CRITICAL LITERATURE REVIEW & ANALYSIS

Enterprise Architecture: What is it and why should we care?

Ahmad K. Shuja

Abstract

We hear the term "Enterprise Architecture" (EA) in almost every technology strategy and management meeting and forum any company you visit. However, when you inquire about this term, if not more, you will certainly find as many views as there are individuals. From academic perspective, any paper you read on EA, you will find a different view. Such varying definitions and understandings of EA … In this paper, I will perform a critical analysis of the varying views in the academia related to EA, I will establish a ground that without a thorough understanding of what EA is, it may not be possible for "global" enterprises to successfully inhibit newly developed technologies across their businesses.

…

Keywords: Enterprise Architecture, habitability, adoption…

1. PROBLEM STATEMENT

In this paper, I would specifically like to draw your attention to the research carried out, both in academia as well as in industry, in the space of Enterprise Architecture (EA). Varying views on EA lead to lack of unified knowledge (knowledge required to relate systems, processes, and people in different enterprises within an enterprise, understanding the dependencies that exist between them, and relating them to the overall strategic goal of the enterprise) and presence of varying cultures, policies, and systems across the globe prevent enterprises from managing the process of innovation, building software, process, and policy solutions to resolve critical business challenges, and integrating those solutions across the enterprise in an effective and efficient manner.

2. HYPOTHESIS & RESEARCH QUESTIONS

The research questions I will focus on are as follows:

RQ1: How many varying EA views exist and how do these vary?

RQ2: How do these views impact the approaches we take to resolve ever increasing multi-disciplinary challenges of managing complexity, innovation, engineering, development, and habitation of new solutions?

RQ3: What is the relationship between habitation and adoption? Is the former not possible without the later? That is, is it true that something will not be successfully inhibited unless it is adopted and widespread dispersed?

RQ4: How does technology adoption relate to habitation and what is the role of EA in all this? What is the relationship between EA and enterprise-wide habitability of enterprise solutions?

RQ5: Can an EA that does not ensure appropriate habitation of intended enterprise-wide solutions be considered a holistic one?

3. METHODOLOGY

In order to answer the above questions, I will need to carry out a multi-disciplinary research involving Science, Technology, Socialization, Architecture, and Human Values.

4. REVIEW OF LITERATURE

EA is a new and heavily used term in the industry and almost every professional I speak to perceives himself/herself to be some form of Enterprise Architect. There is nothing wrong with such a perception until it does not affect the actual value that EA is supposed to deliver. Unfortunately, … Therefore, in this section, I will establish that EA is sometime "confused" and other times "misinterpreted" by both practitioners as well as researchers. Following this argument, I will propose the holistic view of EA and will substantiate this view by presenting sound ……

4.1 Existing EA Views:

IEEE 1471-2000 standard defines Software Architecture as the fundamental organization of a system, embodied in its components, their relationships to each other, and the principles governing its design and evolution.

Tarabanis, Peristeras and Fragidis (2001) view EA more at a data modeling level and use the concept to achieve the following goals:

- Create an Integrated Process & Data Repository for Public Administration that could serve as a knowledge base for all PAs.
- Structure the above processes and data in a Generic Process & Data Model.

However, according to some researchers, EA has should have a greater role to play in aligning technologies with businesses to achieve competitiveness. For example, Wegmann (2002) claims that EA is a discipline whose purpose is to align more effectively the strategies of enterprises together with their processes and their resources (business & IT). For META Group, EA represents a process, not a thing. The process will result in the creation and iterative refinement of many artifacts that collectively define a future enterprise architecture, and it will identify the gaps between the current state and this future architecture. The EA, in effect, describes the logical linkages between the enterprise business, information and technical architectures, and the enterprise solutions architectures (Buchanan & Soley, 2002).

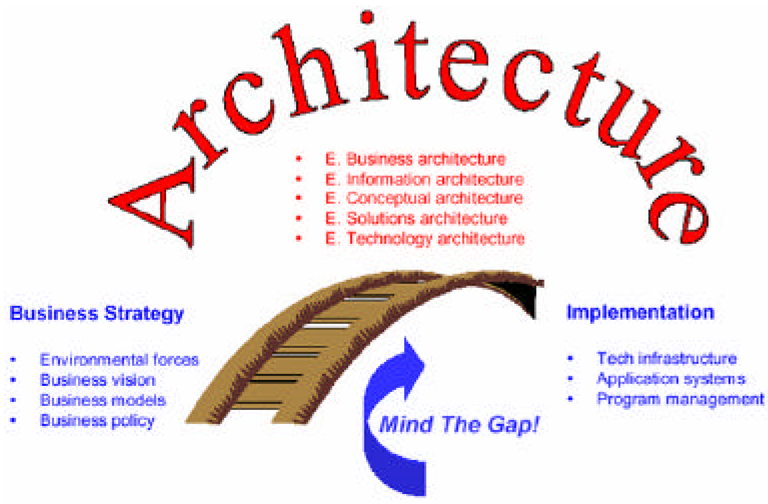


Figure I: EA serves as a bridge between business strategy and program management

Buchanan and Soley (2002) continue and mention that, "The traditional notion of an enterprise architecture is extended so that the hierarchy or architectures extends from the business strategy level and links to the IT investment plans, and facilitates communication and decision-making between business strategy and IT management groups."

There seems to be a huge discrepancy between how Wegmann (2002) view EA compared to Buchanan and Soley (2002); Wegmann (2002) says that EA's core purpose is help enterprises align their businesses with IT whereas according to Buchana and Soley (2002), it is supposed to be an extension of EA, which the paper does not define anywhere. In addition, the view presented in Figure I assumes that EA helps bridge the gap between business strategy and implementation. However, it appears from the discussion that Buchana and Soley (2002) assume that "Implementation" is not within the scope of EA. In fact, that is where it should play a central role in order to ensure successful implementation of the business strategy that represents corporate goals. Therefore, if even if you take the view presented by Buchana and Soley (2002), you are very likely left with dealing with the most challenging part of implementing the strategy on your own. Such an approach to EA does not take into account the core components (cultures, people, and processes within both operations as well as innovation groups of an enterprise) required to ensure strategic delivery of enterprise-wide solutions and therefore presents a perfect recipe for failure.

The Zachman framework as it applies to Enterprise is simply a logical structure for classifying and organizing the descriptive representations of an Enterprise that are significant to the management of the Enterprise as well as to the development of the Enterprise's systems (Popkin, 2003). The framework (Zachman, 1987) is a matrix which describes the various ways the stakeholders of an enterprise view the business and its systems. It characterizes architecture in terms of the perspectives of the different stakeholders (represented by rows) and focuses on the different aspects of architecture (represented by columns) (ZIFA, 2003). The framework is claimed to have been derived from the analogous structures that are found in the older disciplines of Architecture / Construction and Engineering / Manufacturing that classify and organize the design artifacts created over the process of designing and producing complex physical products (e.g., buildings or airplanes).

	The Zachman Framework	DATA *What*	FUNCTION *How*	NETWORK *Where*	PEOPLE *Who*	TIME *When*	MOTIVATION *Why*
Business Managers	SCOPE (Contextual) *Planner*	List of Things Important to the Business	List of Processes the Business Performs	List of Locations in Which the Business Operates	List of Organizations Important to the Business	List of Events Significant to the Business	List of Business Goals/Strategies
Business Managers	ENTERPRISE MODEL (Conceptual) *Owner*	Semantic Model	Business Process Model	Business Logistics System	Work Flow Model	Master Schedule	Business Plan
IT Managers and Developers	SYSTEM MODEL (Logical) *Designer*	Logical Data Model	Application Architecture	Distributed System Architecture	Human Interface Architecture	Processing Structure	Business Rule Model
IT Managers and Developers	TECHNOLOGICAL MODEL (Physical) *Builder*	Physical Data Model	System Design	Technology Architecture	Presentation Architecture	Control Structure	Rule Design
IT Managers and Developers	DETAILED REPRESENTATIONS (Out-of-Context) *Sub-Contractor*	Data Definition	Program	Network Architecture	Security Architecture	Timing Definition	Rule Specification
IT Managers and Developers	FUNCTIONING ENTERPRISE	Actual Business Data	Actual Application Code	Actual Physical Networks	Actual Business Organization	Acutal Business Schedule	Actual Business Strategy

The Zachman Framework

4.2 Adoption, Diffusion & Habitation – What is the relationship?

The EA views presented above come from some of the leading industry practitioners and research groups. Note that none of these views entirely share the same concept and neither of these views takes into account the most fundamental factors such as habitation. Before analyzing what do I mean by "habitation" and why it should be one of the most important attributes of EA, let's first look at some of the more familiar terms such as adoption and diffusion.

According to Merriam-Webster Online Dictionary the term "**adopt**" means 1) to take by choice into a relationship; especially, to take voluntarily (a child of other parents) as one's own child,

2) to ***take up and practice or use***, 3) to accept formally and put into effect. The term "**diffusion**" is defined as the ***spread of cultural elements*** from one area or group of people to others by ***contact.*** The term "**habitat**" is defined as 1) the place or environment where a plant or animal naturally or normally ***lives and grows***, 2) the typical place of residence of a person or a group, 3) a housing for a ***controlled physical environment*** in which people can live under surrounding inhospitable conditions (as under the sea), 4) the place where something is commonly found. Here is how I see these terms related to technology. A new technology is adopted by an adopter because s/he perceives a certain value to be realized as a result of adoption. The term "adopt" here does not take into account the extent and life of the relationship post-adoption i.e., you may adopt a certain technology and abandon it (may be after realizing costs involved in deploying it). I will illustrate that "adopt" has always been limitedly used to refer to the fact that a company or an individual has invested some resources in acquiring the new technology. What happens after that is neither considered nor analyzed. As more and more people adopt the new technology, it starts spreading from one group of people to others by contact leading to a wide diffusion and thus saturation. Following adoption, in order to realize the value, the technology must be deployed. Post-deployment, appropriate technology advancements and proper technology management is required in order to ensure that the technology lives and grows overtime. The goal for any technology should not be to be "adopted" or just "deployed" by masses, but in fact, "inhabited". A study of how Microsoft ensured successful habitation compared to its competitors may be a good case.

Let's now analyze what the researchers say about innovation and diffusion. Many observers in the past have pointed to the fact that when the number of users of a new product or invention is plotted versus time, the resulting curve is typically an S-shaped distribution (Griliches, 1957; Mansfield, 1961). It seems natural (and is a common view) to imagine adoption proceeding slowly at first, accelerating as it spreads throughout the potential adopters, and then slowing down as the relevant population becomes saturated. For innovations in IT, however, to have a positive impact on quality and productivity, they must actually be deployed (Fichman & Kemerer, 1999) and then inhabited (defined later). Innovation researchers have known for some time that a new technology may be introduced amid great enthusiasm and enjoy widespread initial acquisition, but nevertheless still fail to be thoroughly deployed among many acquiring firms (Fichman & Kemerer, 1999). Liker, Fleischer and Arnsdorf (1992) report that Computer Aided Design (CAD) technologies had achieved unusually rapid market penetration in the 1980s, yet, as late as 1992 "true CAD/CAM [utilization was] still quite rare". Cooper and Zmud (1990), in a study of material requirements planning (MRP), report that, while 73% of surveyed companies were using MRP, only 27% of respondents had progressed beyond Class C MRP implementation, a relatively low level of utilization. Eveland and Tornatzky (1990), in describing the fate of machine vision systems (a popular innovation introduced in the late 1970's) observe that: "Many plants simply gave up. Some, large and expensive, machine vision systems were 'de-installed'. Automation consultants, in visits to plant, found unused machine vision systems sitting in boxes, relics of failed deployment". These examples very clearly illustrate that, "widespread acquisition of an innovation (sometimes termed as diffusion) need not be followed by widespread deployment and use by acquiring organizations". The implications of this insight have been incorporated into some of the more recent studies focusing on the antecedents of organizational innovation (Meyer & Goes, 1988; Cooper & Zmud, 1990).

I will now analyze the impact of these implications on the process of diffusion. According to Hall and Khan (2002), diffusion can be seen as the cumulative or aggregate result of a series of individual calculations that weigh the incremental benefits of adopting a new technology against the costs of change, often in an environment characterized by uncertainty and by limited information. Roger (1995) defines diffusion as a process whereby an innovation spreads across a population of potential adopters over time. A typical approach is to define adoption as the purchase or physical acquisition of the innovation, and then to fit a times series of observed cumulative adoption counts or percentages to some functional form, such as the logistic distribution (Mahajan & Peterson, 1985). Some studies seek to infer support for alternative theories of diffusion based on the observed pattern of adoption for a particular innovation (Brancheau & Wetherbe, 1990; Gurbaxani, 1990; Gurbaxani & Mendelson, 1990). Others compare multiple innovations, seeking to explain why some innovations diffuse more rapidly and widely than others (Mansfield, 1993). Still others have a more applied focus and seek to make predictions about the future course of innovation for a technology (Mahajan, Muller & Bass, 1990). When it can be safely assumed that later events in the process of intra-organizational assimilation will nearly always follow quickly on the heels of earlier events, then the observed pattern of cumulative adoptions will not vary much depending on the particular assimilation event used to define the time of adoption (Fichman & Kermerer, 1999). The diffusion

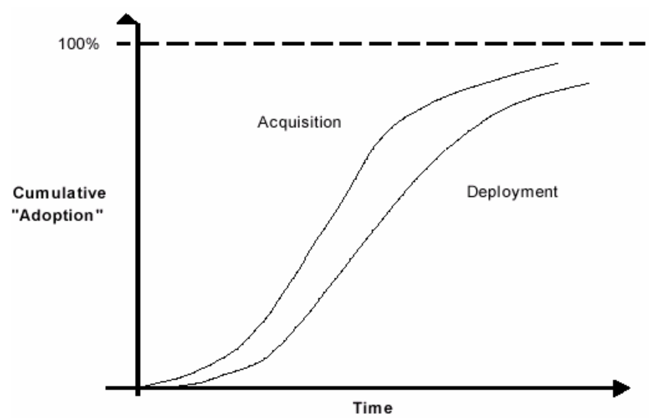


Figure III: Diffusion Curves for Alternative Definitions of "Adoption" pattern that results when an earlier event (e.g., acquisition) is used will closely mirror the pattern that results when a later event is used (e.g., deployment), as illustrated in Figure III. In this case, the conclusions a particular study draws are not likely to be contingent on the definition employed for adoption (Fichman & Kermerer, 1999). However, for some technologies it may be inappropriate to assume that in most organizations these later assimilation events will automatically follow earlier events. In their study, Fichman and Kermerer (1999) show that as a result, the pattern of cumulative deployments may not closely mirror the pattern of cumulative acquisitions, but rather, there may be a widening "gap" between the two curves plotted as a function of time (see Figure IV), termed as "Assimilation Gap". The Assimilation Gap therefore can be defined as the difference between the pattern of cumulative acquisitions and cumulative deployments of an innovation across a population of potential adopters. Hall and Khan (2002), on the other hand, do not take "Assimilation Gap" into account and argue on two stylized facts about the adoption of new technologies: first, adoption is usually an absorbing state, in the sense that we rarely observe a new technology being abandoned in favor of an old one. This is because the decision to adopt faces a large benefit minus cost hurdle; once this hurdle is passed, the costs are sunk and the decision to abandon requires giving up the benefit without regaining the cost. Second, under uncertainty about the benefits of the new technology, there is an option value to waiting before sinking the costs of adoption, which may tend to delay adoption. Such an approach to adoption, which overlooks critical aspects such as deployment, presents a potential trap for researchers as well as practitioners, as argued by Fichman and Kermerer (1999).

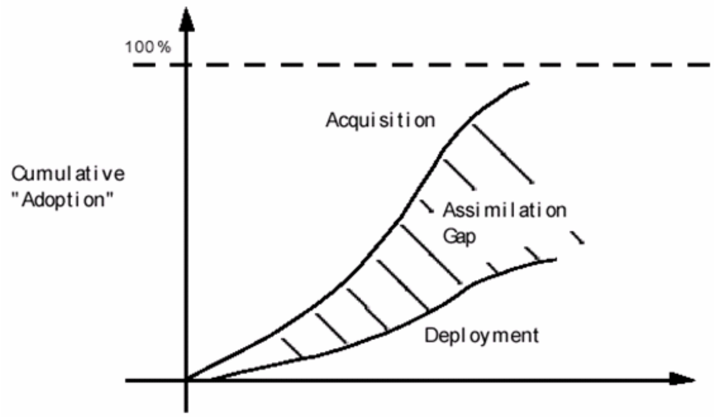


Figure IV: Assimilation Gap

When a substantial assimilation gap exists for an innovation, the use of cumulative acquisition as the basis for diffusion modeling can present an illusory picture of the diffusion process—leading to potentially erroneous judgments about the robustness of the diffusion process already observed, and about the technology's future prospects (Fichman & Kermerer, 1999). Researchers may draw inappropriate theoretical inferences about the forces driving diffusion.

Practitioners may commit to a technology based on a mistaken belief that pervasive adoption is inevitable, when it is not.

Prior innovation research provides potential explanations for why some innovations might be prone to an especially large assimilation gap. For example, Rosenberg (1972) argued that the skill level of workers and the state of the capital goods sector are two of the important determinants of diffusion of a technology to individual firms. It could be that high knowledge barriers, which have been found to generally slow diffusion, tend to have an especially negative effect on deployment compared with acquisition (Attewell, 1992). Alternatively, it could be that the potential option value to use some innovation in the future is so high that many organizations are willing to initiate deployment simply to preserve this option [Cohen and Levinthal 1990]. Or, perhaps something about the way some innovations are marketed leads many organizations to acquire technologies under one set of expectations, only to subsequently encounter a much different, less favorable reality [Rosenberg 1976]. Whatever the reason for the existence of pronounced assimilation gaps, the first step towards using the concept to make predictions or to test rival theories is to develop a foundation of definitions, measures and analytical techniques for the concept.

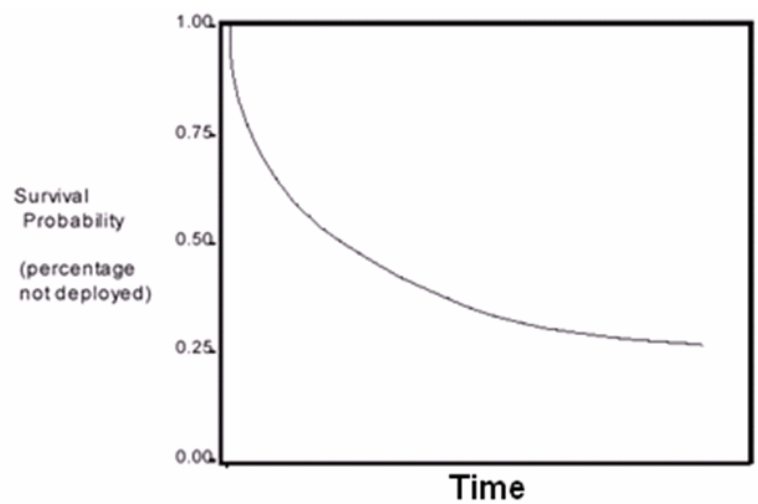


Figure V: Survivor Function

The survivor function provides a summary view of the event times for a population. More specifically, the survivor function provides an estimate of the proportion of a population expected to have an event time exceeding any given time T. In this case we are interested in the time it takes for an acquiring firm to deploy a technology, so the "survivor function" can be thought of as the "survival" of the earlier technology, despite acquisition of the new technology.

Fichman and Kemerer (1999) present this disconnect and conclude that innovation researchers have known for some time that a new information technology may be widely acquired, but then only sparsely deployed among acquiring firms. When this happens, the observed pattern of cumulative adoptions will vary depending on which event in the assimilation process (i.e., acquisition or deployment) is treated as the adoption event. Instead of mirroring one another, a widening gap—termed here an assimilation gap—will exist between the cumulative adoption curves associated with the alternatively conceived adoption events. When a pronounced assimilation gap exists, the common practice of using cumulative purchases or acquisitions as the basis for diffusion modeling can present an illusory picture of the diffusion process—leading to potentially erroneous judgments about the robustness of the diffusion process already observed, and of the technology's future prospects. Researchers may draw inappropriate theoretical inferences about the forces driving diffusion. Practitioners may commit to a technology based on a mistaken belief that pervasive adoption is inevitable, when it is not.

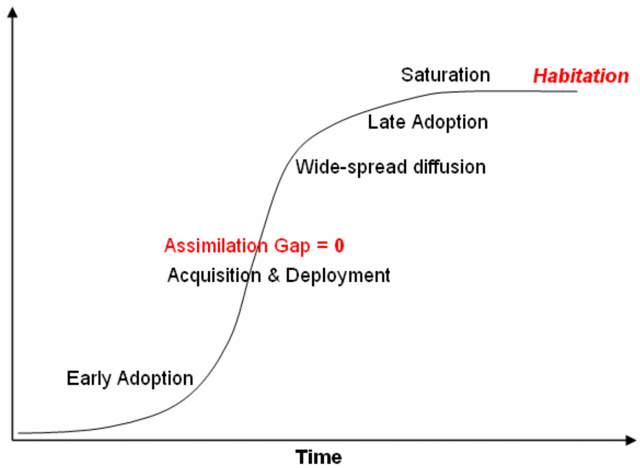


Figure VI: Where is *Habitation?*

Based on the research carried out by Fichman and Kemerer (1999), my inclination to define "habitation" ….. as a state that follows an adoption S-curve where assimilation gap does not exist and a steady state is maintained post saturation.

Mahdavi (1998) views design as intervention involving three pertinent systems, i.e., System Environment, System Built Structures, and System Inhabitants. A discourse of design may address these at various strategic levels of observation, and the boundaries of the system elements may be defined in various scales, from narrow to broad. Conventional practice has a radically limited view of each system: Environment is often only a "site," built entities are seen only in their individuality and devoid of an infrastructural context, and inhabitants' needs are typically considered only in so far as they are represented in code-type minimum requirements. At a highly abstract level, however, we may define the objective function of building activity as one that is geared toward provision of desirable occupancy conditions while reducing (ideally eliminating) negative ecological impact (Mahdavi 1997).

Winisdoerffer, F., & Soulez-Lariviere, C. (1992). It is generally accepted that high quality internal environment shall strongly support crew's adaptation and acceptance to situation of long isolation and confinement. Thus, this paper is an attempt to determine to which extent the resulting stress corresponding to the anticipated duration of a trip to Mars (1 and a half years to 2 and a half years) could be decreased when internal architecture of the spacecraft is properly designed. It is assumed that artificial gravity shall be available on board the Mars spacecraft. This will of course have a strong impact on internal architecture as far as a 1-g oriented design will become mandatory, at least in certain inhabited parts of the spacecraft. The review of usual Habitability functions is performed according to the peculiarities of such an extremely long mission.

It was surprising for me to see no mention of "habitation" in relation to technology. There is a lot of literature that talks about adoption and dispersion. In my view, there is clearly a relationship between adoption and habitation. In fact, habitation follows successful and widespread adoption. If I want to show it on the S-Curve, here is how it should look like:

Saying that "habitation", a term never used in relation to IT, neither by the researcher nor practitioners, with either adoption or diffusion may not be appropriate. In fact, I am not even confident if the terms like "adoption" is used consistently throughout the industry.

4.3 Discussion – Role of EA to ensure Habitation

Each IT professional, that you speak to, will have a different perception of what is meant by EA and varying definition. Do Enterprise Software Architecture, Enterprise System Architecture, Enterprise Architecture mean the same thing? I am not sure. I do know that there is frustration out there related to these terms. Merriam-Webster Dictionary defines these terms as follows:

Enterprise: A project or undertaking that is especially difficult, complicated, or risky. A systematic or purposeful activity

Architecture: The art or practice of designing and building structures and especially habitable ones. Formation or construction as or as if as the result of conscious act. A unifying or coherent form or structure

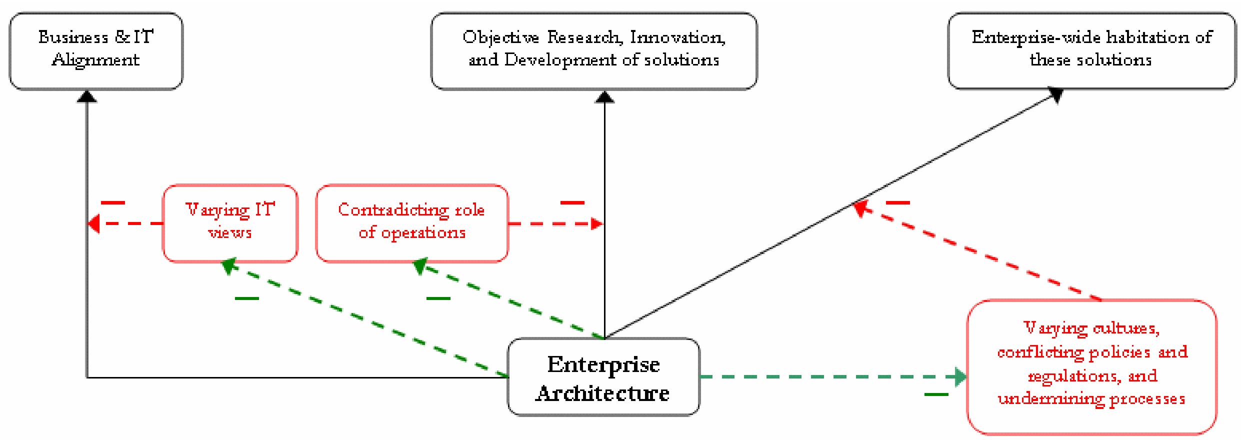
From the above definitions of the two terms, you should be able to derive what "Enterprise Architecture" may mean. Therefore, I am more inclined towards defining "Enterprise Architecture" in two parts i.e.

> "Enterprise Architecture may be defined as a risky and complicated project that involves design and construction of unifying, coherent, and habitable structures that affect the entire enterprise."
>
> "Enterprise Architecture will then ensures that there are right organizational structures, policies, procedures, governance, languages, people, processes, and tools to ensure that these habitable structures get socially, culturally, and technologically integrated across the enterprise to ensure habitability."

I feel comfortable with this definition of EA since it seems to support my industrial understanding of this term. I specially like the term "habitable". It does not matter how great an architectural master piece is that you have created, if it is not inhabited the way it was envisioned to be, its architecture failed. I think that it very well applies to EA. For a moment, I want to bring your attention to individual technology solutions that are built within a research group (presuming that it has an understanding of critical business problems) within a global enterprise like Citigroup Inc. That solution would not be inhabited at a level which allows the entire enterprise to realize the complete value (in some cases it may fail) unless it is, most importantly, culturally and, less importantly, technologically integrated across enterprises within an enterprise. In order to accomplish such level of integration, there are factors other than just technology that are required to be given special attention, which presently and most often are overlooked.

From my professional experience, whenever we plan to do anything that involves some form of enterprise architecture, we most definitely get involved with most of the following, which I want to call EA domains of interest (DOI). Operations, Innovation & Emerging Technologies – Business Driven, Technology Driven, and Hybrid, Development (programs and projects), Integration (system and culture integration), and Migration (migrating enterprise from a current state to the target state to help it accomplish it's business goals). People – Users, customers, sponsors, builders/developers, architects, engineers, managers. Processes – Processes required to align research with critical risks and to ensure that solutions that are developed actually mitigate those risks. Policies – Information Security, continuity of business, Procurement, Quality Management, and Audit. Governance – Budget, Control, IT Portfolio Management, Risk, Prioritization, Rationalization, Approvals, Reviews, Change Support

These (and probably others) DOI need to collaborate and work as a team in order to enable the enterprise to meet its strategic and tactical business goals. The implementation of these inter- and intra-domain collaborations is non-trivial and very often presents significant obstacles in accomplishing the business goals. These obstacles originate due to varying processes, policies, cultures, languages and stakes. There is a huge opportunity for defining and engineering a methodology for managing EA by utilizing top-down (identifying the over-arching architectures of these domains across an enterprise and their relationships) and bottom-up (defining the goals / obstacles, processes / sub-processes, actors - committees, individuals primary and secondary roles for the domains of research interest)



In the context of an enterprise, I have a strong feeling that EA should

It is continuing adoption of a given technology that will ensure habitation. To ensure habitation, there will be continuing need to innovate to improve existing technologies and / or to introduce new technologies to meet the needs of the customers. For example, to ensure optimal habitation of email service providers, not only is it important to ensure widespread adoption and diffusion of the email services but also to continuing to innovate and improve the email service provided by a given service provider. Otherwise, email users will abandon that given service, switch to other service…

CONCLUSION AND DISCUSSION

Adoption, diffusion, and habitability may not the same terms and may depend on each other for success. For instance, if I refer to urban architecture and design, choice for individuals to move from one region to another region will be driven by the choices an individual makes to adopt may be certain style of life or values. So, in other words, decision to adopt certain values will result in the habitation of a particular region. If we assume this to be true, then it is crucial for the region to ensure that those values are provided to ensure successful adoption of those values and subsequently habitation of the region. The same concept may be applied to

The contribution of new technology to economic growth can only be realized when and if the new technology is widely diffused and used. Diffusion itself results from a series of individual decisions to begin using the new technology, decisions which are often the result of a comparison of the uncertain benefits of the new invention with the uncertain cost of adopting it (Hall & Khan, 2002).

It is diffusion rather than invention or adoption that ultimately determines the pace of economic growth and the rate of change of productivity. Until many users adopt a new technology, kit may contribute little to our well being. As Nanthan Rosenberg said in 1972, "…in the history of diffusion of many innovations, one cannot help being struck by two characteristics of the diffusion process: its apparent overall slowness on the one hand, and the wide variations in the rate of acceptance of different inventions, on the other."

Diffusion can be seen as the cumulative or aggregate result of a series of individual calculations that weigh the incremental benefits of adopting a new technology against the costs of change, often in an environment characterized by uncertainty (as to the future

References

Attewell, P. & Rule, J. (1984). Computing and Organizations: What we Know and What we Don't Know. *Communications of the ACM,* December, 1184-1192.

Brancheau, J., & Wetherbe, J. (1990). The Adoption of Spreadsheet Software: Testing Innovation Diffusion Theory in the Context of End-User Computing. *Information Systems Research*, 1(2): 115-143.

Buchanan, R. & Soley, R. (2002). Aligning Enterprise Architectures and IT Investments with Corporate Goals. Retrieved on November 26, 2004 from World Wide Web: http://user.cs.tu-berlin.de/~hochnade/mda/align.pdf

Cooper, R., & Zmud, R. (1990). Information Technology Implementation Research: A Technological Diffusion Approach. Management Science, 36(2): 123-139.

Eveland, J., & Tornatzky, L. (1990). The Deployment of Technology. The Processes of Technological Innovation. Tornatzky and Fleischer, Lexington, Massachusetts, Lexington Books: 117-148.

Fichman, R., & Kemerer, C. (1999). The Illusory Diffusion of Innovation: An Examination of Assimilation Gaps. Information Systems Research, 10(3): 255-275.

Gurbaxani, V. (1990). Diffusion in Computing Networks: The Case of BITNET. *Communications of the ACM,* 33(12): 65-75.

Gurbaxani, V. & Mendelson, H. (1990). An Integrative Model of Information Systems Spending Growth. *Information Systems Research,* 1(1): 23-47.

Hall, B., & Khan, B. (2002). Adoption of New Technology. Retrieved on November 28, 2004 from the World Wide Web: http://elsa.berkeley.edu/~bhhall/Hall_Khan_diffusionJan03.pdf

Liker, K., Fleischer, M & Arnsdorf, D. (1992). Fulfilling the Promises of CAD. MIT Sloan Management Review.

Mahajan, V., Muller, E., & Bass, F. (1990). New Product Diffusion Models in Marketing: A Review and Directions for Research. *Journal of Marketing,* 54(January): 1-26.

Mahajan, V., & Peterson, R. (1985). Models for Innovation Diffusion. *Sage Publications,* Beverly Hills: CA.

Mahdavi, A. (1997). A negentropic view of computational modeling. In Yu-Tung Liu, Jin-Yen Tsou, June-Hao Hou (eds.). Proceedings of the Second Conference on Computer Aided Architecture Design Research in Asia: CAADRIA ’97, 107-122. Hsinchu, Taiwan.

Mahdavi, A. (1998). Steps to a General Theory of Habitability. Human Ecology Review, Society of

Human Ecology, Vol.5, No. 1.

Mansfied, E. (1961). Technical Change and the Rate of Imitation. Econometrica, 29(4): 741-766.

Mansfield, E. (1993). The Diffusion of Flexible Manufacturing Systems in Japan, Europe and the United States. *Management Science*, 39(2): 149-159.

Meyer, A., & Goes, J. (1988). Organizational Assimilation of Innovations: A Multilevel Contextual Analysis. Academy of Management Journal 31(4): 897-923.

Popkin. (2003). Building an Enterprise Architecture: The Popkin Process. Retrieved on November 27, 2004 from the World Wide Web: http://www.popkin.com/government/frameworks/zachman%5Fframework.htm

Rogers, E. M. (1995). Diffusion of Innovations. *New York*, The Free Press.

Rosenberg, N. (1972). Factors Affecting the Diffusion of Technology. Explorations in Economic History, Vol. 10(1), pp. 3-33. Reprinted in Rosenberg, N. (1976). Perspectives on Technology, Cambridge University Press, Cambridge.

Tarabanis, K., Peristeras, V., & Fragidis, G. (2001). Building an Enterprise Architecture For Public Administration: A High-Level Data Model For Strategic Planning. Global Co-operation in the New Millennium, The 9th European Conference on Information Systems, Bled, Slovenia, June 27-29, 2001.

Wegmann, A. (2002). The Systemic Enterprise Architecture Methodology (SEAM). Technical Report EPFL / I & C, No. 200265.

Winisdoerffer, F., & Soulez-Lariviere, C. (1992). Habitability constraints/objectives for a Mars manned mission: internal architecture considerations. Advanced Space Research. 2(1):315-20.

Zachman, J. (1987). A Framework for Information Systems Architecture, IBM Systems Journal, 26(3).

ZIFA. (2003). The Framework for Enterprise Architecture (The Zachman Framework) and the search for the Owner's View of Business Rules. Retrieved on November 27, 2004 from the World Wide Web: www.zifa.com

Zvi, G. (1957). Hybrid Corn: An Exploration in the Economics of Technological Change. Econometrica, Vol. 25: 501-522.