta-theory that dwells on the dynamic conceptualization of structure continually producing and reproducing itself by practice, in effect, a recursive process (see Figure 14) [46]. This provides an opportunity to study organizational change and human behavior, including conflict, obstruction, resistance to change, and the withholding of critical EA design information by stakeholders) and its broad implications related to social processes and the establishment of an ontology predicated on human society [40][95].

In most organizations, many forces, both internal and external, influence change that affects the success and/or failure of the venture. In EA. two recognized forces that affect social change in an organization are [95]:

- Technolgy including the the new processes, procedures, and tasks introduced by the technology
- The new roles, duties, and responsibilities assigned to stakeholders

These two forces alone usually result in a transformation of the enterprise's social, political, and economic structure and thus represent an influence on stakeholder attitude and behavior.

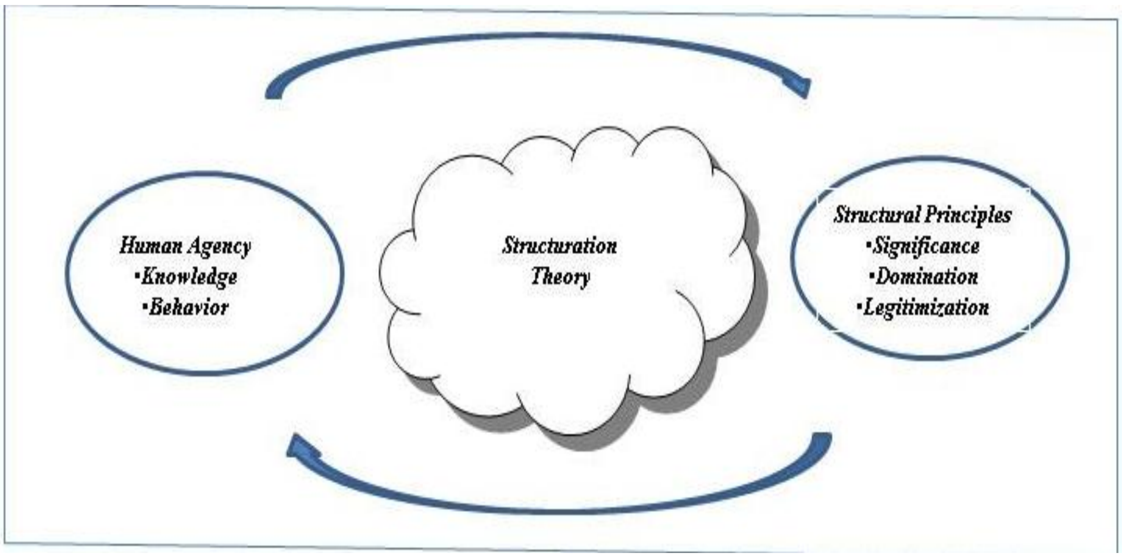

Figure 14. Recursive Nature of Human Agency

As can be seen, EA alters stakeholder perceptions of the enterprise and as such changes their behavior which can seriously jeopardize the EA. The *Theory of Structuration* takes into account both social structure and human action providing a means to analyze the unintended consequences of human action. Application of the theory to technology, the relationship between human agents and technology can be explored to understand the inherent changes to organizational structure resulting from technology and the impact new technology has on stakeholder use of the technology.

Orlikowski, et al, recognized the impact technology has on human behavior and explored the application of Gidden's *Theory of Structuration* inseveral papers cited in this dissertation [95][96][99]. The following section discusses her work.

4.3 The Structurational Model of Technology and Enterprise Architecture

Orlikowski proposed the *Structurational Model of Technology (SMT)* to provide a more complete model of understanding of how technology affects organizations [95]. Her theory is based on the perceptions of the *Duality of Technology* and the *Interpretive Flexibility of Technology* [95]. The *Duality of Technology* posits that the socially created view and the objective view of technology is not exclusive but rather intertwined and are differentiated because of the temporal distance between the creation of technology and usage of the same. Technology is both created by humans and used by huans to accomplish some task [95]. It considers current views of technology as either an objective force or as the socially constructed products of human action to be a false dichotomy.

Interpretive Flexibility of Technology defines the degree to which users of a technology are engaged in its constitution (physically and/or socially) during its development. A corollary to the *duality of technology*, this aspect of the *Structurational Model of Technology* reflects the inreraction between technology and organizations stating that it is a function of different actors and the environment or socio-historic context of its development and use [95].

The *Structurational Model of Technology* has three components – the *Human Agents*, *Technology*, and the *Institutional Properties of Organization*. The model specifies an interactive relationship among these components that are essentially recursive in that each of these components influences and is at the same time influenced by the others. Technology is proposed to be the product of human action in that it is created and exists through ongoing human action. Humans constitute technology by using it, while at same time making it an outcome of human actions such as design, development, appropriation and modification. However, once technology is implemented it facilitates and constrains human action through the provision of interpretive schemes, facilities and norms.

From the organizational perspective, institutional properties influence humans in their interaction with technology, through, by constituting: professional norms; rules of use – design standards and available resources (i.e., time, money and skills). There is, however, a consequence of the institutional interaction with technology. They are manifested by impacting the institutional properties of an organization through reinforcing or transforming structures of signification, domination and legitimization that characterize the institutional realm.

The *Structurational Model of Technology* is based on technology being created by humans and used by humans to accomplish some task [95] and is equivalen to the technology to be deployed in EA. It recognizes that technology can be constrained and limit human action while acknowledging that human actors, stakeholders, can accept and use technology as designed and intended, reject its use outright, and/or modify it to satisfy their own wants and/or desires. In the case of EA, stakeholder behavior often traces to the behavior discussed in Orlikowski's work.

4.4 Summary

Enterprise Architecture (EA) design and modeling approaches pervade the world of information techology (IT) all aimed at improving operational efficiency, effectiveness, and producing the real reason for EA, profit at low cost [72][91]. However, the organizational goals and objectives desired of EA are not always those of stakeholders responsible for doing work and as such pose a paradox and a dilemma associated with this subject.

Until recently, the *Theory of Structuration*, has been based on the social sciences, human action, and organizational structure paying little attention to IT. However, the application of the *Theory of Structuration* to IT lends itself as a design tool for EIAs to better understand stakeholder behavior and the conceptual impact of technology on organizational behavior. Orlikowski, one noted advocate for using the *Theory of Structuration* in IT development and deployment, proposed the *Structurational Model of Technology* as a means to understand how technology affects organizations and vice versa [95].

In summary, the theoretical premise of the *Theory of Structuration* and the *Structurational Model of Technology* is an acknowledgement that organizational structures, technology and human action are not distinct but are intertwined such that each is continually reinforced and transformed by the other [46][95]. A logical conclusion can therefore be made that an initiative such as the formulation of enterprise architecture remains incomplete if it does not explicitly take into account human action. Structuration theory provides a framework, which if adopted could form a basis of a behavioral and inclusive approach towards formulating an EA. Specifically structuration provides a lens for the Enterprise Information Architect (EIA) to understand the dynamics of an organization and use that information to formulate an EA that is contextual to that particular organization and advocated by the human stakeholders.

However, it should be stressed that though there might be significant benefits to be derived in using structuration theory as part of the EA design process, to be consistent and ensure EA, strucuration alone might not be the complete solution to EA. Other socioloically oriented principles and practices, such as those detailed in Chapter Three, may have to be used to augment the principles and pracices enumerated in GIddens' theory.

With this in mind, the issue confronting the EIA is that of taking advantage of these circumstances recognizing that human beings, in EA our stakeholders, are purposely able to provide reasons for their activities, including perhaps even lying about them. However, this behavior can be managed by promoting an environment that encourages stakeholder participation in the decision-making process. EIAs are faced with three behavioral issues: the introduction of technology into organizations, changes in stakeholder behavior resulting from technology and resistance to change with organizations seeking equilibrium at the same time. The end-result of this behavior if negative is “poor architecture”.

Successful implementation of new technology is the product of successfully navigating human behavior and the resultant influence on organizational change. For example, three of the factors associated with EA failure are poor leadership, lack of top-management support, and poor project management. These issues can be addressed by implementing an open-ended communication system where there are no boundaries, either horizontally or vertically, for sharing of knowledge, knowhow, ideas, potential problem solutions, and it provides a forum for “brainstorming.” This in effect, solves other issues such as poor communication and lack of understanding as to the rationale for EA and organizational change. It also serves as a mechanism to mitigate stress and a willingness to share and provide quality design requirements to the EA. As such, management behavior, attitudes, rules, and policies can avoid maintaining an ingrained mechanistic view of technology and approach EA from a more humanistic venue.

In this context, the actions of management and EIAs lead to changes in the way people behave. In a business context, human behavior and organizational factors contribute more to the success or failure of an EA than technical factors. Simply stated, people are affected by IT change and are unlikely to be impressed and possibly sabotage change if the change is forced upon them without warning and input from them.

We envision an approach that highlights the impact of change on an organization relative to human behavior that can be utilized to enhance and extend the capabilities of well known architectural framework models used in an EA project. The approach fosters stakeholder ownership of the EA while building relationships through a coupling of EA and structuration.

Chapter Five – Modeling Enterprise Architecture

Enterprise Architecture (EA) is based on assumptions, principles, preferences, and supporting models, frameworks, and giudelines for the design, verification, and validation of new information systems (IS) [7][32][91][128]. However, the implementation of an EA usually causes a significant change in the enterprise's structure, characteristics, culture, and social environment that typically manifests itself in new behavioral patterns exhibited by stakeholders [23][90][99]. These new behavioral patterns may be either be in concert with or be contrary to and conflict with organizational desires, goals and objectives such that they affect the quality of the design requirements [89][90][95]. These requirements are vital to EA as they make up the design requirements contained in the EA plan (EAP) used to implement the EA [72][88][106].

Most information technology (IT) practioners, such as Enterprise Information Architects (EIA), project managers, systems analysts, and others charged with software development believe that the EA design process, specifically the requirements elicitation, verification, and validation aspects of EA, can be achieved only by using the techno-centric processes encapsulated within today's traditional frameworks and modeling techniques [41][47][94]. Though the existing frameworks are robust, consisting of a discipllined set of processes, procedures, and inclusive from a techno-centric perspective, many EA projects fail for a myriad of causal factors not all of which are of a technical nature (see Chapter Two). This chapter explores the existing requirements modeling processes used in EA design from two points of view:

- A requirements engineering (RE) perspective that evaluates the current technical techniques used to model the requirements generated from several popular EA frameworks (EAF).
- A humanistic perspective that analyzes the existing techno-centric modeling so that principles and practices can be integrated into the modeling framework from the fields of sociology, organization theory, and psychology to enhance the quality of the requirements used in EA design.

An analysis of several existing modeling frameworks is provided in our compilation of Table 5 and, though not inclusive of all of the current modeling frameworks, the table highlights the mmost popular. This dissertation asserts that the inherent weaknesses of today's approach to modeling EA are deficient in their failure to fully take into account human behavior as a significant input to EA design. The chapter concludes by recommending modeling stakeholder requirements from a different perspective, one that takes into account human behavior as a significant force behind EA development.

5.1 Modeling Enterprise Architecture Background and Context

Implementation of an Enterprise Architecture (EA) information system (IS) requires the use of various types of processes and procedures to ensure the alignment of organizational business goals and objectives and IS applications. One of the processes, requirements engineering, describes a state-of-the-practice aspect of software engineering focused on the elicitation of requirements designed to ensure the alignment process by [28][35][116]:

- Identifying high-level requirements (i.e., goals) to business assets.
- The alignment of low-level functional requirements (i.e., objectives) attached to properties from the IS solution.
- The elicitation of non-functional requirements at the earliest stages of the engineering process to asses their impact on all facets of the EA activity and to establish quality of service (QoS) guidelines for the EA.

Requirements for EA design originate from various entities/sources (i.e., stakeholders) such as [3][30][91][126]:

- Local, State, and Federal governments with changes to regulations and compliance demands
- Industry forces brought about by competition and/or changes in the business environment
- Requests for information from banks, investors, and other similar external stakeholders
- Organizational management with requests to perhaps take advantage of new and/or enhanced technology or to simply improve operational efficiency, effectiveess, and to increase employee on-the-job productivity
- End-users who desire to imporve system(s) usefulness and ease-of-use

Taken together, these entities represent the total collection of stakeholders that provide the organization knowledge from which to draw on and from which EA design requirements are derived and defined. Each entity, unfortunately, has it's own set of goals, objectives, and interests which may be in conflict with the organization and therefore taken into account during EA design. These requirements, however, are necessary as they drive EA design and implementation [127] and, therefore, must be recognized as perhaps the most critical factor leading to either EA success or failure [87][116][127]. In the case where erroneous requirements are introduced into the design process, regardless of their source, failed EA is the consequence with the fault typically attributed to “poor architecture” [39][43][44][113].

At first glance, the task of defining, analyzing, decomposing, and translating stakeholder requests for information into design requirements might seem like a relatively simple task. In the first three instances listed above, the requests for information from governmental agencies, industry, banks, etc., may be difficult, with the design and implementation perhaps even complex [8][30]. However, the requirements are usually clear-cut, well defined, and not subject to much negotiation with the tradional approaches to modeling the requirement adequate enough to ensure their validity. As such and depending on the source, there is usually not much that can be done other than fulfill the request. As can be seen, these requests do not pose any serious threat to EA implementation and are therefore left for future research.

On the other hand, where organizational management and end-user acceptance and use of EA is at stake, the difficulties in verifying and validating the product of the requirements elicitation process becomes more murky because of organizational culture, politics, and social aspects associated with the process and therefore fraught with risk. It is here where the latter two groups of stakeholders, orgnizational management and end-users, provide requirements that poses the most serious threat to EA [43][44][74][113].

In Chapter One, many of the causes of IT failure are listed and detailed. Though the list may not include all of the possibilities, it is comprehensive with the preponderance of research literature and supporting statistics overwhelmingly pointing to poor communications, misunderstood, and/or the miscommunication of design requirements as leading causes of EA failure. An analysis of each of these causes shows that they may be the by-product of adverse human behavior resisting organizational change and the subsequent change in stakeholder roles, duties, and responsibilities within the enterprise [20][58][90][99]. This behavior may be intentional or unintentional, either a covert or overt reaction to the EA with the underlying intent to sabotage and avoid organizational change brought about by the EA and thus a major risk to EA.

The typical focus of current research literature for processing EA requirements follows traditional computer science approaches that: elicit, analyze, verify, and validate the requirement. These processes typically include a modeling component that [13][35][63][117]:

- Formalizes the information and knowledge created and exchanged during the elicitation process.
- Integrates EA and requirements engineering techniques and methods facilitating a systematic approach to business and IS alignment.
- Analyzes the requirements process using a cost-benefit analysis focused on a return on investment.

While new processes in traditional approaches to modeling EA and requirements engineering become available offering new solutions to software and architecture development, the trends tend to remain technically oriented and embedded in the computer science principles and practices of the past. For example, a new trend in modeling practices that is becoming more popular in fields such as agent-oriented software engineering, requirements engineering, and organizational process modeling focuses on what are referred to as agent-oriented models [26][51]. This work will analyze this trend in more detail in the discussion of the i* modeling framework [137][139].

There are few that would question the importance of requirements modeling in developing and supporting EA with goals focused on the products, services, processes, and applications of an enterprise [38][52][73]. The modeling should take place at both the verification and validation phases of EA requirements engineering. However, the techno-centric aspects of requirements engineering modeling schemes fail to take into account two significant non-technical forces that seriously affect EA [20][90][98]:

- Stakeholder behavior
- Organizational transformation

As stated earlier in Chapters Two, Three, and Four, failure to recognize, plan for and implement motivational processes that mitigate negative stakeholder reaction to EA can lead to failure. These chapters describe how the lack of understanding, inadequate communication, and proper governance procedures between the internal stakeholders (management and end-users) and IT staff can lead to project failure with stakeholder rejection of and use of new EA technology.

In this chapter, the difficulty associated with eliciting, analyzing, verifying, and validating EA design requirements is explored and investigated from a human behavior point-of-view. The intent of this research aims to highlight what we believe to be deficiencies in existing tools and frameworks used to model EA (see Table 2 and Table 5). Current modeling techniques point to a need for a new class of IS which specializes in integrating the technical aspects of requirements engineering with sociological issues related to the workplace such as i*. Our approach also takes into account requirements management to ensure traceability through the development and implementation of the EAP. Requirements management alone can lead to cost overruns and delay in completing, or even abandoning, the EA *on time*.

In many cases, changes to EA requirements result from misunderstanding and miscommunication of information between stakeholders and IT technical staff (e.g., EIAs). As stated earlier, the misunderstanding and miscommunication of organizational knowledge may be the by-product of stakeholder resistance to organizational transformation and therefore a product of their behavior. This leads to two problems:

- The effect of changing requirements during EA design and implementation
- The cost and time to maintain systems after deployment

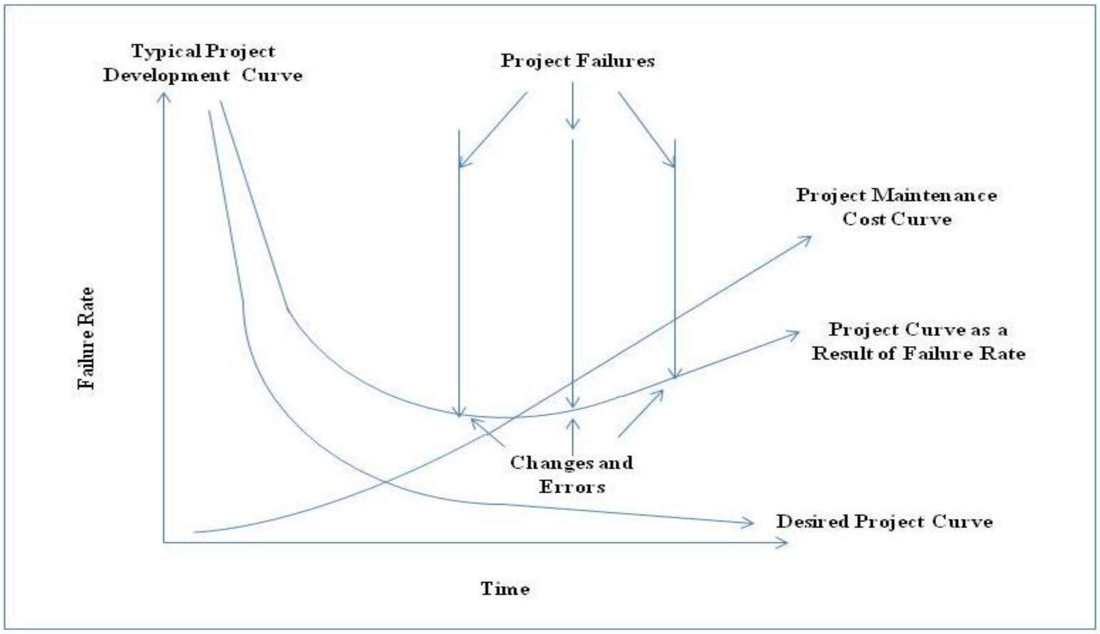

Figure 15. Failure and Maintenance Curve for Enterprise Architecture

We also explore the cost and time to maintain software applications where parts of an application system are implemented while other segments are still under development (see Figure 15).

The approach taken explores the use of practices and principles from organizational theory, management theory, psychology, and sociology that focus on the social dimensions of requirements engineering and the tools and techniques used by EIAs to gather, analyze, document, and implement stakeholder requirements. The aim of this research explores stakeholder behavior and the effects of organizational transformation that include changes in the organizational politics, culture, and social issues that influence EA design, development, and implementation. Particular attention focuses on and directed at the importance of communication throughout the modeling aspects of EA.

An analysis of current modeling frameworks used to support several popular Enterprise Architecture Frameworks (EAF) is included to assess their adequacy and relevance in validating EA requirements and to identify deficiencies where the modeling framework(s) can be improved. The implications of human behavior, motivations, emotions, and value are taken into account, analyzed, and interpreted to better understand and provide potential solutions to mitigate EA failure. The objective of this chapter is to assist organizations to better manage the requirements processes and provide modeling mechanisms that identify implicit factors that create problems during this requirements engineering phase of EA.

5.2 Enterprise Architecture Modeling Frameworks

Enterprise Architecture (EA) involves applying a comprehensive and rigorous method for describing the current "*as is*," and the future "*to be*" structure and behavior for an organization’s processes, information systems (IS), infrastructure, resources, and organizational units and sub-units [14][61][91][128]. The focus of EA and this process that to align organizational strategic goals and objectives and it’’ information technology (IT) component and capabilities [91][109][141]. The product of this process is an EA plan (EAP) or blueprint created by an EA framework (EAF) [91].

Supporting the EAF are a number of frameworks that provide tools and mechanisms for modeling the EA. Modeling an EA must include various aspects of enterprise engineering, software engineering, and requirements engineering from a macro-oriented high-level of abstraction. The EA modeling tools, techniques, and methods must provide for enterprise models, languages, generic enterprise modeling concepts, partial models, and modeling notations for software intensive systems. The focus of existing modeling software development has continually evolved with an emphasis on modeling ideas that incorporate and support model-centric technical styles for process and software development.

The terms frequently applied to most of the modeling literature today are model-driven architecture and model-driven development [25]. Model-driven architecture is part of a collection of guidelines and model-oriented standards from the Object Management Group (OMG) [124]. Model-driven architecture supports several notational several standards such as the: Metalanguage Interchange (XMI), Unified Modeling Language (UML), Common Warehouse Model, and the Meta-Object Facility [25]. Model-driven architecture is based on the idea that a system or system component can be modeled from two categories of models: Platform Independent Models and Platform Specific Models.

Model-driven development is focused on a practical approach to the creation, evolution, and maintenance of models focused on large-scale developmental technical and risk in a project [25][38]. Guidelines for structuring requirement functionality from implementation express the requirement in the form of a model that facilitates transformation of the model from one layer of abstraction to another [25][124].

Though it appears that Model-driven architecture is becoming an industry standard supporting a number of EAFs such as Zachman [141], The Open Group Architecture Framework (TOGAF) [109], and the Federal Enterprise Architecture Framework (FEAF) [30], the processes, procedures, tools, and techniques are strictly technical in nature with no apparent provisions for including human behavior as part of the modeling scheme.

5.2.1 Business Process Modeling (BPM) Frameworks

A business process is the procedure an employee follows to perform a work-related task [4][8]. Business Process Modeling (BPM) frameworks strive to conduct an in-depth analysis of business processes and thus define the business requirements of an enterprise [9]. The typical modeling process includes peer and client reviews of the business process under question in order to verify, prioritize, facilitate validate, and obtain stakeholder acceptance of the process [9]. Addressing these issues, most of the Enterprise Architecture (EA) frameworks (EAF), such as the Zachman Architecture Framework (Z|AF), The Open Group Architecture Framework (TOGAF), the Federal Enterprise Architecture Framework (FEAF), and the Department of Defense Architecture Framework (DoDAF), acknowledge the importance of modeling EA development from a business perspective [4][7][8][11][140].

The traditional supporting EA modeling schemes specify, document, communicate, and reason about organizational goals and requirements while focusing on enterprise applications, products, services, and processes from a technical perspective [32][42][91][127]. Given this perspective, most methods used to model EA focus on the *what* the enterprise should do with little or no acknowledgement of the *why* it should be done. Communication of the *why* something should be done is vital to stakeholder acceptance and use of the new technology. The typical modeling techniques are used to represent the "*as-is*" and the "*to-be*" architectures in terms of techno-centric processes or models at different architectural layers of abstraction such as the business, application, and technology layers. However, the underlying motivation for modeling EA, stakeholder behavior including their concerns and the high-level goals that address these concerns, is missing in existing EA modeling processes.

5.2.2 Modeling the Zachman Architecture Framework (Z|AF)

The Zachman Framework (Z|AF), described in Chapter Two, consists of a six-by-six matrix of rows and columns with the intersection of a row and column called a cell. According to Zachman, each cell represents a model and/or perspective of one sort or another [140][142][143]. For example, the rows consist of the following perspectives, the [42][122][141][143]:

- Scope (Contextual) – represents the *Planner's* perspective and describes the models, architectures, and representations that provide the boundaries for the enterprise. It describes what senior executives should consider in their interactions with the business environment/world.

- Business Model (Conceptual) – describes the *Owner's* perspective and the models, architectures, and descriptions used by the owners of the business process.
- System Model (Logical) – describes the *Designer's* perspective and the models, architectures, and descriptions used by various engineers to mediate between what is desirable and can be done technically.
- Technology Model (Physical) – represents the *Builder's* perspective and the models, architectures, and descriptions used by various technicians, engineers, and contractors who actually design and build the actual end-product.
- Detailed Representation (Out-of-Context) – describes the *Sub-Contractor's* perspective and the actual elements or parts (e.g., software components) that make up the final product.
- Functioning Enterprise – describes and represents the actual deployed elements (e.g., architecture, software, etc.), data, and people of the enterprise, the "real-world" with all of its complexities and the underlying abstract perspectives of the rows above it.

The columns describe the abstractions that define each row perspective answering in each column respectively the questions *what, how, where, who, when*, and *why*. Zachman proposes models with a simple illustrative concept for each column. For example [42][142][143]:

- Data – *What* is it composed of? The model framework is a *Thing - Relationship – Thing.*

- Function – *How* does it work? Focuses on the functions or transformations of the product. The model is *Process – Input/Output – Process*.
- Network – *Where* are the elements relative to each other? Focuses on the interconnectivity of the product. The model *Node – Line – Node*.
- People – *Who* does the work? Focuses on the people and the documentation or procedures used to do the work. The model focuses on *People – Work – People*.
- Time – *When* do things happen? The focus is on timing, life-cycles, and schedules used to control and perform activities. The model is *Event – Cycle – Event*.
- Motivation – *Why* do things happen? Goals, plans, and rules that prescribe policies and ends that guide the enterprise are defined. The model is *End – Means – End*.

The Zachman Framework is a primitive allowing each cell to be modeled independently (i.e., “normalized”) with the aggregation of all of the columns for a given row making up the modeling perspective for the row. In addition, all of the cells in a given column are related to each other as they focus on the same type of element. Analyzing the given framework finds it deficient in its failure to include human behavior both in its framework and in its approach to modeling.

5.2.3 Modeling The Open Group Architecture Framework (TOGAF)

As stated in Chapter 2, The Open Group Architecture Framework’s (TOGAF) Application Development Method (ADM) drives the iterative process for development of an Enterprise Architecture (EA) [109]. Stakeholders are addressed in Part III, ADM

Guidelines and Techniques, Section 24 "Stakeholder Management" in both Version 9 and 9.1 documentation [108][109]. In this context, Enterprise Information Architects identify stakeholders based on their position within the enterprise and address their concerns by:

- Identifying and refining the requirements stakeholders have provided
- Developing views of the architecture that show how the concerns and requirements will be addressed
- Showing the trade-offs that will be made to resolve conflicts between different stakeholders

Stakeholder Management identifies "the most powerful" stakeholders focusing on early recognition of their potential impact on the architecture and communication of the benefits and explaining what processes are in designing the EA [108][109].

The Open Group Architecture Framework, better known as TOGAF, both views and models architecture from four levels or perspectives [109][122]:

- Business architecture
- Application architecture
- Data architecture
- Technical architecture

The cornerstone of TOGAF, the Architecture Development Method (ADM), provides the architectural process for developing and modeling the EA.

The latest version of TOGAF, Version 9.1 was released in December, 2011 and contains a number of changes to Version 9 which was released in 2009. The changes requested by EA practitioners are a refinement and do not represent any significant material differences between Version 9 and 9.1 [108]. TOGAF complements and can be used with the Zachman framework with Zachman providing architectural taxonomy for categorizing the design artifacts and TOGAF's ADM providing the processes for creating them [122]. In TOGAF, the Preliminary Phase and Phase A of the ADM, the Architecture Vision, establishes the principles that govern the architecture process or the implementation of the EA [108][109][110].

TOGAF Version 9.1 references various aspects of the proposed EA to be modeled throughout the architectural development and implementation process. For example, Business Models are to be modeled based on logical extensions of the business from the Architecture Vision so that the requirements can be mapped from high-level and to more detailed ones in lower levels. A variety of modeling tools, such as ArchiMate, Casewise, Orbus Software, and Sparx, are available for use in modeling what TOGAF defines as *Activity Models* or *Business Process Models* [110][125]. In TOGAF and at this modeling level, the business activities and functions are described including the data and/or exchanged information (i.e., activities) from both internal and external models [109]. TOGAF modeling also subscribes to the OMG's model-driven architecture standard for modeling business activities using MDA's Business Process Modeling Notation (BPMN) with which to specify and document business processes, steps/tasks, and the documents produced [109].

The framework's documentation includes the use of:

- Use Case Models – describe and model either business processes or systems functions depending on the effort being modeled. Use case diagrams and use case specifications describe the enterprise's business processes in terms of the process and actors/participants.

- Class Models – describe static information and the relationships between information and informational behavior. Class models can represent business domain entities, system implementation classes, and various levels of granularity.

The Unified Modeling Language (UML) can be used to annotate the process being modeled.

Modeling the various TOGAF viewpoints and phases of the framework are described in detail, identifying *what* is to be achieved and *how* it is to be achieved at that particular process. The TOGAF Version 9.1 document is extensive with the present document consisting of 692 pages [109]. Throughout the document, each aspect and process being performed at that aspect provides for a model to be used to verify and validate the architectural design. However, references to stakeholders and their concerns are addressed and modeled from a technical and business orientation. For example, in Section 8.4.1.1, Determine Overall Modeling Process, a procedure for modeling various architectural viewpoints is described as follows:

- For each viewpoint, select the tools and methods to model and support the specific view
- Create models that ensure stakeholder concerns are covered

The procedure then continues with recommendations regarding the use of Use Case and other notational languages to document the model. This process is repeated for each architectural viewpoint described in the document with each relevant chapter containing the process, Determine Overall Modeling Process, to be performed for that function. There are no references related to stakeholder resistance to the EA or to the impact organizational transformation has on stakeholder behavior.

In Chapter 12, Section 12.4.1.5, Identify Types of Requirements to be Collected, requirements may [109]:

- Relate to the technical domain
- Provide detailed guidance to be reflected during design and implementation to ensure the solution addresses the original architecture requirements

While this procedure may satisfy the architectural desires of the EA, is does not provide any mechanism that ensures stakeholder acceptance and use of the solution. However, TOGAF does provide for stakeholder review of the proposed architecture with a re-do of process if necessary.

Chapter 24, Stakeholder Management, holds the most interest in terms of addressing stakeholder behavior and their role in EA. This chapter recognizes stakeholder management as an important consideration and discipline to win early project support [109][110]. For example, stakeholders are categorized as to:

- The influence they will have on the EA
- Which stakeholders and/or groups of stakeholders will contribute most to the project
- Who will gain or lose from the effort

The intent of this effort is to suggest a strategy be developed to cope with the situation.
A better solution is offered in the following Chapters.

5.2.4 The Federal Enterprise Architecture Framework (FEAF)

The Federal Enterprise Architecture Framework (FEAF) is the EA framework for the Federal government. It identifies how the federal government can simplify processes, reduce cost of IT development and acquisition, and share information and resources across agencies within the lines of business [5][7][30]. FEAF processes encourage the use of both Zachman and TOGAF to achieve EA goals and objectives. Thus, if used, modeling schemes used to support each of these frameworks are available and applicable for use in the requirements modeling phases of EA.

In the FEAF literature, recommendations for modeling of the EA are describes at the following levels [8][30]:

- The Business Reference Model
- Service Component Reference Model
- Technical Reference Model
- Data Reference Model
- Performance Reference Model

For example, the Business Reference Model (BRM) describes the business operations of the Federal Government independent of the agencies that perform them. The BRM model, life the ADM in TOGAF, is the primary layer of the FEAF. The BRM is divided into high-level Business Areas to be modeled. The Business Areas are decomposed into lower levels of granularity the represent the lowest levels of the BRM.

Each of the remaining reference models provide abstractions relevant to the reference. An analysis of the reference models did not reveal any provisions for the inclusion of stakeholder behavior in the literature.

5.2.5 The Department of Defense Architecture Framework (DoDAF)

DoDAF is a foundational EA framework used by the Department of Defense to establish a baseline for a common and consistent approach to architectural software

Modeling Approach	Definition Documentation	Ease of Use	Stakeholder Behavior
Unified Modeling Language (UML)	Well defined, industry-standard notation lending itself to several automated modeling tools.	The present version is overly complex, though Version 2.0 may be addressing this issue. It does not lend itself alone to modeling business requirements as needed in EA.	UML is not used extensively in EA development. It does not take into consideration stakeholder behavior in its scheme for modeling specifications and requirements.
Model-Driven Architecture (MDA)	Provides guidelines for structuring system specifications. Typically just as much as model-driven automation as it is about model-driven architecture.	Uses XML and UML to generate and produce modeling diagrams, notation, and semantics for the system. Often used with other modeling schema such as EUP and RUP. Encourages developers and architects to work at higher levels of abstraction.	The primary focuses of MDA are mapping documents, transformation, and UML profiles. A review of various works published on MDA methodologies does not highlight any issues on the process regarding human or organizational related to this approach.
Zachman Framework (Z|FA)	Uses rows and columns to define an EA. The notation used within Z|FA represents various/ different views of stakeholders.	The framework consists of thirty-six cells each of which supports one or more artifacts. It can lead to a personalized biased approach to an EA solution.	In Zachman's EAF , human behavior is not a part of the Zachman Modeling Scheme though each cell is considered a modeling point.
Enterprise Unified Process (EUP)	An instantiation of the Unified Process (UP) and RUP.	Explicitly brings EA into the RUP arena.	Human behavior not considered as part of this approach.
Rational Unified Process (RUP)	Defined for software development and follows the Unified Process (UP). It reflects business "best practices" and typically does not codify approaches until they are well established in the field.	IBM's approach to software Development, a well-defined and rigorous process. Divides the development process into phases with each concluded with a project milestone.	Provides for agreement with stakeholders on lifecycle objectives for the project and the design and implementation focusing on a viable marriage of essential business requirements and the technical architecture.

Table 5. Comparison of Enterprise Architecture Requirements Modeling Schemes

development. The purpose of the framework defines models and concepts usable in six core processes [4]:

- Joint Capabilities Integration and Development (JCIDS)
- Planning, Programming, Budgeting, and Execution (PPBE)
- Acquisition System (DAS)
- Systems Engineering (SE)
- Operations Planning (OP)
- Capabilities Portfolio Management (CPM)

Modeling DoDAF in Version 2.0 of the framework uses the IDEAS Group foundation ontology as a basis for its Defense Meta Model (DM2). The IDEAS Group or International Defense Enterprise Architecture Specification formulates a data exchange format for military EAs. The DM2 process separates and models desired architecture from three views:

- The Conceptual Data Model (CDM)
- The Logical Data Model (LDM)
- The Physical Exchange Specification (PES)

An analysis of available documentation finds no reference to human behavior in either the DoDAF or DM2.

5.3 Enterprise Architecture and Requirements Engineering

Software development is an iterative, recursive, and incremental process predicated upon an understanding of the business process to be solved. This understanding is based on requirements provided by stakeholders as input to the solution the system is being created to solve. Requirements engineering, that phase of Enterprise

Architecture (EA) that elicits and validates the requirements used to design the system(s) architecture, is thus a key and essential phase and critical component for both successful software development and EA implementation [41][88][91]. The framework, an EA framework (EAF), used to gather the *known* requirements produces an end-product, an EA plan (EAP), that describes businesses' both *as is* and the *to be* architectures with the process defining *what* the enterprise should achieve and *how* the *what* is to be achieved [38][41]. Throughout this process, many different kinds of information must be captured, analyzed, refined, agreed-upon, communicated, and integrated to develop the EA plan (EAP) [25][39][91][106]. The corollary to the EAF, modeling tools and techniques are used to support and enable the EA process.

In today's environment, most EA modeling techniques focus on the informational, architectural behavior, and structural model elements at different design layers of abstraction. For example, the three layers defined in Chapter Two (see Figure 4): the Abstract Enterprise Architectural View, Domain View, and the Application System and Subsystem View are both directly and indirectly influenced by the EAF and the quality, reliability, effectiveness, and efficiency of the delivered EAP [5][63][127][117][120]. The EAP in turn expresses the total *known* institutionalized knowledge (i.e., information) base of the enterprise [23][88][97]. As can be seen, capturing and validating the design requirements directly affects EA design and accordingly the success or failure of EA [87][88][91][127]. In this context, *known* knowledge is considered only in relation to the need to uncover the *unknown* knowledge affecting EA.

In the realm of institutionalized enterprise/organizational knowledge (information), requirements are the accumulation and assimilation of knowledge learned and retained by stakeholders over some period of time. This knowledge falls into two significant categories [87][88]:

- Explicit – that knowledge which is documented and *known* to the organization, the *formal system* that describes the way work is supposed to be performed.
- Implicit – that knowledge which is not normally documented usually restricted in stakeholder distribution and therefore *unknown* except to only a single individual or select group(s) of people. This knowledge forms the basis for the *informal system* which frequently describes the actual way some work is performed. This often takes the place of the *formal system* when new processes and procedures are enacted, undocumented, and perhaps where the *formal system* is not accepted and therefore modified by stakeholders to meet their respective goals and objectives.

Together, this knowledge provides the necessary high-level of abstraction, requirements, and artifacts necessary to develop the aggregate design requirements needed for the EA [91].

From a human behavioral viewpoint, the tacit or implicit pool of stakeholder knowledge presents the most serious threat to EA as this knowledge is not commonly known within the enterprise and as such can be withheld intentionally or unintentionally, covertly or overtly from EA design by stakeholders [87][88][89]. Though expectations are that all organizational knowledge will be willingly shared by stakeholders, reality indicates that, in many cases, this information is withheld either intentionally or unintentionally so as to resist organizational change brought about by EA and to perhaps even sabotage the effort [89][90].

EA and its intersection with requirements engineering identifies several weaknesses in the traditional approach to modeling EA such as [35][95][130]:

- The lack of well-defined concepts for the requirements elicitation and modeling process
- A lack of detailed analysis to ensure understanding of *what* is to be achieved and *how* it is to be achieved
- The lack of a rigorous analytical and systematic approach to verification and validation of both functional and non-functional requirements
- The failure to recognize the influence of individuals on a group or the influence of the group on an individual
- A lack of stakeholder understanding of what EA is about
- The working relationships between people and the fit of technology within workgroups

These weaknesses are, in effect, deficiencies not only in current EAFs (see Chapter Two) but also to EA tools, techniques, and frameworks used to model EA (see Table 5). As can be seen, the weaknesses point to both technical concepts, which we believe to be present from a technical perspective, and to human behavioral issues which are missing from existing modeling frameworks. As technological approaches to software technologies advance so does the high failure rate of their solutions [43][44][113]. Therefore, getting the requirements right becomes vital pointing to a need for a different approach to modeling frameworks. Such an approach would support the formalization of information and knowledge created and exchanged by:

- Using traditional techno-centric models associated with business processes and architectural domains
- Integrating aspects of sociology, organizational theory, management theory, and psychology into the modeling tolls and techniques.

This would facilitate an EA component that with traditional requirements engineering techniques and methods provide a more systematic, humanistic, and therefore a more holistic approach to align business and EA.

Obviously, business processes play a pivotal and key role in the operations of most organizations and therefore become the first order of business in determining *what* EA is to achieve. These processes provide the first steps towards understanding and gathering the requisite knowledge needed to develop an effective information systems (IS) [9]. This aspect is the subject of much literature focused on Business Process Modeling (BPM) techniques that are widely used to document, explain, analyze, and redesign business processes [9][25][38]. In fact, one approach worth mention is Object Management Group's (OMG) Model Driven Architecture (MDA) that supports reuse of "best practices" to organize and manage EA [25][38]. The OMG's MDA approach is relatively comprehensive using a variety of modeling tools such as the Unified Modeling Language (UML), Meta-Object Facility (MOF), Metadata Interchange (XMI), etc., to build and describe enterprise solutions. However, like the other modeling frameworks, stakeholder resistance to change and stakeholder behavior related to EA are not included in the current MDA framework.

The second order of business is more difficult as it varies widely from organization to organization, to application domain, and to the people involved in the process. Taken together, the business problem to be solved involves two perspectives be considered:

- The business processes and operation (systems) *as-is*
- The business processes and operation (systems) *to-be*

In both cases, the focus of existing modeling techniques consider these perspectives as representing two distinct and separate business and IT alignment domains [38][61]:

- Business and technology planning
- Business and technology operations

For the most part, the primary focus of the alignment issue has been to bring business and IT closer ignoring the impact that technology has in the workplace. However, most stakeholders are not interested in the architecture of EA but only the impact it will have on their daily lives [21][46][58][82]. Therefore, modeling EA must include the capacity to recognize and include techniques that simulate behavioral patterns that might jeopardize EA.

5.4 The Elicitation and Validation of Stakeholder Requirements

As part of the EA design process, the elicitation of functional and non-functional design requirements (hereafter simply requirements), the requirements engineering facet of EA, requires the capture of that institutionalized enterprise knowledge from stakeholders to satisfy and motivate "real world" solutions to business problems [3][29][127]. Without assurance of the validity of these requirements, the robustness and value of the EA will fall short of meeting both enterprise and stakeholder expectations.

Unfortunately, the elicitation of tacit information, the *informal system* described in Chapter 5, is the most difficult to gather and verify because of the influence of stakeholder behavior in its capture. For example, if the stakeholder is not committed to EA, this information may be withheld from the requirements elicitation process, a defensive and protective mechanism, and/or provided erroneously, an attempt to deceive, mislead, and/or distort the requirement and perhaps sabotage the EA. As such, this facet of requirements process poses the greatest threat to EA success and the foundation for EA failure and "poor architecture". Thus, we can conclude that EA design relies on how well the quality, veracity, and validation of the information provided by stakeholders as input to EA is handled and managed.

Software engineering, systems design, and thus EA depends upon two types of requirements which together fall into two categories of institutionalized enterprise knowledge [28][72][127]:

- Functional – those requirements that describe *what* the system should do
- Non-functional – those requirements that describe *how* the functional requirement is to be implemented

For example, a functional requirement might specify how a particular transaction is to be processed while the non-functional requirement might state that the transaction is to be completed in five seconds or less. Typical non-functional requirements relate to security, performance, maintainability, scalability, reliability, governance, and compliance.

Another way of viewing a requirement is as a desired *goal* or statement that a system should achieve [28][73]. In this scenario, goals are objectives the projected system should ensure and as such are intended properties to be satisfied. In this vernacular, functional requirements are associated with services to be provided while non-functional requirements are associated with quality of service such as security, reliability, scalability, and maintainability of the solution [127][128][139].

Regardless of how defined and/or categorized, requirements are formulated at different levels of abstraction depending on purpose and use. For example, requirements defined from a high-level strategic concern are typically included in an Enterprise Architecture Plan (EAP) or systems document where the granularity of the requirement does not have to be as detailed as those needed for a lower-level. Lower-level requirements become increasingly technically oriented with detail included for use such as in software development [71][73][106]. Regardless of use, whether at a high-level or low-level of abstraction, we view requirements engineering as a multi-disciplinary, human-oriented process [94].

5.4.1 The Requirements Elicitation Process

Effective elicitation of stakeholder requirements depends upon discovery and understanding exactly what stakeholders expect from Enterprise Architecture (EA). The activities in this process are both generic and common to all requirements engineering processes (see Figure **16**) [61][106][127]. The total requirements engineering spectrum includes:

- Requirements elicitation – gathering information from stakeholders of desires, wants, needs, etc.
- Requirements analysis – assessment of the practicality, technical and organizational feasibility of implementation including cost/benefit analysis and return on investment issues and concerns.

- Requirements verification – ensuring the requirement is what is to be achieved in language understandable by both technical and non-technical personnel.
- Requirements validation – any and all means such as modeling the requirement to ensure it delivers what is expected.
- Requirements management – a process to ensure traceability and manage requirement changes throughout its life-cycle.

In the activities listed, requirements management is not typically included in most traditional requirements engineering literature and therefore processes. In reality, requirements management is a critical component to EA design as changes to design requirements impact product delivery, project cost, and project schedule.

In attempts to create seamless integrated information systems, the activities described above rely on models and model driven architectural software development tools and techniques to ensure veracity of design requirements. These activities are at the heart of the design, requirements elicitation, and validation of EA design [25][32]. However, the success rate of large-scale, complex information technology (IT) projects is not high [43][74] with failure attributed to such factors as failure to [23][90][97]:

- Manage the effects and impact of new technology on organizational and stakeholder behavior
- Mitigate stakeholder resistance to change
- Assess and resolve stakeholder reluctance to use the new technology

In EA, the three areas to be covered include the Abstract Enterprise Architecture View, the Domain View, and the Application System and Subsystem View (see Figure 4) [78][79][127]. In each case, the architectural descriptions are heterogeneous, with each view modeling its own description of the domain it represents using either textual or graphical techniques and formal or informal meanings to define the process [25][72][119]. In this case, current models and modeling techniques allow and facilitate technical abstractions of the physical system permitting EIAs and other technical development personnel to ignore extraneous details and thus focus on relevant ones.

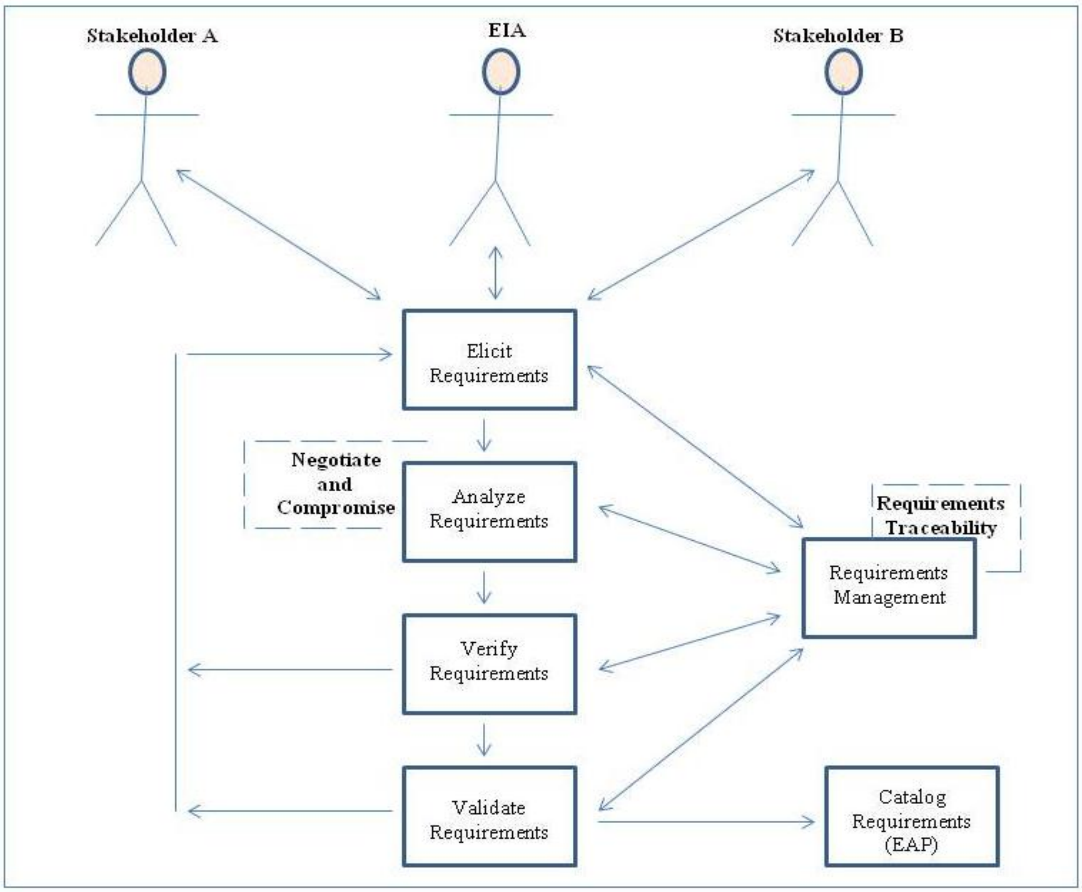

Figure 16. Requirements Elicitation and Validation Process

In each of the views enumerated above, explicit and tacit knowledge defines the necessary components needed to determine the functional and non-functional requirements needed for EA and thus must be elicited, analyzed, and modeled during the EA design phase [28][91][127]. The process is recursive throughout the EA life-cycle and therefore it is a continually evolving and iterative process that depends on stakeholder input [87]. The critical nature of this knowledge in EA design changes the significance and the complexity in evaluating the elicitation process and thus poses a dilemma in determining and assessing how stakeholders create, process, produce, and provide organizational knowledge as input to EA. This is especially true where new and/or enhanced technology is involved and being introduced into an organization.

Given this perspective, stakeholders have the capacity to either share tacit organizational knowledge or withhold it from others. This sharing of tacit organizational knowledge is frequently determined in how the EA is presented to the enterprise and thus the stakeholder and in how it is implemented by management. For example, if EA is unexpectedly introduced into the organization and without any concern or input from stakeholders, it may be either accepted or rejected by stakeholders [39][76][83][85][95]. In the case of implementation, if the EA is mandated by management, it may again be either accepted or rejected by stakeholders. Their behavior in either case may be exhibited in defensive routines and mechanisms such as stakeholder attempts to deceive, manipulate, and distort information needed to satisfy design requirements [83][85]. Therefore, user behavior becomes a critical and potentially costly component to EA affecting project success and/or failure with a need to mitigate stakeholder and organizational resistance to change and their respective attitudes towards new technology [95].

In the context of enterprise-scale application development, an approach that assists EIAs and other IT technical staff in how stakeholder information is elicited, modeled, and validated has to take into account organizational and human behavior to ensure new software architecture satisfies enterprise strategic goals and objectives. For example, the process must ensure both the functional and non-functional relationship between the requirements is validated and that it provides the kinds of emotional and motivational requistes that facilitate stakeholder acceptance and use of the EA. Unfortunately, this latter requisite is missing from both current EAFs used to design EA and modeling frameworks that support the design.

If we consider EA design as an evolving and recursive process (see Figure 12), we can demonstrate the importance of the elicitation process as both critical and vital to EA. The elicitation process must describe the requisite technical functional and non-functional requirements for organizational IT systems and subsystems. The level of detail would be prescribed at each layer of abstraction of the EA.

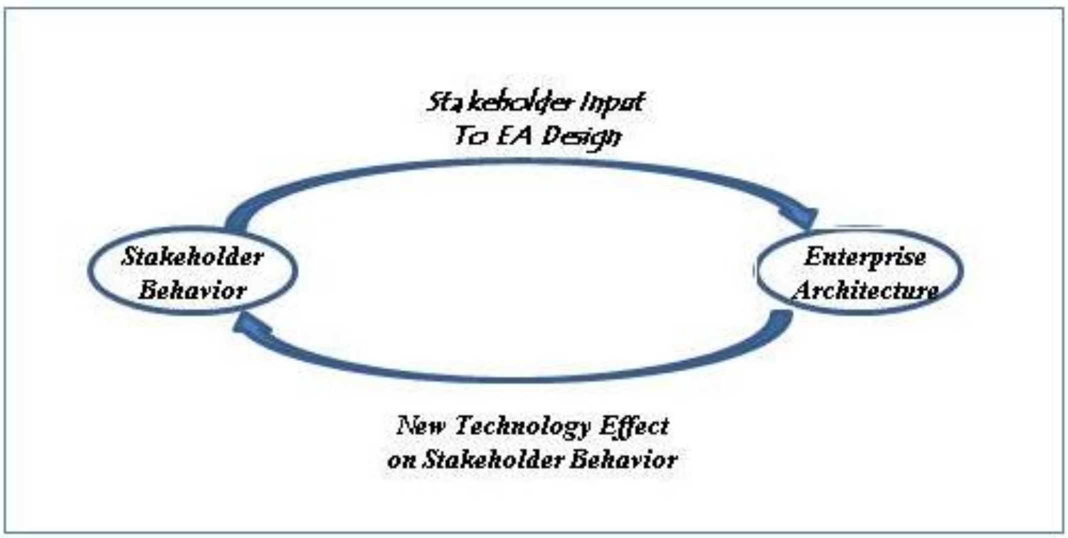

Figure 17. The Recursive Nature of Enterprise Architecture Design

The requirement elicitation process as described is iterative and includes verification and validation (including modeling) of the requirement aimed at obtaining written acceptance by the stakeholder (redoing the specification if it is invalid) while keeping the effects of new technology in-line with stakeholder capacity for change, the cognitive affect stakeholder behavior has on their capacity to contribute (see Figure

11). In effect, conforming to the recursive behavior described in Giddens' *Theory of Structuration* [52]. This requires the EIA to maintain a perspective remembering that stakeholder capacity for change is affected by several factors: their past and present organizational experiences, organizational behavior, and what they might perceive and expect in the future. Failure to capture contextual variations in stakeholder perceptions within and across departments within an organization, coupled with failure to communicate and define valid, objective, uniform work flows, processes and information needs can adversely affect EA design.

The typical process would model the requirement to test and ensure the validity of the process (see Figure 18). To be effective however, the elicitation or information gathering phase of EA design and the validation process or modeling methodologies must include the:

- Logical arrangement of both business models representing the processes of the enterprise and enterprise modeling schemes that provide the detail about the enterprise, its goals and objectives, its processes and organization, its systems and data, the technology used, and the infrastructure needed to support all relevent shperes of interrest [42][66][72].
- The interactions and behavior of stakeholders involved in EA design [23][87][95].

Therefore, EA management and the Enterprise Information Architect (EIA) must ensure validation of two key aspects of an EA [28][79]:

- The business process

- The supporting technical functional and non-functional system and subsystem requirements

In the first aspect, business processes describe *how* the enterprise's structured activities, raw materials, tasks, procedures, and workflows are performed by stakeholders to produce a product and not on *what* is produced [9][79]. In the second aspect, supporting the technical system and subsystem requirements necessitates the use of several technical disciplines that include processes and methodologies from enterprise engineering, software engineering and requirements engineering in order to understand and manage the complexities of large-scale system and subsystem design [106][127].

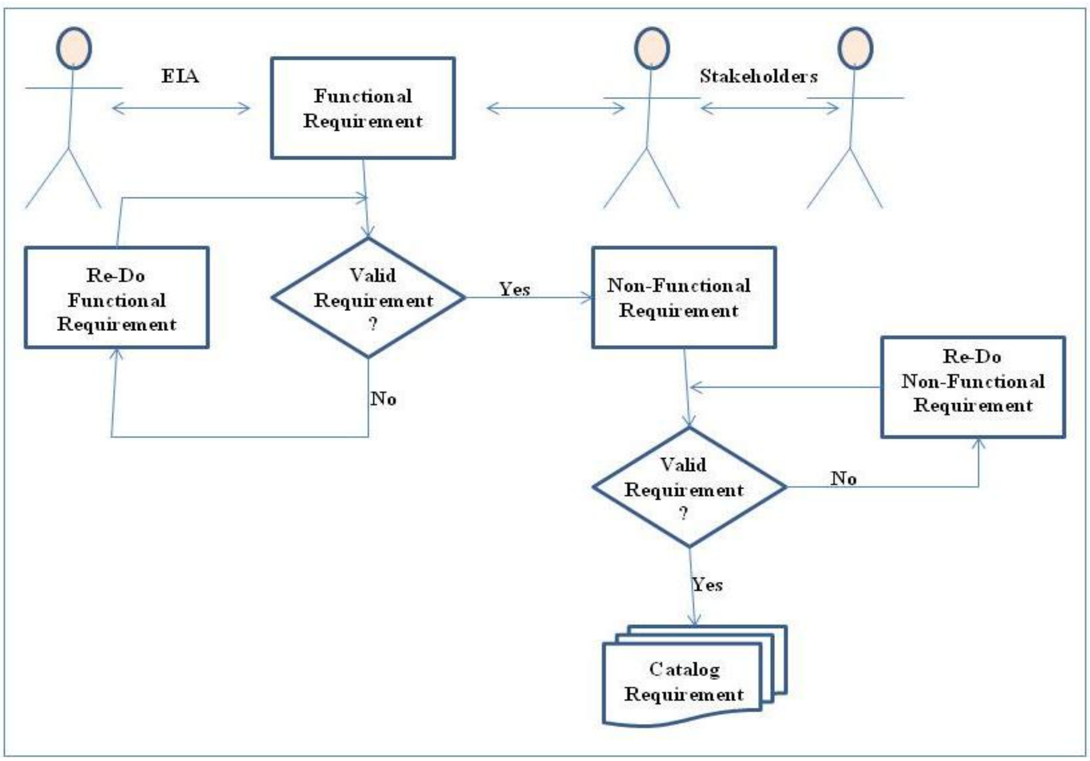

Figure 18. Functional and Non-Functional Validation Process

The vehicles currently used to satisfy these aspects of EA utilize a comprehensive set of techno-centric, computer oriented processes grounded in computer oriented and computer science theories that together formulate models that describe the organizational structure and all of the relevant functions of an enterprise [9][25][28]. EA however poses several unique problems.

First, most traditional approaches consider EA as residing at three different layers of design (see Figure 4) and thus allows design and validation of stakeholder requirements to take place at that particular level of abstraction. For example, at the Abstract Enterprise Architecture View a conceptual model of the complete system is defined where major components of the EA are represented which can then be designed and modeled at a high-level of abstraction. At this top hierarchical level, artifacts such as data objects, processing functions, and behavior (not to be confused with human behavior) are detailed without regard to the lower level system components.

Progressing the design and modeling through to the bottom two layers, the Domain View and the System/Subsystem View, the level of design and requirements detail increases as does the complexity of the requirements detail needed to be modeled. As such, the modeling requirements coupled with the complexity of modern organizations (including miscommunication between business, operational and technical staff, and experts who speak their own language, and the moving target of business services and technology) reinforces the need to ensure quality requirements enter EA [5][22][33].

In analyzing the architectural design and modeling methodologies used for validating enterprise business processes, industry literature abounds describing various software solutions advocating Business Process Models (BPM), Business Process Management, and Business Process Management Systems (BPMS) all aimed at modeling of business transactions, information, objects, actors, roles, strategy, goals, value, etc.

[9][25][117]. The granularity required in each of these processes depends upon the level of abstraction needed to satisfy the design architecture. For example, the potential list of specific models that might need to be created depends upon the scope and scale or magnitude of the business requirements definition phase. Large scale projects require a higher-level of granularity in the modeling process than one where there is less complexity and/or the domain is smaller and therefore a lower granularity would be sufficient [106].

However, the processes and methodologies fail to take into account the impact stakeholder behavior has on EA and therefore must be investigated and modeled from perhaps two diverse research perspectives:

- User satisfaction and acceptance point of view
- A technological acceptance point of view

Though both of these topics have been individually explored and commented upon to some extent, little literature exists where both viewpoints have been fully investigated and integrated. Each perspective tells only part of the story. Missing is a complete understanding of the way in which systems features are used by stakeholders and how that usage ultimately influences EA design, either negatively or positively [12]. For example, typical modeling techniques consider user satisfaction and acceptance of an information system (IS) only in how the associated design non-functional attributes are satisfied as measures that validate the system design and ensure design criteria are met. This is not enough as the results obtained are no guarantee that the system will be used.

To be effective, any EA framework (EAF) used to develop an EA must include the logical arrangement and use of comprehensive models with tools and techniques that represent and support both the business processes of the enterprise and the requirements of stakeholders. Given this context, any effective enterprise modeling processes must provide enough detail about the enterprise, its goals and objectives, its structure and processes, its systems and data, the technology used, the infrastructure needed to support all EA design relevant spheres of interest, and measure the impact the solution has on stakeholder acceptance and use of the new design [28][66][72]. As such, EA would then capture the relatively stable parts of business and technology with the unpredictable nature of human behavior.

From a purely historic perspective, a significant number of EA failures can be directly attributed to human behavior ranging from:

- Poor motivation
- Inadequate understanding of the organizational environment by the EIA
- Lack of stakeholder buy-in and commitment
- Failure of management to educate and train stakeholders in what EA is
- Insufficient and/or inadequate communication processes between all EA stakeholders
- Lack of discipline in using formal approaches to EA design [87][89][106].

Resolving these factors in some cases is difficult because the organization's environment inherently limits and constrains human action. In others situations, causal factors differ requiring different solutions.

EA efficiency and the effectiveness of an EAF requires coordinated and disciplined stakeholder behavior driven by a common set of goals and objectives with effective collaboration and a shared knowledge base [39][128]. However, an effective

EAF will only empower appropriate enterprise behavior if it is used in conjunction with a clear governance model and a formalized and consistent approach to stakeholder management. In this sense, we can consider the instruments used for developing an EA, the EAF integrated with corresponding modeling techniques and governance policies to be effective only if they assist in formally translating EA strategy into action via formal humanistic processes for decision-making with roles, duties, responsibilities, and accountabilities allocated to appropriate stakeholders in the context of the EAF [88][89]. Stakeholder resistance to change, rejection of and use of new technology are key sources of EA failure [87][95]. Therefore, it is important to employ a systematic and coordinated approach coupled with complementary management and communication techniques and an appropriate governance policy to ensure that those responsible for the business EA transformation are properly motivated and understand what and why they need to do the tasks necessary to ensure overall success.

Though current state-of-the-practice EAFs and modeling techniques provide adequate processes and procedures for EA design and validation, they fail to take into account stakeholder behavior in their methodologies [87][89]. From this point-of-view, both EAFs and modeling techniques must continue to evolve towards a more integrated perspective of an enterprise with processes still to be developed that capture and intertwine the human behavioral aspects of EA design into a more cohesive and coherent methodology. The views and concerns of individual stakeholders are different with each stakeholder vested in their own set of goals and objectives which might be foreign to those of the enterprise.

Well-designed EAs are not static but dynamic and continue to change over time as a result of both internal and external influences on the enterprise. Internal influences consist of management policies and practices, changed business strategies, and stakeholder behavior. External influences include competition, environment, and government. Therefore, in order to remain viable, an EA must provide mechanisms that allow the EA to evolve and ensure the reliability and validity of design requirements.

5.5 The i* Modeling Schemes

Existing modeling techniques and approaches to requirement verification and validation has not solved the problem of failed Enterprise Architecture (EA). Questions remain such as:

- Will the solution solve my problem?
- Is the software reliable, trustworthy and efficient?
- Does the solution threaten the stakeholder's responsibilities and status within the organization?
- Will the stakeholder's job be easier and effective?

However, given the great potential for improving the lives of people and business, a different approach to information technology (IT) is needed that better ensures EA success, one that opens the door to user acceptance and use of new technology afforded by EA. One such approach is an *early* requirements form and phase of requirements engineering traditionally performed informally with little technical support or tools available to do the work. The orientation is on what is described as *agent-oriented* recognizing that software agents have autonomy and are social in that they communicate, coordinate, and cooperate with others to achieve *goals* [26][51][137].

In EA solutions to RE concerns and software development must support transformation of requirements between and through various layers of abstraction (see Figure 4). In this regard, there have been many agent-oriented solutions proposed to model and assess the validity of EA design requirements [41][66][106][138]. One such modeling framework for consideration is i*, an early requirements analysis framework based on notions such as *actors, agent, role, position, goal, softgoals, tasks, beliefs,* and various kinds of *dependency* between actors [69]. In this modeling scheme, the actors, their goals, dependencies are identified using a graphical notation that provides a unified and intuitive version of the environment in which the application(s) is/are being modeled [26]. At present, i* consists of three main streams [26] [139]:

- Seminal i* - proposes an agent-oriented approach to requirements engineering aimed at the intentional characteristics of the agent.
- Goal-oriented Requirement Language (GRL) – provides a language supporting goal-oriented modeling and reasoning of requirements. Designed especially for dealing with non-functional requirements.
- Tropos – represents an i* complementary modeling primitive designed to support requirements analysis and software development through the project life-cycle.

In i*, agents build relationships and dependencies amongst each other attributing intentional properties such as goals, beliefs, abilities, and commitment. The dependencies between agents are both opportunities and challenges with associated vulnerabilities providing alternative configurations to assess their strategic impact on requirements engineering and software development from a social perspective [139].

GRL consists of three categories of concepts: intentional elements, links, and actors providing a different kind of requirements modeling focused on *why* certain choices were made for behavior and/or structure were made or constraints introduced. The process omits operational details of processes or system requirements focusing on a higher-level or strategic view towards modeling current of the future software system, The process supports the reasoning behind scenarios modeling goals and scenarios from a strategic perspective.

Tropos is a software development methodology that includes agent, goal, task, and (social) dependency in its approach to modeling and analyzing early and late software requirements. Yu process consists of five phases:

- Early Requirements
- Late Requirements
- Architectural Design
- Detailed Design
- Implementation

As an agent oriented software engineering (AOSE) methodology, it covers the whole software development process. It supports mentalistic notions of agent, goals, and plans in all phases of software development and the kinds of interactions that should occur between software and human agents [51][139].

The i* framework consists of two modeling components each corresponding to a different level of abstraction [26][138][139]:

- The *Strategic Dependency* (SD) model which is used to describe the dependency relationships between actors in an organizational context and the intentional level.
- The *Strategic Rationale* (SR) model which describes stakeholder interests and concerns and how they might be addressed by various configurations of systems and environments.

The notations used in i*, GRL and UCM, facilitates identification of *actors* and a set of *dependencies [26]*[51][139].

In the i* literature, the SD diagram consists of a set of nodes that represent *actors* showing a set of *dependencies* reflecting the relationships among them. The process expresses that actions of an actor (*depender*) depends on an action by some other actor (*dependee*) in order to obtain some objective (*dependent*). The *dependent* is an *intentional element* that can be some *resource, task, goal,* or *softgoal*. The SR diagram, on the other hand, complements and refines the SD diagram with reasoning capabilities by allowing intentional elements to be visualized and linked within the boundary of an actor. The SR diagram decomposes its elements into two types of links:

- *Measured links* that establish one or more intentional elements as the means contributing to the achievement of an end. In this case, the “end” can be a goal, task, resource, or softgoal with the “means” representing a task to be performed. The means-end link is an *or* relationship when there are many means with many different ways to obtain the end.

- *Task decomposition links* decomposes task into different intentional elements. It is an *and* relationship where a task is decomposed into more than one intentional element.

The i* framework views organizational actors as having intentional properties such as goals, beliefs, abilities, and commitments with the actors depending on each other to achieve their goals, the tasks to be performed and the resources to be furnished. *Actors*, in turn, can be decomposed into *agents, roles,* and *positions*. A position covers a number of roles. Agents represent particular instances of people, machines, or software within the organization and they occupy positions (and as a consequence, they play the roles covered by these positions) or are instances of other agents. *Is-a-part-of* and *is-a* relationship.

The aim of the framework is to facilitate actors reaching their goals which may be impossible or difficult to attain by their depending on others to assist. Actors in this sense are viewed as strategic entities that are concerned about opportunities and vulnerabilities that seek rearrangement of their environments to better serve their interests.

i* addresses the need for and application of *soft people* skills in the design process. At present, the i* solutions consider behavior only from a software-based human-computer interface point-of-view and as such do not take into account stakeholder behavior and the sociological aspects of enterprise engineering that might impede EA design. However, some research has been written that investigates the working relationship between people and the fit of technology within the workgrop [48][129].

This literature explores two human behavioral application of i*. The first, attempts using i* to ascribe intentions to actors where goals are used to model and reason functional and non-functional requirements for the system "*to be*" and at the same time represent the dependencies among stakeholders [48]. The second, considers a socio-psychological approach applying it and extending it to i* as a means of analyzing requirements for socio-technical systems. In this context, the knowledge, skills, and abilities of agents (i.e., stakeholders) determine how well the human resources and their respective cognitive skills fit the needs of the tasks and group objectives.

5.6 Summary

Establishing and maintaining an Enterprise Architecture (EA) is clearly a complex task involving a diverse group of people with different backgrounds and experiences coupled with the difficulties associated with technology. EA systems can be modeled at different levels of abstraction or viewpoints and designed to validate stakeholder requirements at that particular level of abstraction. The modeling requirements, the complexity of modern organizations, the magnitude and scope of applications, as well as miscommunication between business, operational and technical staff and experts who speak their own language, and the moving target of business services and technology only reinforces the need to ensure quality requirements enter EA [5][22][33].

In current business practice, an integrated approach to business and EA is more of a sales pitch than it is a reality. There is little question that changes in an organization's business environment, strategy, and goals present a number of significant problems for an enterprise to solve. The consequences of failure affect all domains of the organization and its structure. In this chapter, current approaches to EA modeling practices have been described highlighting their respective strengths and weaknesses and, in some cases, the languages used.

With the possible exception of one modeling scheme, *i**, none of the modeling scheme described in this chapter consider human behavior of any significance in EA design. The focus of their approach is only on the technical aspects of the EA. Requirements are predicated on gathering, analyzing, and validating two kinds of organizational knowledge: explicit or that which is documented and known throughout the organization and implicit/tacit or that which is usually undocumented and known only to a select individual or group of people.

The fallacy in all of the EA frameworks and their associated or accompanying modeling methodologies is that they fail to address elicitation of tacit stakeholder knowledge. Gathering this information is critical to EA design and implementation and may be withheld by stakeholders as a result of resistance to organizational change and the potential threat EA poses to their respective position and status within the enterprise. Recognizing these behavioral tendencies exist in all stakeholders, principles and practices from the fields of sociology and psychology coupled with principles and practices from organizational theory and management behavior provide new avenues for exploration in implementing information technology (IT).

For example, use of tools such as a socio-communicative approach to requirements elicitation and stakeholder education and training in the new technology are only two motivational techniques available. The purpose of this process is to encourage:

- Sharing of ideas to facilitate decision-making and problem solving
- Explaining decisions and providing an opportunity for clarification
- Sharing responsibility for decision-making and implementation

- Providing specific instructions and closely supervising and rewarding performance (governance)

The goal of this process is to create and maintain stakeholder participation and collaboration in the requirements elicitation process to ensure the validity of the delivered EA.

Chapter Six – A Sociological and Humanistic Approach to Enterprise Architecture Design

Users of technology (i.e., stakeholders) have historically accepted the infusion of technology (e.g., hardware, software, and processes) solutions into their daily lives without question. That is no longer true today. Stakeholders frequently question, either covertly or overtly, new or enhanced technology in relation to how it might affect the environment in which they function [23][99]. This change in behavior, therefore, poses a topic of high relevance to Enterprise Architecture (EA) management and in how Enterprise Information Architects (EIA) do their work given that the premise that new or enhanced technology in the workplace can be accepted, rejected, or modified to fit the roles desired by stakeholders [20][99]. For example, stakeholders may attempt to create new institutions by leveraging existing sets of taken-for-granted practices, technologies, and rules if they are able to associate the old with the new. In some literature this is referred to as “mimicry” [75] These issues also raise questions about how EIAs must evaluate the quality of the elicited specifications and how the unanticipated use of technology might affect EA design throughout the EA design effort [99].

If we consider the elicitation of stakeholder requirements as knowledge creation, simply organizational knowledge held by stakeholders, induced by the intersection and interaction of technology and stakeholder behavior, then how stakeholders create, process, and provide that knowledge as input to the EA becomes a recursive process directly related to organizational behavior and environment in which it functions. This knowledge is then a dynamic, recursive re-conceptualization of organizational knowledge creation that directly affects the quality of EA design requirements while providing a paradigm for effective EA.

Organizational behavior, on the other hand, is based on a set of standardized rules, procedures, processes, and systems (collectively referred to as rules) that sets the tone and the tenor for the workplace environment [58][83][85]. These rules constitute a set of coordinated and controlled activities with institutional work (i.e., output) produced from complex networks of technical relations that span and cross-organizational boundaries [99]. The rules and activities after examination under the rubric of institutionalized behavior then become ingrained and an integral part of prevailing social behavior within the organization and are subsequently built into the society as reciprocated interpretations [32][46]. However, conformity to these rules and activities is often problematic as it conflicts with organizational efficiency by undermining, constraining, and inhibiting organizational flexibility. This rule-based environment inhibits and limits a dynamic view of the organization and discourages participation and, in general, is not conducive for EA stakeholders to be innovative, creative, and therefore more receptive to change [46][99].

6.1 The Rationale for a Socio-Communications Channel

In the *Theory of Structuration*, the *duality of structure*, *agency*, *transformation*, the relationship between agency (i.e., human actors/agents - stakeholders) and structure (i.e., systems/organizations/society) [46][89][95], are considered in the following contexts:

- How are the actions of individual agents related to the structural features of organizations/society?

- How do individual agents act on a day-to-day basis?
- How are individual actions reproduced?

The *Theory of Structuration* posits that structure exists only in and through the activities of human agents and gives form to social life but that that form is itself not the shape of it. Giddens' agency does not refer to people's intentions in doing things but focuses on the behavioral patterns exhibited by people's actions [46]. The *duality of structure* suggests a social structure consisting of rules and resources with rules being applied to govern and regulate social life and resources including both human and non-human elements that can be transformed into power.

Humans interact via communication schemes and in so doing, they draw on interpretative schemes and their respective cognitive knowledge base to make sense of their own actions and that of others. As a result, they produce and reproduce structures of significance [46]. As a human artifact, technology is created and used by human actors and is sustained, maintained, and adapted by human action [95]. Humans also sanction or justify their behavior and actions by drawing upon norms or standards to legitimize, produce, and reproduce structures that guide their actions [46].

Taken together, the *Theory of Structuration* and the *Structuration Model of Technology* highlight those factors that may affect the veracity of those specifications and requirements needed for quality EA design. A logical conclusion can therefore be made that an initiative such as the formulation of enterprise architecture remains incomplete if it does not explicitly take into account human action and organizational behavior from which to derive a dynamic theory of social and institutional order. Any project such as an EA must have the support of all stakeholders involved in the process. This means stakeholders must collaborate and work towards a more coordinated and controlled design and implementation plan. Therefore, the solution to this problem requires a radical shift in the way organizations approach EA.

This shift involves the use of communication between people to exchange information via interpretive schemes such as a form of modality that includes languages and symbolic artifacts. In one article [107], reference was made to over 200 pieces of literature published in communication and management journals, multiple research-based books, and texts on theoretical perspectives and paradigm development that reflects a growing consensus in the study of communication as a motivator in managing stakeholder behavior. A solution can be found in the following section where a communications path/channel is established and maintained that encourages knowledge sharing among stakeholders to better ensure and manage EA design.

6.2 The Socio-Communicative Approach to Enterprise Architecture Design

Many of the emergent causal processes that lead to EA failure have been well documented with those factors of significance attributed to EA failure detailed in our earlier papers [89][90]. The challenge facing an Enterprise Information Architect (EIA) and the organization is how to avoid these factors, prevent failure, and cope with these issues when they arise. Analyzing these challenges, the answer might lie in the ubiquitous nature of communication, its relevance to human behavior, and its implementation as a modifier for human behavior.

From a purely research-oriented historical perspective, social theorists posit that organizational behavior directly reflects the attitudes and behavior of top management and that over time this behavior becomes ingrained and an integral part of organizational behavior [46][58][83][85]. In concert with this hypothesis, we find the addition of technology significantly influences human behavior and the attitudes, feedback loops, and selection mechanisms that typically are used in the EA [99][120]. These then form the basis for an analytical approach wherein socio-communicative processes provide a more meaningful and cogent solution to many EA failure factors.

In earlier work, [87][89] and in Chapter Two, we cataloged and detailed the makeup of “poor architecture” and linked this attribute directly to stakeholder behavior. A correlation between the elicitation of stakeholder requirements, understanding of those requirements, and subsequent transformation of those requirements into detailed EA design specifications can easily be drawn upon review and analysis of the root-cause of failure detailed in published writings [11][36][37][43][44][74][113]. However, the problem may go far beyond just poor requirements and specifications.

In most organizations, people behave as the group behaves and tend to use technology in ways in which they are both familiar and understand [32][99]. In addition, their actions and motivations typically are influenced and driven by group behavior [57][84]. Therefore, the goal motivating this research is to establish an environment where human agents/actors (i.e., stakeholders) are willing to share explicit (i.e., formal knowledge), commonly known and perhaps even documented, knowledge and, more importantly as it may be that needed to ensure EA success that “tacit” knowledge of what and how they really perform their day-to-day activities. In effect, an environment as stated above that promotes, encourages, and fosters user “ownership” of the EA.

The challenge associated with this goal requires that the EA environment transcend technical and business issues and become more focused on the recursive nature and human aspects of the EA. This challenge also requires mechanisms that support not only traditional “formal” means of communication but to also encourage “informal” lines of communication. Human behavior then becomes a prime concern of EA design with communication (the exchanging of information, messages, ideas, opinions, and explicit and tacit knowledge) the motivational mechanism used in clarifying otherwise ambiguous and sometimes abstruse goals and objectives and solving complex IS issues and concerns. The effect would almost represent a peer-to-peer environment between all project stakeholders.

This aspect of EA then is just as or more important than any technical and/or business acumen. As the mechanism to progress EA design, communication is an effective learnable skill. To illustrate the communications issue, organizations are faced with three behavioral concerns:

- The introduction of new technology into organizations
- Changes in human behavior resulting from new technology
- Resistance to change

The rationale for this behavior traces to varying views of technology by people reacting to it accordingly, and for several legitimate reasons [58][83][85]:

- Low tolerance for change – the stakeholder believes the new is worse than the known
- Misunderstanding - the stakeholder doesn’t understand the reason for change
- Power – the stakeholder has the power to ignore, obstruct, and avoid the new
- Distrust – the stakeholder doesn’t trust the enterprise’s motivation for the change

Based on our research, we propose an alternative solution that puts in place a communications mechanism where an environment exists that fosters and encourages:

- Sharing of ideas that facilitate decision-making and problem-solving
- Explaining decisions and providing an opportunity for clarification
- Sharing responsibility for decision-making and implementation
- Providing specific instructions and closely supervising and rewarding performance (governance)

Our approach establishes, as a first step, EA governance at the beginning of EA design and defines how it will be documented, continued, and maintained throughout the EA life-cycle. The second step requires top-level management to publish a description of what EA is and describing its purpose, the reasons for, and the role EA has within the organization. This document should also detail an initial list of EA goals and objectives as well as the magnitude, scope, and boundaries for the EA. The third step defines and establishes the communications process to be followed during the EA life cycle.

6.3 Summary

Large-scale organizational structures emerged from direct forms of personal administration in the late nineteenth and early twentieth century towards an environment dominated by economic, social, and political factors [55][76][83]. These structures have since evolved to an institutionalized state that is sometimes viewed as a purposeful and challenging system being spontaneously and homeostatically maintained [67][112]. People, on the other hand, have the potential of synergistic collaboration and contribution to organizational goals and objectives [20][96]. There are also risks of the opposite [46][58].

The introduction of technology into the workplace has typically been followed by significant changes to organizational philosophy, social structure, and environment coalesced into three crucial artifacts affecting stakeholder behavior [20][23][97]:

- The magnitude of noxiousness of a depicted event
- The probability of that event's occurrence
- The efficacy of a response

Investigation into the relevance of these components leads to potential solutions easily addressed using communication as a process to initiate a corresponding cognitive appraisal of stakeholder behavior and technology [107].

Our research into the organizational communication process has focused on and will continue to focus on mechanisms for motivating stakeholders and that, at the same time, manipulates and mediates stakeholder attitudes towards organizational change. In this context, communication is a choice and, therefore, requires encouragement and willingness on the part of stakeholders to participate to be successful and thus act as a stakeholder motivator [87]. There is a fine line between success and failure of any project which depends upon organizational management's ability to establish and create conditions conducive to stakeholder involvement. Putting in place a communications mechanism and path extending from both a top-down and a bottoms-up scheme fosters such an environment.

As envisioned, the first step of the process would encompass three aspects of communications: disclosure, analysis, and feedback (see Figure 12) establishing an on-going, open-ended forum for transmission and reception of all ideas, comments, observations, and questions ("brainstorming") related to the EA. The process would also provide for identifying potential surrounding internal and external influences that might affect the project. The ontology, processes, and procedures for EA management, measurement, and governance are instantiated, documented and distributed to all stakeholders, and initiated before EA design begins. We see the process as defining how the EA will be conducted, documented, continued, and maintained throughout the EA life-cycle.

The second step requires top-level management involvement. It begins by instantiating management to publish a description to be distributed to all stakeholders of what EA is, describing its purpose, the reasons for, and the role EA has within the organization. The document should also include an initial list detailing the goals and objectives of EA including the magnitude, scope, and boundaries for the EA.

The third step of the process defines the detail for: the communication process such as formats for all correspondence; the procedures to be used for collection and feedback of EA requirements; the rules, policies, and practices to be used to manage, measure, and monitor EA design and progress; etc.

AS can be seen, management and its behavior play a significant role in governing and controlling organizational operation. It also sets the tenor of the organization environment. In this regard, it can take two forms. It can be [54][58][83][85]:

- Proactive – where management makes things happen anticipating actions be stakeholders without waiting for something to happen
- Reactive – where management reacts to change rather than anticipating and shaping change

The characteristics of proactive management are:

- They plan ahead anticipating change and identifying ways of managing and controlling change
- They clarify goals and objectives for team and individual to motivate and to avoid behavioral issues
- They encourage team members and individuals to state their views and to respond to those views and suggestions
- They seek to maintain high-levels of team and individual morale

On the other hand, the characteristics of reactive management are:

- They respond to changes and problems after they have occurred
- They defend the goals and objectives taken by groups/teams a and individuals
- They seek to defend the team and individual against criticism

As can be seen, management behavior exerts a major influence on the organization's work environment and political and social structure [46][58][81][83][85]. With organizational behavior focused on operational efficiency and effectiveness, they frequently miss understanding the unpredictable nature of humans involved in doing work and therefore provide a forum for negative stakeholder behavior [31][46][95]. This becomes evident when technology such as an EA is introduced into the enterprise ineffectually by avoiding stakeholder input to the EA and it meets with resistance.

Chapter Seven – Conclusion

In today's Enterprise Architecture (EA) environment, the traditional, linear, one-dimensional, techno-centric approach fostered by existing EA framework (EAF) strategies to EA design are not enough to ensure delivery of an effective and efficient EA design that meets user expectations [87][89]. The large number of EA projects documented that are either partially implemented or completely abandoned show that the majority of these project fall short failing to deliver desired organizational and stakeholder goals, objectives, and requirements [36][37][44][113]. The cost of these failed projects is estimated annually into the billions of dollars [74].

Chapter One begins our work with a broad wide-ranging discussion of the factors and problems influencing EA. The motivation and rationale for undertaking this effort and a brief synopsis of the material covered in each chapter of this disseration are provided. One of the confusing aspects of EA, what is EA and what is information technology (IT), is covered and discussed in Section 1.1 of this chapter and, at least for this document, IT and information systems development are considered *doing EA*.

Our research and analysis into EA finds that the underlying factor affecting EA design and implementation is not of a technical nature but more the lack of those responsible for EA to recognize:

- The impact EA does or will have on both stakeholder and organizational behavior
- How organizational transformation will affect stakeholder behavior

- How human behavior can be managed to better ensure EA success
- Employee motivational tools that might better serve the enterprise
- How best can EA design achieve organizational goals and objectives

As can be seen, these issues are not technical but are related to human behavior.

In this chapter, we identified two human behavioral issues that significantly influence EA design:

- The elicitation of stakeholder requirements
- The organizational transformation that takes place resulting from new technology

These two issues led to identification of a wide-range of other human behavioral patterns discussed in Chapters Three and Four and provided us the impetus to search for, explore, and/or develop human motivational tools and mechanisms that facilitate successful EA and, at the same time, mitigate negative human behavior. The focus of our work in this area examined sociological, psychological, organizational theory and managemen behavior principles and practices to assess and determine their applicability to EA and, in a more general sense, to overall IT development.

Our research and analysis of available literature written on IT and enterprise information systems (EIS) design and implementation reflect the on-going effort of academicians and practitioners to highlight the difficulty and complexity in developing large-scale EISs that *work* [3][6][8]. Unfortunately, the literature by and large addresses EA and IT from a purely techno-centric position and does not effectively offer any effective solution(s) to the issues raised above. The literature actually obfuscates what we believe the real root-cause of failure, human behavior.

Next, we introduce EA with a broad inclusive definition of what EA is and it's relevance and rationale for enterprise use. Our discussion of EA outlines a layered approach to EA and the overall strategies, techniques, and methodologies such as EA frameworks (EAF) and modeling schemes used to design and develop EA. The role of EA is differentiated from IT stipulating that IT is, in reality, *doing EA* and thus relating IT failure in most situations to inadequate EA which we define as "poor architecture."

Next, we introduce human behavior as an influence on EA based on their reaction to and either acceptance, rejection, and/or modification of new technology introduced into the workplace. From this perspective, we consider the impact of technology, the elicitation of stakeholder requirements, and the consequences of organizational transformation from a human behavioral perspective as major forces to be reconciled during EA. In summary, we state that humans are purposeful beings capable of intentionally or unintentionally affecting EA either positively or negatively with a capacity to act for or at odds with an organization's structure, character, culture, social, and political environment. This dissertation asserts that human behavior must be considered a major influence on EA design and therefore must be taken into account and included as part of any EAF and modeling scheme to ensure successful EA.

Chapter Two provides a historical background, perspective, and context of EA . The work in this chapter includes our analysis and comparison of several popular EAFs (the Zachman Enterprise Architecture Framework (Z|FA), The Open Group Architecture Framework (TOGAF), the Federal Enterprise Architecture Framework (FEAF), and the Department of Defense Architecture Framework (DoDAF)) used to develop EA which we compiled and detailed in Table 2. This table highlights the strengths and weaknesses of each EAF from a stakeholder behavioral point-of-view. We found the EAFs deficient in their failure to recognize or include any reference to the impact EA has on either stakeholder behavior, the issues pand/or problems associated with any form of stakeholder behavior, and the potential changes to be found in organizational transformation. The significant weaknesses in each EAF found that they fail to take into account:

- The cultural effects on human behavior caused by the environment of the enterprise and the cognitive aspects of stakeholder behavior.
- The behavior and influence an individual has singularly or on and within a group.
- The social change within the enterprise resulting from the EA.
- The changes to the enterprise's political and economic systems caused by the EA.
- The social conflict that might result from the EA.

In this chapter, we reinforce the tie between IT and EA restating our assertion that IT is responsible for *doing EA* thus providing both the ratonale and the motivation for this dissertation. Table 1 contains our analysis and compilation of organizational stakeholders identifying their roles and defining the influence each role might play in EA . Included in this chapter is a detailed statistical analysis of causal factors related to and the statistical significance for EA, and IT, failures.

We discussed the skill set currently found in use by Enterprise Information Architects (EIA) and the need to advance these skills by inclusion of principles and practives from other disciplines such as sociologyl, psychology, organizationaltheory, and management behavior.

In Chapter Three, we discuss the literature supporting our analysis of the human behavioral issues confronting EIAs, management, and other stakeholders and the impact behavior has on organizational transformation. The chapter looks at early group behavioral studies such as the Hawthorne Experiments and the human behavior theories postulated by noted sociologists such as:

- Frederick Winslow Taylor and *Taylorism* and his *Scientific Management Theory*
- Abraham Mazzlow and his *Hierarchy of Needs*
- Douglas MacGregor;s *Theory X* and *Y*
- William Ouichi's *Theory Z*

Our assessment of their potential application in handling stakeholder behavior in EA finds their respective value worthy of merit. The Hawthorne Experiments, even though their results are sometimes questioned today, and the theories ascribed above proffer activities, processes, and procedures for EIAs and management to consider and use to evaluate stakeholder (employee) performance. This research also provided us the insight into techniques, principles, and practices to better understand human behavior and thus investigate avenues that motivate humans. Our findings support incorporation of various aspects from these studies and theories in EA.

Next, we explored stakeholder resistance to change, a typical by-product of organizational transformation, which leads to acceptance, rejection, and/or modification of technology and therefore EA. In examining the human behavioral factors associated with EA failure, we identified and discussed several counter-productive leading causes of failure such as:

- Poor communication
- Lack of leadership
- Lack of top-management support and sponsorship
- Underestimating the importance of change and change management
- Lack of technical and business knowledge
- Poor project management

These factors are counter-productive yet we believe they can be minimized and mitigated by providing an environment where stakeholders are involved with and are active participants in and are receptive to change.

We conclude this chapter with a recommendation that encourages an enterprise environment that fosters collaboration and information sharing where stakeholders communicate both horizontally (i.e., peer-to-peer) and vertically (i.e., up and down the hierarchical organization chart) whenever and however they need to in order to solve problems and exchange knowhow and knowledge.

Giddens' *Theory of Structuration* and Orlikowski's *Structurational Model of Technology* formulate Chapter Four's assertion that both of these sociological theories are applicable to EA. The focus of our research developing this document is grounded in and the foundation for this dissertation. Though not included as part of this document, our research and analysis of the literature used to develop this dissertation finds both theories adaptable for useful in IT development.

Reading and understanding Giddens' *Theory of Structuration* was found to be difficult and laborious. However, it does provide an understaning and an insight into the recursive nature of human behavior, a meta-theory or perspective on all human activity. This is needed to study, understand, and analyze the interactions of humans and organizations. The theory considers human behavior from a social perspective defining human action as purposeful, recursive, and thus continually reproducing itself. It looks at social or organizational structures as influences on agents' (stakeholder) action yet does not consider these structures to exist independently of the agents. In this context, structures exist as they are enacted by human agents consitituing a recursive relationship, a *duality of strcuture* in Giddens' terms, between people and structures. From this position, structures both enable and constrain but do not determine human action.

The *Structurational Model of Technology* uses concpets from Giddens' *Theory of Structuration* and thus ties the *Theory of Structuration* to technology. The *Structurational Model of Technology* discusses human (stakeholer) action in the creation and useage of technology. The theory enumerates and describes the impact and implications technology has on human behavior and it's acceptance, rejection, and/or modification by users.

The use of both theories in our research progresses our desire to augment and enhance existing EAF processes and procedures to include sociological, psychological, organizational theory, and management behavior principles and practices in developing EA.

Chapter Five recognizes the importance of modeling the enterprise *as is* state to the desired future or *to be* state of the enterprise Table 5 contains our analysis of several popular modeling tools and technigues to ascertain their use in developing EA from a human behavior perspective. Like our analysis of existing EAFs illustrated in Table 2, our findings found the current state of modeling schemes deficient regarding the impact of human behavior in the modeling process. However, we did find one potential modeling scheme, Eric Yu's *i**, that considers human behavior from a *dependee* and *depender* position. This modeling scheme dentifies the reliance of one stakeholder on another and thus recognizes stakeholder behavior from this position. Literature on *i** is limited on its use in assessing the impact of human behavior in modeling. Therefore, whether *i** satisfies fully our desire to include a modeling scheme that takes into account the human behavioral issues and concerns discussed in Chapters One through Four remains to be detrmined.

Chapter Six restates several concepts enumerated upon in earlier chapters with a focus on developing processes and procedures aimed at stakeholder motivation and mitigation of negative influences on EA design and implementation. It describes the use of a socio-communicative process tat fosters both a horizontal (peer-to-peer) and vertical (up and down the organizational chart) communications chaneel for diseminating information related to EA and it's progress. The idea behind this communications path seeks to encourage stakeholder participation in the decision-making and design process while providing a forum for stakeholders to offer innovative and creative ideas "brainstorming" to the EA.

Finally, a summary of our work accompanied by a detailed explanation of our contributions to software engineering, especially EA, are followed by a brief discussion of future planned research is described in this chapter, Chapter Seven.

7.1 Dissertation Contributions

This dissertation contains the results of research and analysis into the factors influencing Enterprise Architecture (EA) failure from a non-technical perspective. From this effort, the following four (4) publications have been tendered, accepted, and presented to several IEEE recognized world conferences on software engineering:

- "*On Applying the Theory of Structuration to Enterprise Architecture Design*," Computer and Information Science, 2010 IEEE/ACIS 9th International Conference on Software Engineering Research, pp 859-863, 2010.
- "*Applying the Theory of Structuration to Enterprise Architecture Design*," 2011 World Conference in Computer Science, Computer Engineering and Applied Computing, 2011.
- "*Enterprise Architecture: A Framework Based on Human Behavior Using the Theory of Strcuturation*," International Association of Computer and Information Science, 2012 IEEE/ACIS 10th International Conference on Software Engineering, Research, Management, and Applications, Studies in Computational Intellifence 430, Springer-Verlag, Berling, Heidelberg, pp 65-79, 2012.
- "*Enterprise Architecture and Organizational Transformation: The Human Side of Information Technology Using the Theory of Structuration*," 2012 World Conference in Computer Science, Computer Engineering and Applied Computing, 2012.

Each publication represents a building block constructing a more holistic humanistic approach to EA. Our focus is aimed at improving EA design by including human behavior and organizational transformation as major inputs to and a lens guiding the design and implementation process. For example, our first publication, "*On Applying the Theory of Structuration to Enterprise Architecture Design,*" identified a series of major human and organizational behavior impedidments to EA. This paper also introduced Goddens' *Theory of Structuration* and Orlikowski's *Structurational Model of Technology* and their potential use informulating EA.

Our second publication,"*Applying the Theory of Structuration to Enterprise Architecture Design,"* progressed our analysis of the the factors influencing and impeding EA providing insight into possible stakeholder motivational schemes to encourage and facilitate stakeholder participation and inclusion in the EA design and decision-making process. The focus of our effeort in this paper was on a socio-communicative apprtoach to EA.

Publication three, "*Enterrise Architecture: A Framework Based on Human Behavior Using the Theory of Structuration*," describes our premininary work towards an enhanced process for developing EA from a humanistic point-of-view. Our approach to EA proposes several humanistic processes and procedures that can be used to enhance existing EAFs or as a stand-alone EA framework. In addition to be presented at the *International Association of Computer and Information Science, 2012 IEEE/ACIS 10th International Conference on Software Engineering,* this paper is available in the Springer text "Studies in Computational Intelligence 430, Software Engineering Research, Management and Applications 2012".

Our fourth publication, "*Enterprise Architecture and Organizational Transformation: The Human Side of Information Technology Using the Theory of Structuration*," discusses stakeholder acceptance and/or rejection of EA based on the organizational transformation that inevitably follows implementation of EA. It explores in depth the elicitation of stakeholder reuirements process and the implications to EA casued by failure to gather adequate design requirements.

Todate, our work has been based on the analysis of topical literature available from a wide and diverse range of sources. The literature used in our research has been analyzed as it relates to both human and organizational behavior and to the failure of existing EAFs and modeling schemes to take into account and include processes and procedures to handle these aspects of EA. The focus of our work has been on the impact of human action, reaction to, and interaction of stakeholders to and with new technology. Based on this work, we believe a better solution to EA design and implementation is needed that extends beyond the traditional technical and business skill set of an Enterprise Information Architects (EIA) to one that includes principles and practices from sociologically oriented disciplines. From a purely motivational point-of-view,we believe stakeholders would therefore be more receptive to change. not, cannot be overlooked in EA.

Our conclusion is that EAFs, EA modeling schemes, EIAs, and management must reach out and embrace new interdisciplinary processes and procedures found in the principles and practices of sociology, psychology, organizational theory, and management behavior so as to better understand stakeholder behavior and the influence it has on EA. EA presents unique opportunities to implement new information technology in an organization and increase business value. However, we find the change in organizational structure and, more importantly, stakeholder attitudes, beliefs, values, and behavior are implicit in EAs implementation and can have serious consequences to the morale and stability of the organization’s workforce if not taken into consideration. In some cases these consequences can be catastrophic affecting and jeopardizing the viability of the enterprise. For example and in the case of stakeholder behavior, studies show that offering rewards are often only short term “bandaids” to workforce performance and acceptance of organizational change.

7.2 Future Research Work

Enterprise Architecture (EA) and the introduction of new and/or enhanced technology into an organization often results in a sociological, psychological, and a political change in the hierarchical structure of the enterprise [20][46][97]. This is evidenced by a dynamic paradigm shift in internal and perhaps external perceptions of the organization. Stakeholder roles and responsibilities invariably change because of new rules, policies, procedures and processes introduced by technology that requires stakeholders to learn new ways to doing their work [38][52][55]. Therefore, the manner in which the EA design takes place can seriously affect acceptance and/or rejection of the EA by different stakeholders [88][90]. As stated above, stakeholders in the past have unquestionably accepted new ways of doing work but that is no longer true today. However, given an environment where they become part of the decision-making process and allowed to project an influence on the way work is performed, they more likely than not will accept “ownership” of the work.

To advance this work into gaining a better understanding of human behavior and the influence it has on EA, either positively or negatively, by progressing the work we began and published on:

- Establishing a Socio-Communicative Approach to EA Design [87]

- A Humanistic Framework for EA [88]
- EA and Organizational Transformation [90]

This work, ”Enterprise Architecture: A Framework Based on Human Behavior Using the Theory of Structuration,” was presented at the *International Association of Computer and Information Science, 2012 IEEE/ACIS 10th International Conference on Software Engineering, Research, Management, and Applications*, in Shanghai, China in May, 2012, and published in the text *Studies in Computational Intellifence 430, Springer-Verlag, Berling, Heidelberg, pp 65-79, 2012*. The underlying influence for this work is based on Giddens' *Theory of Structuration* and Orlikowski's *Structuration Model of* Technology. Our desire is to provide a better framework and platform based on the human side of technology from which to manage and govern the EA design process. A description of our approach is detailed below.

In our socio-communicative approach to EA, literally the keystone of our methodology, we established the need for a communications process that encouraged stakeholder participation and commitment by making them part of the decision-making process. This, in effect, shares responsibility for project success and/or failure based on their input to the design process. In our desired humanistic framework for EA, we defined three distinct processes:

- Design and use of an Architectural Design Plan (ADP) that describes the conduct of the EA based on an analysis of the existing environment and management style
- The use of the Socio-Communicative Process described in [87] that handles all aspects of inter- and intra-organization communication

- Implementation of a Requirement Process Chain (RPC) for elicitation and verification of EA design requirements

The ongoing development of this framework targeted at a more holistic and humanistic procedure based on psychological and sociological principles and practices. The proposed process aimed at both motivating and acknowledging positive human behavior incorporates checkpoints to synchronize, govern, and control design activities and to anticipate and provide a paradigm to resolve and mitigate negative human behavior and influences on EA. A brief description of the proposed framework follows.

7.2.1 The Enterprise Architecture Design Plan

In a typical EA, it is not a matter of choosing which requirements to meet but of trying to meet all practical requirements. This first step proposed for EA is an Architectural Design Plan (ADP) consisting of two components: a Development Plan (DP) and a Control Plan (CP) (see Figure 19).

The ADP documents and establishes how the overall conduct of the EA is to be progressed, stakeholders selected and assigned to the project, the kinds of procedures to be used in eliciting design requirements, the communications and feedback loop(s) needed to verify design requirements, and the measurement, monitoring, and governance techniques needed to ensure the validity of the design requirements. The primary purpose of the plan is twofold:

- Provide the mechanism for the EIA to learn the existing organizational environment and identify areas of potential concern
- Provide the basic scheme for eliciting information (requirements) from which to design the EA

This process details an excellent opportunity for the EIA to learn not only what needs to be done but also who is to participate along with their personalities, how the project is to be managed and governed, and why it needs to be done.

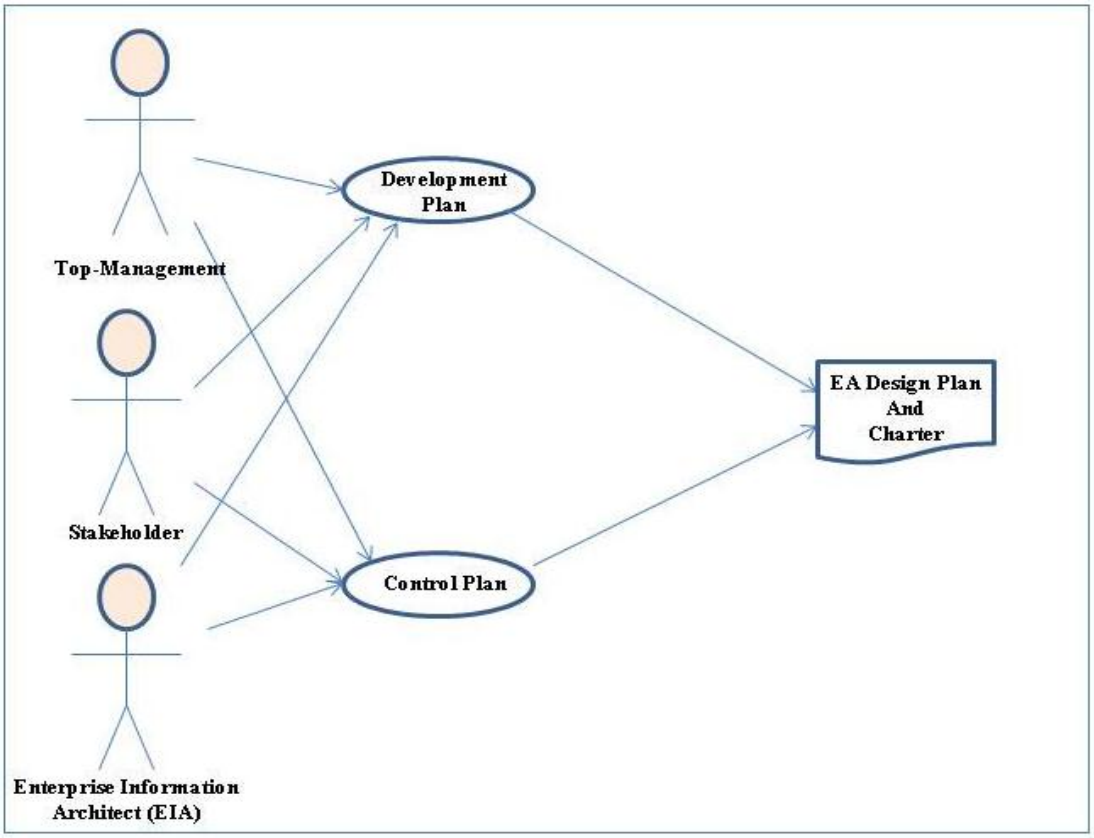

Figure 19. The Enterprise Architecture Design Plan

Kepner-Tregoe [67] uses an interesting technique in their quality assurance process. It asks the questions *why* and *why not*. We plan to use such an approach in the stakeholder selection process asking the questions “*who* is not involved in the process and *why not*?’ We plan to incorporate this aspect of stakeholder selection in our proposed framework so as to ensure the *right* and *all* necessary stakeholders are included in the selection process. Similar question will be evaluated in other aspects of EA design to assess their relevance and applicability.

7.2.2 A Socio-Communicative Approach to EA Design

The second step in this process defines and describes the specific design handles used to ensure stakeholder requirements are met. Organizational capabilities, organizational reaction to nonconformance and then exact critical in-design parameters that control the quality attributes of the design are documented and assessed to ensure that exact stakeholder expectations are met. This communications process is performed simultaneously with the ADP and formulates and establishes the detail horizontal and vertical communications scheme that will be used throughout the project life cycle (see Figure 12).

Investigation into the relevance of this aspect of our framework leads to potential solutions easily addressed using communication as a process to initiate a corresponding cognitive appraisal of stakeholder behavior and technology. The communication process focuses on mechanisms for motivating stakeholders and to mediate negative attitudes and behavioral patterns towards change. In this context, communication becomes a choice and therefore requires encouragement and willingness on the part of stakeholders to participate to be successful and thus become a stakeholder motivator.

The process defines how the EA will be conducted, documented, continued, and maintained throughout the EA lifecycle. The second step requires top-level management to publish a description of what EA is, describing its purpose, the reasons for, and the role EA has within the organization detailing an initial list of EA goals and objectives including the magnitude, scope, and boundaries for the EA. Depending on the complexity of the anticipated work, plans for scheduling any education and training of stakeholders should be included and distributed to all project Alters internal and external perceptions of the organization and stakeholders. Education, training, and the communications channel can also be viewed as stakeholder motivators.

This step defines and establishes the communications process describing the:

- Formats for all EA design and implementation correspondence such as distribution lists, review meetings, and progress reports
- Procedures to be used in the collection and feedback of EA requirements
- Rules, policies, and practices to be used to manage, monitor, model, and measure EA design and progress
- Mechanisms for administering and managing the EA governance
- Procedures providing for input to the EA design suggesting innovative and creative ideas, opinions, and endogenous and exogenous factors ("brainstorming") that might influence the decision-making process

7.2.3 The Requirements Process Chain

The third process of our paradigm, the Requirement Process Chain (RPC), consists of four distinct phases:

- The Requirement Collection Process
- Management, Monitoring, Measurement, and Governance
- Validation and Reliability
- Failure Risk Analysis and Effects Mode

The Requirement Collection Process details the methods to be used such as interviews, questionnaires, surveys, and analysis of existing documentation all aimed at the elicitation of explicit and tacit stakeholder knowledge (requirements) and describing how the information will be verified, validated, and accredited (see Figure 4).

The second step of this process describes how the overall EA will be managed, monitored, measured, and governed such that all stakeholders are aware of the procedures and feedback loops are to be employed. This phase assigns specifics related to stakeholder requirements are to be handled and modeled to ensure the process is capable of meeting stakeholder needs and requirements.

The Validation and Reliability phase ensures proper communication takes place between all parties affected by the new design. Results of tests, models, human-computer interface analysis in the traditional technical behavioral sense, documentation, and stakeholder acceptance and sign-off procedures will be distributed to top-management through the DAF communications channels.

The Failure Assessment and Effects Phase, a "brainstorming" event, examines and analyzes every possible failure mode for the process under examination in order to understand the consequences of process failure from the stakeholder perspective. The goal of this phase is to provide a risk-analysis for the failed process and a plan to correct the deficiency in system or software design and development.

The reliability and management system based on human behavior discussed above will be expanded to pursue development of a modeling scheme that better ensures EA quality through the requirement elicitation, analysis, and specification phases. The communications path we propose will be further defined to include management and control techniques designed to handle EA design complexities and risk aspects associated with project scope and stakeholder requirement ambiguity.

The elicitation and documentation of each stakeholder desired requirement will include a provision for verification and validation via an agreed-upon, in writing, mechanism between stakeholders and the EIA. As with any scheme used by the EIA, the modeling of complex requirements must include a mechanism that provides full traceability for each requirement through transformation to a technical specification to final product deliverable. Therefore, we plan to explore establishing a process, a baseline, to handle requirement traceability from which future comparisons can be made between the current state of the requirement and its final technical specification.

The goal of this proposed framework is to create an environment and as architecture that provides best chance for success as well as the most adaptable, practical solution for the future and which aligns strategic business with IT plans.

7.3 Dissertation Summary

To manage and govern the complexity of an enterprise requires the coordination and control of activities embedded in the complex networks of techno-centric relations and boundary spanning exchanges. The development of enterprise information systems (EIS) as well as their deployment and operation often imposes new challenges for the organization and the Enterprise Information Architect (EIA) to solve. However, successful implementation of an Enterprise Architecture (EA) can lead to significant business advantages and an edge over other competing organizations. In many organizations, businesses must collaborate and cooperate across organizational boundaries, perhaps work cultures, and political environments to ensure the coordination needed to successful development of large-scale complex information systems (IS).

The real-world development and deployment of EA can be viewed from several points-of-view such as the technical and engineering prevalent is most literature and research on the topic so far. If we explore and analyze EA from a humanistic perspective, successful participation of project stakeholders is ultimately a matter of the stakeholders understanding the peculiarities of their respective behavior and its applicability to and impact on EA. The cognitive issues related to stakeholder behavior impacts EA:

- Knowledge transfer
- Knowledge management strategies
- Knowledge sharing in both formal and informal settings
- Task allocation
- Communication
- Collaboration

These issues can be managed and controlled when sociological and psychological principles and practices are an integral component of EA.

An organizational environment featuring proactive management behavior fosters collaboration and information-sharing by encouraging stakeholders to communicate both horizontally (i.e., peer-to-peer) and vertically (i.e., up and down the hierarchical organization chart) whenever and however they need to in order to solve problems and exchange knowhow and knowledge. This possibility and prospect becomes realizable if an enhanced working environment where participation in the design, decision-making, and implementation of new EA technology is welcomed and not perceived as a threat to stakeholder well–being. The benefits from such an environment can only improve workforce morale and productivity. In our increasingly digitally encoded environment, EIAs holds the potential to become major players who can assist enterprises achieve their respective goals and objectives.

In conclusion, the *Theory of Structuration* provides a means of understanding human behavior and its relationship to organizational change. *SMT*, on the other hand, addresses the effects of technology on human behavior [46][99]. Taken together, they conceptualize the unique opportunities for an EIA to implement an EA.

We plan to continue progressing our earlier work [87][88][89][90] by expanding our exploration into the possibilities extant and the potential contribution gained as the result of using the *Theory of Structuration* along with *SMT* and thus improve on and enhance the EAF process. We consider a communication process based on human behavior the prime motivational element in behavior modification and offer it as a means to augment existing EAFs. Coupled with the communication process, future work includes expanding our research into two areas:

- To obtain a better understanding of human behavior and the influence it has on EA so as to provide a better platform to manage and govern the design process.
- To explore EA modeling schemes to assess their ability to cope with human behavior in their respective approach to requirements modeling. The focus of this effort is to better ensure the quality and reliability of design requirements input to EA.

Modifying human behavior to more readably accept organizational change represents a major component requiring design and implementation of tools and mechanisms that facilitate stakeholder willingness to share knowledge. Quality requirements are essential to EA success. Therefore, we plan to expand our research and explore EA modeling schemes to assess and better ensure EA quality through the requirement elicitation, analysis, and specification phases of EA.

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