

Enterprise Architecture

Development Issues

This document is all about Enterprise Architecture Development and the Issues when Implementing ERP.

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Table of Contents

- Enterprise Architecture Development5
- Introduction.....5
- Enterprise Architecture5
- Enterprise IT Architecting6
- Enterprise Integrating6
- Enterprise Ecological Adaptation6
- Enterprise Architecture Frameworks11
- The Enterprise Architecture Cycle12
- Figure 1.The Enterprise Architecture Alignment Cycle.14
- Maintaining Enterprise Architecture14
- Figure 2. How Popkin’s System Architect 9.0 Supports enterprise architecture.16
- How to Create Enterprise Architecture17
- Agree on the Need17
- Establish an Organizational Structure.....17
- Select a Framework18
- Select a Tool and Repository19
- Organize the Existing Material19
- Begin Using the Enterprise Architecture20
- Extend and Maintain the Architecture20
- Aligning the Organization21
- Aligning Business22
- Figure 3. Aligning Processes, Applications and Databases.....23
- Issues with Enterprise Architecture Development23
- Consequences24
- Causes24
- Critical Implementation Concerns25

Top Management Commitment	26
Reengineering	27
Integration.....	27
ERP Consultants	30
Implementation Time	30
Implementation Costs	31
ERP Vendors.....	32
Selecting the Right Employees.....	32
Training Employees	33
Employee Morale.....	33
Related Studies	34
Pearl Zhu of <i>Future of CIO</i> website	34
Fitness for Purpose.....	34
Senior executives buy-in and continuous focus and support upon the EA program	34
Understand Stewardship and Ownership differences	34
EA Maturity	35
Organizational Maturity	35
Business/Architecture Alignment	35
Move from Vendor/Group/Institute-centric EA to Customer-centric EA.....	35
Constant Jockeying with "tactical project savings" vs. "sustainable strategic advantage" argument	35
Mature EA Team.....	36
EA Skills/Talent.....	36
Dean Griffin of <i>Accenture</i>	36
Compliance.....	36
Security.....	37
Privacy.....	37

Technology Refresh.....	38
Productivity	38
Time to Market.....	39
Getting ready for Service-Oriented Architecture	39
Convergence, Content, and Communications	40
Openness	41
Exception and Event Processing	41
EA Issues by Antoine de Saint-Exupery	42
Lack of Sponsorship	42
Hiring or Promoting the Wrong Person	43
Building an Ivory Tower	43
Policing and Insensitivity to Culture	43
Maintaining the EA Artifact Factory	44
Clinging To a Particular Framework or Tool	44
Thinking Enterprise Architecture Equals Technology Architecture	44
Taking the "Enterprise" Word Literally	44
Research study by Agnes Nakakawa, Patrick van Bommel, and H.A. Erik Proper.....	45
<i>Challenges of Involving Stakeholders When Creating Enterprise Architecture.....</i>	<i>45</i>
Analysis	46
Conclusion.....	47
Recommendation	48

Enterprise Architecture Development

Introduction

In the early days of computing, technology simply automated manual processes with greater efficiency. As technology evolved, new innovations enabled new capabilities and processes in the enterprise that were driven by IT. Gradually, IT changed the business but not necessarily in alignment with the business strategy. This lack of alignment resulted in significant waste of resources and missed opportunities, and placed the organization in a competitive disadvantage in the market.

To align the strategies of business with IT, a new approach for managing IT has been developed called Enterprise Architecture. Just as architecture provides a blueprint for constructing a building, Enterprise Architecture provides a blueprint and roadmap for aligning business strategy with IT.

Enterprise Architecture

Enterprise Architecture (EA) is a method and an organizing principle that aligns functional business objectives and strategies with an IT strategy and execution plan. The Enterprise Architecture provides a guide to direct the evolution and transformation of enterprises with technology. This in turn makes IT a more strategic asset for successfully implementing a modern business strategy.

An Enterprise Architecture typically produces deliverables such as:

- Current State Enterprise Architecture model
- Future State Enterprise Architecture reference model that is needed to execute on the proposed business strategy
- Gap analysis that identifies the shortfalls of the current state in terms of its ability to support the objectives and strategies of the business
- Architecture Roadmap that defines the initiatives required to migrate from the current state into the future state.

By taking an enterprise-wide perspective across business services, business processes, information, applications, and technology, an EA ensures the enterprise goals and objectives are addressed in a holistic way across all IT projects.

To be successful, an Enterprise Architecture needs to be woven into the enterprise's culture, not treated as a closed-scope project. The value of an EA is greatly enhanced when it is organically embedded into the lifecycle of the organization, including capital planning, project management, asset management, resource allocation, and strategy formulation.

Enterprise Architecture is a journey, not a project. It evolves over time and needs to maintain the flexibility required to adjust to changing market conditions, strategy shifts, and new innovations in technology. EA frameworks have emerged to manage the increasingly complexity of innovation and change.

Enterprise Architecture is as much about ongoing communications among business and IT leadership as it is about technology innovations and architectural choices. Enterprise Architecture facilitates business and IT communication with common language, process, and structure.

Enterprise IT Architecting. According to this category, the purpose of EA is the greater alignment between IT and Business concerns. The main purpose of EA is to guide the process of planning and design the IT/IS capabilities of an enterprise in order to meet desired organizational objectives. Typically, architecture proposals and decisions are limited to the IT/IS aspects of the enterprise; other aspects only serve as inputs.

Enterprise Integrating - According to this category, the purpose of EA is to achieve greater coherency between the various concerns of an enterprise (HR, IT, Operations, etc.) including the linking between strategy formulation and execution. Typically, architecture proposals and decisions encompass all the aspects of the enterprise.

Enterprise Ecological Adaptation - According to this category, the purpose of EA is to foster and maintain the learning capabilities of enterprises so that they may be sustainable. Consequently, a great deal of emphasis is put on improving the capabilities of the enterprise to improve it, to innovate and to co-evolve with its environment. Typically, proposals and decisions encompass both the enterprise and its environment.

One's belief with regards to the meaning of enterprise architecture will impact greatly how one's see the purpose of EA, the scope of EA, the means of achieving EA, the skills needed to conduct EA, the locus of responsibility for conducting EA.

The term enterprise covers all kinds of business organization, public or private, large or small, including

- Public or private sector organizations.
- An entire business or corporation.
- A part of a larger enterprise (such as a business unit).
- A conglomerate of several organizations, such as a joint venture or partnership.
- A multiple outsourced business operation.
- Many collaborating public and/or private organizations in multiple countries.

The term enterprise includes the whole complex, socio-technical system, including people, information, processes and technologies.

An enterprise architecture description contains a variety of lists, tables and diagrams known as artifacts. These artifacts describe the logical business functions or capabilities, business processes, human roles and actors, the physical organization structure, data flows and data stores, business applications and platform applications, hardware and communications infrastructure.

Normally an EA takes the form of a comprehensive set of cohesive models that describe the structure and functions of an enterprise. The individual models in an EA are arranged in a logical manner that provides an ever-increasing level of detail about the enterprise.

The architecture of an enterprise is described with a view to improving the manageability, effectiveness, efficiency or agility of the business, and ensuring that money spent on information technology (IT) is justified.

Paramount to changing the enterprise architecture is the identification of a sponsor, his/her mission, vision and strategy and the governance framework to define all roles, responsibilities and relationships involved in the anticipated transformation. Changes considered by enterprise architects typically include:

- Innovations in the structure or processes of an organization.
- Innovations in the use of information systems or technologies.
- The integration and/or standardization of business processes.
- Improving the quality and timeliness of business information.

A methodology for developing and using an enterprise architecture to guide the transformation of a business from a baseline state to a target state, sometimes through several transition states, is usually known as an enterprise architecture framework. An Enterprise Architecture framework provides a structured collection of processes, techniques, artifact descriptions, reference models and guidance for the production and use of an enterprise-specific architecture description.

The term “architecture” has been used for many years within the Information System community to refer to various types of overviews that provide guidance to software systems and applications developers. The term is obviously a metaphor derived from the building trade. Just as builders would not undertake the construction of a house or an office building without an architecture, documented in various blueprints, so software developers should not undertake the development of software systems without a detailed plan, documented with software “blueprints” of various kinds.

In the mid-Nineties, the term “architecture” began to be used by business managers, especially those involved in enterprise planning and in business process reengineering projects, to describe an overview of the business. For example, some managers began to refer to a high-level description of all of the core business processes in an organization as “business process architecture.”

Today, there is a growing movement among both business managers and IS managers to use the term “enterprise architecture” to refer to a comprehensive description of all of the key elements and relationships that make up an organization. Increasingly, when managers talk about the alignment between business processes and goals and IS applications and middleware systems, they rely on enterprise architecture to define how the business-IS alignment should be achieved. There are many different approaches to describing the elements of enterprise architecture. One approach that has grown in popularity in the past few years is based on a framework developed by John Zachman. Zachman originally

proposed his framework in 1987 in an article published in the *IBM Systems Journal*. The article created quite a bit of interest when it was published, but was generally dismissed as too comprehensive for IS developers. Over the years, however, as business managers have become more concerned with business processes and with linking strategic goals to business process goals, and both to IS applications and databases, the Zachman framework has become the most popular approach to describing enterprise architecture.

A building's architecture is more than a set of blueprints. High-level diagrams explain the concept of the architecture to the owners of the building and allow them to decide if the overall approach will meet their needs. Second-level diagrams lay out the basic units, the foundation, rooms and roofs. These elements must be designed with each of the other units in mind. A foundation must have the strength to support the rooms. If the house has two or three stories, the foundation must be proportionally stronger. More bathrooms require more water heating capacity and larger pipes. More electrical capacity must be routed to rooms that are going to house utilities, like dishwashers or dryers. In other words, there may be different blueprints, one for the foundation, one for the layout of the rooms, one for the electrical systems, and still another for the plumbing, but there must ultimately be relationships among the various blueprints to assure the house, as a whole, works as it should.

Similarly, one group in an organization may survey the competitive environment and recommend changes in strategy and new goals. Another group may define business processes, and still another may create designs for new software applications. The enterprise architecture defines all of these elements, and also defines how they fit together to assure the organization functions as intended.

I recommend that the enterprise architecture function should be a responsibility of the steering committee, perhaps a specific responsibility of the enterprise planning group. Senior management sets strategy, and strategies and their associated goals should drive the development and change of the business process architecture. A properly defined architecture provides an overview of the enterprise and how it functions. Thus, it provides managers with a context for analysis and decisions.

Let me reiterate: A pile of documents does not make enterprise architecture. To obtain value from the various plans, models and documents that various groups create, they must be integrated. This is normally accomplished by means of a software tool – usually enterprise or

business process modeling tool that relies on an underlying repository. The various plans, models and documents are placed in the repository and the relationships are established by those that place each element into the repository. Different groups using the enterprise modeling tool look at different views of the information in the repository. Business managers, for example, typically look at diagrams of the organization or at specific business processes. IS managers are more likely to check which software applications are associated with specific processes and then go to diagrams describing the applications.

Enterprise architecture is a tool to help executives think about the organization as a whole. An enterprise architecture captures a wide variety of information, establishes relationships among the various documents and diagrams and stores all of the information together in a single repository, so that managers can then see relationships, ask questions, identify problems, or run simulations to help make decisions about changes they are considering.

I have tried to go beyond our general description of enterprise architecture to suggest that there will be problems along the way and disagreements about how to best represent or align different elements. The organizations that succeed in spite of these problems will be those that clearly understand the ultimate value of the enterprise architecture and persevere.

Change keeps occurring faster all the time. Successful organizations need to be very flexible. Thus, every organization needs tools that help its manager's deal with the problems involved in analyzing and implementing potential changes. In the course of the next few years, the enterprise architecture will evolve into one of the major tools of that organizations rely upon to manage change. It will provide the focus around which business and IS managers meet to discuss organizational goals, business processes, and organizational alignment. The enterprise architecture will assure that all necessary information is located in one place, and indexed to business processes. The simulation abilities provided by enterprise architecture software tools will further assure that managers can quickly run simulations to evaluate the implications of any specific change scenario. In other words, the enterprise architecture is the first step toward an enterprise that can respond in real time. It provides managers with the foundation they will need to quickly make the key decisions they will face in the future.

Enterprise Architecture Frameworks

Creating an Enterprise Architecture from scratch can be a daunting task, so EA frameworks were created to simplify the process and guide an architect through all areas of architecture development. An Enterprise Architecture framework provides a collection of best practices, standards, tools, processes, and templates to assist in the creation of the Enterprise Architecture and architectures of various scopes.

Enterprise Architecture frameworks typically include:

- Common vocabulary, models, and taxonomy
- Processes, principles, strategies and tools
- Reference architectures and models
- Prescriptive guidance (EA processes, architecture content, implementation roadmap, governance)
- Catalog of architecture deliverables and artifacts
- Enterprise Architecture Content Meta-model
- Recommended set of products and configurations (optional)

Utilizing an Enterprise Architecture framework streamlines the process for creating and maintaining architectures at all levels (e.g. enterprise architectures, functional business segment architectures, cross-cutting technology domain architectures, and solution architectures) and enables an organization to leverage the value of architecture best practices.

A number of EA frameworks exist in the industry with the goal of addressing the basic challenge of assessing, aligning, and organizing business objectives with technical requirements and strategies. Examples include the Zachman Enterprise Framework, The Open Group Architecture Framework (TOGAF), OMB Federal Enterprise Architecture (FEA), and The Gartner Methodology (formerly the Meta Framework).

Each framework possesses different strengths and weaknesses, which makes it difficult to find any one existing framework that is ideal for all situations. The following chart depicts how four Enterprise Architecture Frameworks compare.

The Enterprise Architecture Cycle

One group must be responsible for maintaining the enterprise architecture. This isn't to suggest that this group must create the architecture, but only that they must pull all the pieces together and maintain them so that anyone else can access the architecture. It suggested earlier that the group to maintain the enterprise architecture was the corporate planning group. Some organizations, of course, place the enterprise architecture function in a different location. To remain neutral, we'll assume that the group that maintains the enterprise architecture is the Enterprise Architecture Committee, a group that reports to the executive steering committee and maintains close relationships with the strategy group and those involved in business process redesign and improvement.

Figure 1 provides an overview of the enterprise architecture cycle that is based on the assumption that an organization has enterprise architecture Committee that is ultimately responsible for the creation and maintenance of the enterprise architecture. As you can see, this committee functions very like the planning committee in many large organizations.

The Enterprise Architecture Committee is responsible for maintaining the organization's architecture and for initiating and prioritizing all changes in the architecture. Thus, they receive inputs from two groups. First, they receive inputs from the strategy committee when they decide that the organization needs to set new strategies or change existing goals. At the same time, the Enterprise Architecture Committee receives inputs from a variety of line managers when they decide that processes they manage aren't performing properly. Different companies allow line managers greater or lesser discretion in initiating their own changes. The key, however, is that all changes that require significant business process redesign or software automation efforts must come through the Enterprise Architecture Committee. It's the only way to assure that IS has a clear set of priorities to guide their efforts.

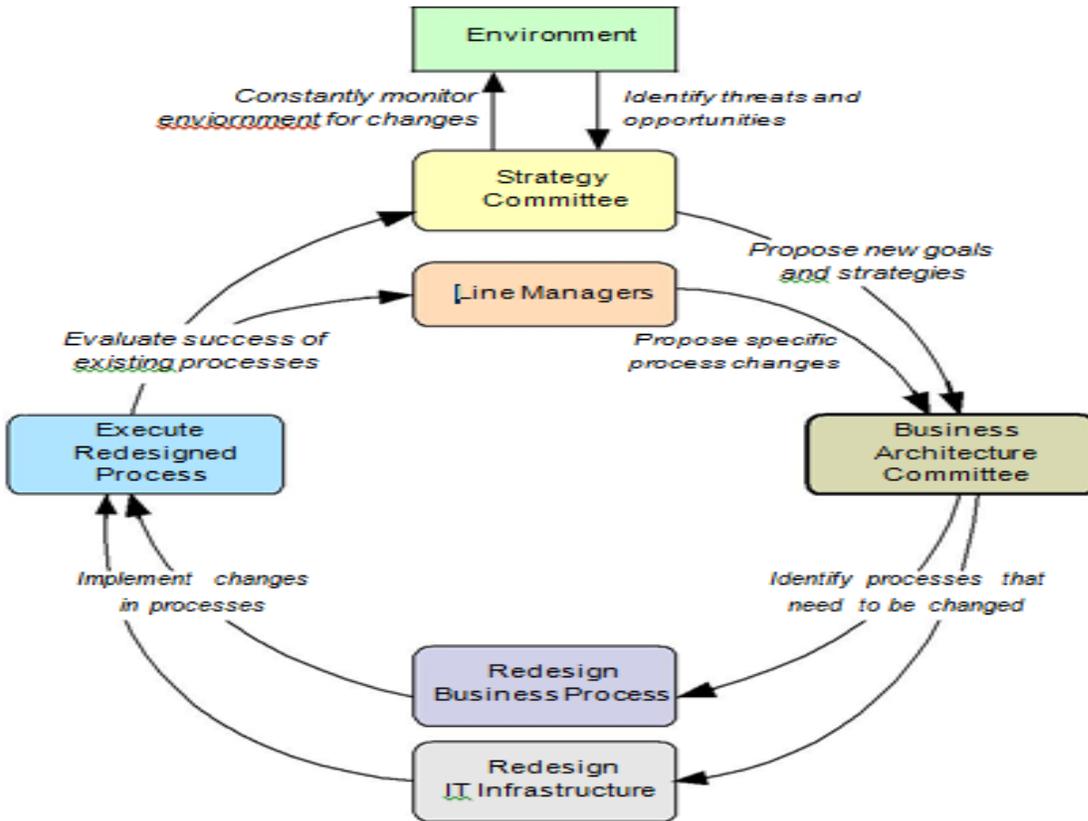
The Enterprise Architecture Committee initiates all significant business process change efforts. I assume that the Enterprise Architecture Committee is just as concerned with processes that are entirely manual as they are with business processes that include automated sub-processes. Thus, some business process redesign efforts will be primarily driven by business managers, while others will be driven by IS managers or by a mix of business and IS managers.

As redesign efforts are initiated that involve systems, the Enterprise Architecture Committee must also consider the wider implications. A process may be automated by a software application, but that application will probably have to rely on new or existing databases and it may require new infrastructure elements. The Enterprise Architecture Committee, working in conjunction with the IS organization, is responsible for initiating not only new applications to support new business processes, but also initiating data and infrastructure changes to support those applications as they come on-line in the future. This isn't to suggest that the Enterprise Architecture Committee actually designs applications, but only that it sets the high-level goals and requirements for those projects. I assume that some IS executives will be members of the Enterprise Architecture Committee to assure that business and IS executives work together to establish the right overall direction and priorities.

Once a given process or set of processes are redesigned and implemented, the cycle returns to where it began. The Strategy Committee continues to watch for changes in the environment that suggest new strategies, and the line managers continue to look for opportunities to increase the productivity of existing operations.

The Enterprise Architecture Committee will not create most of the documents and diagrams that are stored in the repository it manages. Other groups will create these documents in the course of doing their work. The Strategy Committee will create documents defining new strategies and goals. The IS organization will create designs for applications, databases and infrastructure. The Enterprise Architecture Committee, however, is responsible for integrating all of the information and assuring that each group is aligned with others in a satisfactory way.

Figure 1. The Enterprise Architecture Alignment Cycle.



Maintaining Enterprise Architecture

Before going further, let's pause to consider how the Enterprise Architecture Committee maintains and integrates all the information described in the Zachman Framework. In essence, the Enterprise Architecture Committee must rely on a software tool especially designed to maintain enterprise architecture.

There are several tools available that can maintain enterprise architecture in a repository. (A repository is simply a database built specifically to store and relate the various kinds of documents and diagrams described in the Zachman Framework.) A good example of a tool that enterprise architecture Committee might use is Popkin Software's System Architect. System Architect has a special interface that pictures an architectural framework. The default framework supported by System Architect 9.0 is the Zachman Framework. When a user sits down to use System Architect,

they access the Framework screen and click on a given cell on the Zachman framework to immediately access all of the diagrams and documents that are stored in the specific cell.

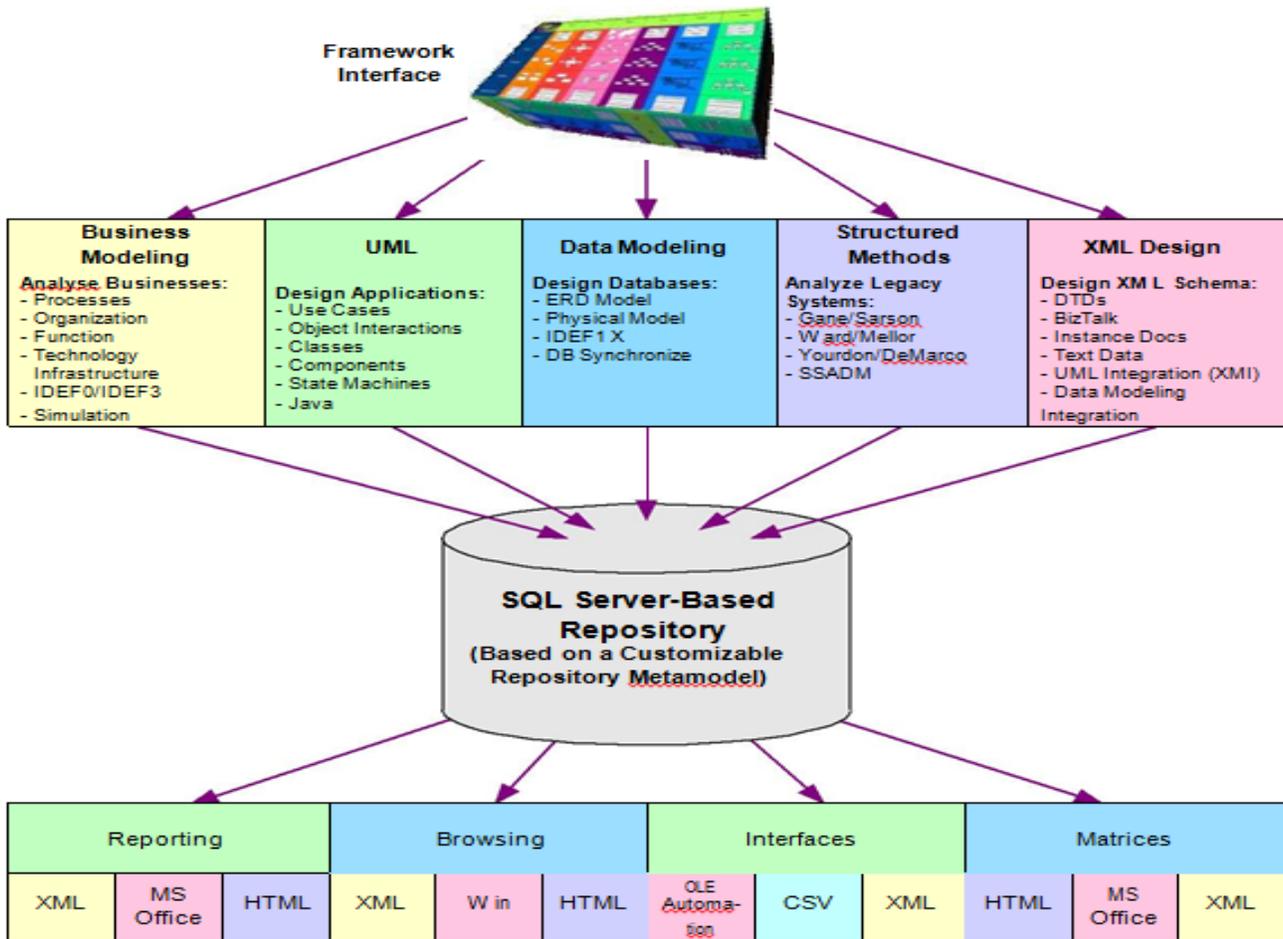
The tool allows the person maintaining the repository to store any of a very wide variety of diagrams, as well as popular document formats, like Word and Excel files, in any of the cells of the framework. Moreover, as long as the naming conventions used are consistent, one can search for a given item and access all documents in all cells of the Framework that refer to a given item. In effect, the person entering information into System Architect's repository maintains the relationships by insisting that similar items use the same naming structures. Thus, if a company establishes that enterprise goal is identified with the number 1, then sub-goals related to that goal might be 1.1, and sub-sub-goals might be 1.1.1. If this approach is maintained, then an executive can ask how a specific goal is being supported, and the Enterprise Architecture Committee can identify business processes, applications, job descriptions, and network systems that are designed to implement or support goal 1 by simply querying System Architect for all items that include goal 1 or extensions of 1.

Figure 2 provides an overview of the relationship between the System Architect framework interface, diagrams and document formats supported by the tool, and the Popkin repository and meta-model.

One important element of any tool is an interface specifically designed to support all of the information required by the framework. Another is support for a wide range of diagrams and document types so that everything can be stored in the repository. Still another is a set of interfaces, including XML and XMI that assure that documents or diagrams developed in other tools can be easily moved into the common repository. In addition, the tool should allow developers to simulate processes so that existing processes can be compared to possible alternative processes. Simulation makes it possible to compare costs and support requirements for specific changes that are being considered. The hard work of analyzing business processes and designing software systems can't be eliminated, but the work of assembling them and tracking the relationships between all the various models and systems can be significantly eased by the use of a good modeling tool with a powerful repository.

At this point, we've described enterprise architecture and suggested how it could be used. Some companies already have established enterprise architectures, but most do not. Thus, I will consider the general steps that a company might take to establish enterprise architecture and a functioning Enterprise Architecture Committee.

Figure 2. How Popkin's System Architect 9.0 Supports enterprise architecture.



How to Create Enterprise Architecture

Most organizations go through a series of steps or phases in order to establish viable enterprise architecture. The differences among company cultures and individual advocates assure that each company follows a more or less unique approach. What I can provide is a general overview of the major steps that most organizations work through.

Most organizations work their way through at least seven steps, as follows:

1. Agree on the Need
2. Establish an Organizational Structure
3. Select a Framework
4. Select a Tool and Repository
5. Organize the Existing Material
6. Begin Using the Enterprise Architecture
7. Extend and Maintain the Architecture

1. Agree on the Need

Nothing happens until senior management agrees that enterprise architecture is needed. Thus, everything starts with an internal sales effort on the part of those who see the advantages of architecture. Since the enterprise architecture is often a responsibility of the IS organization, the CIO or some other senior IS manager often leads the effort to sell other senior managers on the advantages of creating and maintaining enterprise architecture. In other cases, a business manager who is responsible for business process planning takes the lead. The recent support for the enterprise architecture approach provided by analysts like the Gartner Group, and by initiatives like the one being pursued by the U.S. Government, has helped many groups sell the concept to their senior managers.

2. Establish an Organizational Structure

Once there is a general agreement on the need for enterprise architecture, the next question is who is going to manage the architecture. As I have already suggested, I believe it should be a function of the corporate planning group. I believe each company should establish enterprise architecture Committee that creates and maintains the architecture and that serves as the central coordinating unit for all business process and IS planning.

Once the overall nature of the Enterprise Architecture Committee is determined, it must be assigned a manager and a budget. If the function is assigned to an existing group, like the corporate planning group, then it's simply a matter of adjusting their budget and assigning new personnel to support the senior managers already responsible for corporate planning.

As a generalization, organizations with well-defined process architecture are able to redesign or create new process more quickly. The creation and the maintenance of the architecture pays for itself by means of the savings organizations obtain on subsequent business process efforts.

3. Select a Framework

I described enterprise architecture as a comprehensive collection of all of the plans, schedules, goals, documents, diagrams and models used to describe the organization, all integrated together and stored in a common repository. The term "framework" is often used as a synonym for architecture. Others, however, use the term "framework" to describe specific approaches to organizing enterprise architecture. If I assume that the Zachman Framework describes everything that I might want to maintain, and then the Zachman Framework is simply a synonym for comprehensive enterprise architecture. If an organization decided that it wanted to assemble some but not all of the documents and diagrams described in the Zachman Framework, then, in effect, it would be creating its own enterprise architecture framework. In essence, it would be defining its enterprise architecture as something less comprehensive than the Zachman Framework.

In the U.S. Government's enterprise architecture effort, which each major department had been encouraged to develop its own framework and that each was slightly different. The U.S. Treasury, for example, adopted a framework that it calls the Treasury Enterprise Architecture Framework (TEAF). In this case, the TEAF matrix has four rows and four columns. In essence, the TEAF has omitted the bottom two rows of the Zachman Framework and combined four of the Zachman columns into two.

Each organization needs to determine just what types of documents and models it will include in its enterprise architecture. The result defines that organization's framework. Most organizations start with something like the Zachman Framework, and then tailor it to their specific needs. Each organization that elects to rely on enterprise architecture must necessarily decide on the specific types of documents and diagrams they intend to keep track of with their architecture. Many begin with a subset simply to limit the time required to establish all the necessary relationships, in order

to get initial enterprise architecture in place quickly. Later, when the initial architecture is established, they expand the framework and commit to the addition of new information.

4. Select a Tool and Repository

Enterprise architecture must be managed and maintained by a committee or group of individuals. The group will necessarily need to keep track of a wide variety of documents, diagrams, models and charts. The only reasonable way to do this is to use a software tool that organizes the information and stores it in a repository, so that any member of the enterprise team can quickly obtain all of the documents, diagrams or models that refer to a given business goal or process, or to a specific activity or application used in a process.

5. Organize the Existing Material

Once a company has established enterprise architecture group and selected a framework and a software tool, it should begin by collecting everything it can that is specified by the framework. A quick glance at the Zachman Framework illustrated in Figure 1 suggests the range of documentation required for comprehensive enterprise architecture.

Most companies will find that they don't have much of the documentation in a form suitable for the repository. In many cases, plans and processes are not current, or are incompletely documented. In more cases, existing processes aren't documented at all. Similarly, only a few organizations currently have their software applications organized in a way that makes it clear what process is supported by which applications. Any enterprise architecture team beginning an effort will also face huge taxonomy problems. Activities in business processes are named in different ways than they are in software applications or in databases. Names will have changed without other documents being updated, and so forth.

The key to this effort is usually to start at the top and only go into as much depth as is practical during the period allowed for the creation of the initial enterprise architecture. Most companies can identify their corporate strategies and key plans. Similarly, they can probably identify key goals and measures and the key business processes and the major applications that support them. Start by documenting these items and their relationships. Leave the rest for later. Then, as new projects come up that require more detailed documentation, document them and place the new information in the repository. Enterprise architecture isn't a product, it's a process. Just like the organization it models, the enterprise architecture must be flexible, and designed to grow; just as the organization

it grows and changes.

6. Begin Using the Enterprise Architecture

Enterprise architecture, even an incomplete one, should provide planners with a better way of conceptualizing how a change should be organized and phased. Thus, most organizations begin to use their enterprise architecture even before it is complete. If those involved in planning don't want to use the enterprise architecture, it suggests that you need to reconsider how your enterprise architecture is organized, how it's accessed, or how it has been explained to various business managers. Like any other business tool, its use must be explained and those involved will need time to become familiar with it. As the enterprise architecture is used and familiarity grows, managers will learn the value of the architecture and will identify additional uses for it. In time the enterprise architecture will evolve into a key tool for the management of the organization.

7. Extend and Maintain the Architecture

Once the initial enterprise architecture is established, and the initial documentation is placed in the repository, the enterprise architecture group should proceed to extend and maintain the architecture. Improvement usually occurs in two more or less independent, simultaneous phases. First, the architecture group will identify missing elements that it will want to capture as quickly as possible.

A systematic process should be developed to generate and store additional documentation and diagrams in an orderly way. At the same time, the company should begin to use the architecture to scope and structure new projects. In effect, the enterprise architecture is a tool the executive committee and strategists can use to communicate with those charged with changing specific processes. In addition, the architecture committee will emerge as the group that establishes priorities among projects and monitors organizational changes. Obviously, each new business process change effort should be conducted in such a way that the documentation and diagrams produced, and the IS alignment attained via the effort, is all stored in the enterprise architecture.

Just as every company should maintain a business plan, it should maintain enterprise architecture. In essence, enterprise architecture is just a more extensively documented business plan. The more extensive documentation is required because companies are more complex and changes require a better understanding of all of the implications of any change. The payoff is a tool that makes planning and organizational alignment much simpler. The whole effort will come to nothing

if it isn't expanded to include all the necessary documents and diagrams, and if it is not maintained once it's created.

Aligning the Organization

One test of the usefulness of enterprise architecture is its ability to assist with alignment, or to spotlight misalignment. In essence, if goals and measures are organized, managers should be able to see exactly how high level goals are implemented at successive levels of detail. In some cases, everyone will be happy with the iterative subdivision of goals, but in other cases, managers will probably find that goals become subtly distorted as they are implemented in lower level systems. While the enterprise architecture provides a tool that managers can use to see how goals and processes are implemented, throughout the organization, the managers themselves must decide if the various implementations actually accomplish what is intended by senior management.

Organizations are best aligned with goals and measures that determine if those goals are being met. Thus, creating a diagram that shows how a given strategy is to be supported by a specific business process, which in turn is implemented, in part, by software applications and databases, doesn't guarantee alignment. It merely guarantees that the person looking at the diagram knows all of the elements that are supposed to be coordinated to achieve the strategic goal. Even that, however, is a major improvement over situations in which managers are unsure what specific processes a given application is designed to support. Once one knows how the elements are intended to be aligned, one is positioned to use specific measures to determine if the processes, sub-processes, applications and databases are actually achieving their purpose. This is done by working top-downward and refining the goals and measures that will determine success. It begins with statements of what will constitute a success for the strategic initiative. That in turn, is used to determine what outcomes the process or processes assigned to that strategic goal must achieve. Sub-processes within processes are assigned their own specific goals. Applications designed to support sub-processes inherit their goals and measures from their processes, and so forth.

I won't go into the technical details of creating, assigning and monitoring measures here, but suffice to say that most organizations with enterprise architectures integrate their measurement systems with their architecture systems to assure a degree of organizational alignment and measurement that is impossible without enterprise architecture.

Aligning Business

Consider how enterprise architecture can be used to align business processes with information systems. Figure 3 provides a more detailed and concrete example of how processes are aligned with information systems.

In this case, I have taken a slice across the organization and identified four specific business processes: an Order Process, an Assembly Process, a Delivery Process and a Billing Process. Each of these processes is supported, in Figure 3, by a software application, and these, in turn, are supported by databases.

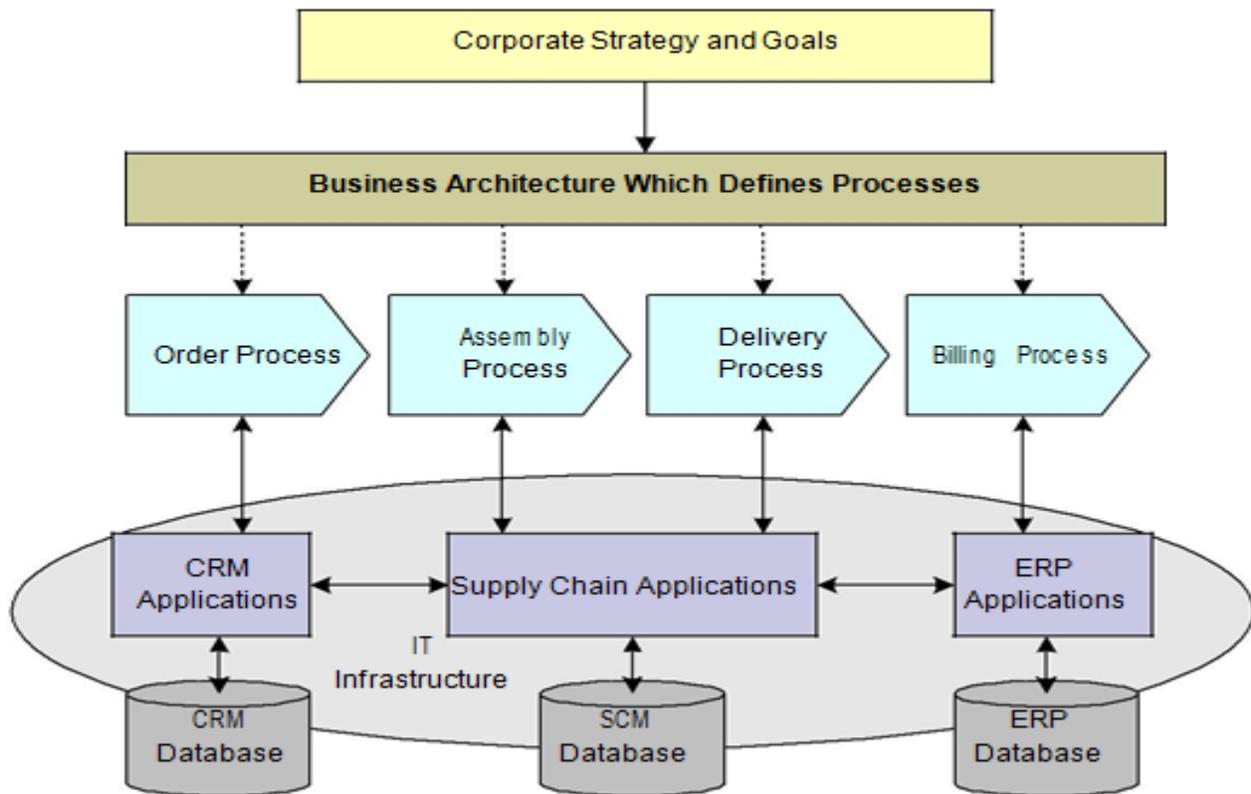
This view of the relationships among processes, applications and databases is a natural outcome of enterprise architecture. Too many organizations, without a comprehensive architecture, associate applications with departments or specific functions. The keys to a well-organized architecture are (1) goals that are tracked through the layers of detail, and, (2) a set of business processes that provide an overview of the work and the outputs of the organization. Together, this information clarifies how processes link, directly or indirectly to customers, and how they achieve specific organizational goals.

When the Enterprise Architecture Committee receives suggestions for strategic changes, they should immediately translate those changes into changes in specific business processes. If the architecture is well-defined, changes in processes will immediately suggest changes in specific applications and databases.

It's important to stress that there is no one-to-one relationship between business processes and applications, or between applications and databases. Business managers usually think of processes in terms of how work flows through the organization and of how employees are organized to accomplish specific tasks. IS managers usually think of processes only as they relate to applications and databases they must support.

Different ways of organizing tasks at different levels should not represent a problem for the Enterprise Architecture Committee, although it does need to be understood. In essence, it is sometimes necessary to "translate" between the boundaries established for business processes and those established for software applications or databases. The development of enterprise architecture can help a company understand just where these translations are necessary.

Figure 3. Aligning processes, applications and databases.



Issues with Enterprise Architecture Development

Architecture is responsible for the final success or failure of an information enterprise.

The main problem today's enterprises face is the fact that most of them are built in ad hoc fashion. As von Halle observes, quick and dirty information systems projects are the rule rather than the exception for enterprises. Academia can help to address this problem only by educating and popularizing ideas of developing enterprises with a well-defined process. In the rest of this section, we will concentrate mainly on technical problems of constructing well-built enterprises.

We will describe two groups of problems. The first group is consequences of actual causes, which is the second group.

Consequences

1. When an enterprise is built out of systems, piece by piece and product by product, it does not work as it is expected because the built systems do not fit together well.
2. Maintenance of systems' relevance to a company work-flow in an information enterprise is time-consuming and expensive.
3. The costs and time of maintenance approximate exponential increases with an increase in the number of systems deployed at an enterprise.
4. Enterprise-wide modeling, as opposed to single system modeling, takes too long. By the time it is completed, the result is usually discredited and out of date.

Problem 2 is featured in software systems as well. On the enterprise level, maintenance difficulties are aggregated from all systems constituting an enterprise, and they become one of the major obstacles for IT professionals as Zachman points out. The other three problems are not experienced in software system development.

Causes

Our research suggests that the following are the actual causes of enterprise problems.

1. Resources and changes are accumulated from each system and become orders of magnitude more than for any single system, which leads to unmanageable enterprises.
2. Lack of ability to consistently and meaningfully describe, analyze, change, and evaluate an enterprise structure as well as to communicate and accumulate positive knowledge about building well-constructed enterprises. This leads to enterprise architectures that are made in ad hoc hand-crafted fashion, are informal, un-analyzable, un-maintainable and not reusable.
3. *Architectural mismatch* is described by Garlan et al. If we project their mismatch taxonomy onto the enterprise level, we have the following main reasons for architectural mismatch:
 - (a) assumptions about the nature of the systems constituting an enterprise;
 - (b) assumptions about the nature of the connectors between systems;

- (c) assumptions about the global architectural structure – about topology of the enterprise communications and about the presence or absence of particular components and connectors;
- (d) Assumptions about the construction process.

Even though the notion of architectural mismatch in software engineering field was first identified for information systems, not for enterprises, clearly architectural mismatch prevents deploying “well-constructed” enterprises.

4. We believe some problems with today’s practice of documenting software systems architectures identified by Shaw and Garlan are also projected on enterprise architectures:
 - a. inability to localize information about interactions,
 - b. poor abstraction,
 - c. lack of structure on interface definitions,
 - d. poor support for components with incompatible packaging,
 - e. poor support for multi-paradigm systems,
 - f. poor support for legacy systems.

In the next two sections, we describe current approaches in practice and research of software engineering to developing enterprise architectures and analyze them from the perspective of these main causes.

Critical Implementation Concerns

Even in a single site, implementing ERP means "Early Retirement Probably." An ERP package is so complex and vast that it takes several years and millions of dollars to roll it out. It also requires many far-flung outposts of a company to follow exactly the same business processes. In fact, implementing any integrated ERP solution is not as much a technological exercise but an "organizational revolution." Extensive preparation before implementation is the key to success. Implementations carried out without patience and careful planning will turn out to be corporate root canals, not competitive advantage. Several issues must be addressed when dealing with a vast ERP system, and the following sections discuss each of them in detail.

Top Management Commitment - The IT literature has clearly demonstrated that for IT projects to succeed, top management support is critical. This also applies to ERP implementations. Implementing an ERP system is not a matter of changing software systems, rather it is a matter of repositioning the company and transforming the business practices. Due to enormous impact on the competitive advantage of the company, top management must consider the strategic implications of implementing an ERP solution. Management must ask several questions before embarking on the project. Does the ERP system strengthen the company's competitive position? How might it erode the company's competitive position? How does ERP affect the organizational structure and the culture? What is the scope of the ERP implementation only a few functional units or the entire organization? Are there any alternatives that meet the company's needs better than an ERP system? If it is a multinational corporation, the management should be concerned about whether it would be better to roll the system out globally or restrict it to certain regional units? Management must be involved in every step of the ERP implementation. Some companies make the grave mistake of handing over the responsibility of ERP implementation to the technology department. This would risk the entire company's survival because of the ERP system's profound business implications. It is often said that ERP implementation is about people, not processes or technology. An organization goes through a major transformation, and the management of this change must be carefully planned (from a strategic viewpoint) and meticulously implemented. Many parts of the business that used to work in silos now have to be tightly integrated for ERP to work effectively. Cutting corners in planning and implementation is detrimental to a company. The top management must not only fund the project but also take an active role in leading the change. A review of successful ERP implementations has shown that the key to a smooth rollout is the effective change management from top. Intervention from management is often necessary to resolve conflicts and bring everybody to the same thinking, and to build cooperation among the diverse groups in the organization, often times across the national borders. Top management needs to constantly monitor the progress of the project and provide direction to the implementation teams. The success of a major project like an ERP implementation completely hinges on the strong, sustained commitment of top management. This commitment when percolated down through the organizational levels results in an overall organizational commitment. An overall organizational commitment that is very visible, well defined, and felt is a sure way to ensure a successful implementation.

Reengineering - Implementing an ERP system involves reengineering the existing business processes to the best business process standard. ERP systems are built on best practices that are followed in the industry. One major benefit of ERP comes from reengineering the company's existing way of doing business. All the processes in a company must conform to the ERP model. The cost and benefits of aligning with an ERP model could be very high. This is especially true if the company plans to roll out the system worldwide. It is not very easy to get everyone to agree to the same process. Sometimes business processes are so unique that they need to be preserved, and appropriate steps need to be taken to customize those business processes. Hydro Agri North America, Inc. implemented SAP R/3 in 1994, and since then the company

is fighting against the integration SAP provides because some of the company's processes are very unique. Trying to fit the SAP mold resulted in a lot of pain and fewer benefits. Now Hydro Agri will either build a different front-end application or use a different package whenever their processes clash with that of the SAP.(n7) The companies also face a question as to whether to implement the ERP software "as is" and adopt the ERP system's built-in procedure or customize the product to the specific needs of the company. Research shows that even a best application package can meet only 70 percent of the organizational needs. What happens to the rest? An organization has to change its processes to conform to the ERP package, customize the software to suit its needs, or not be concerned about meeting the balance 30 percent. If the package cannot adapt to the organization, then organization has to adapt to the package and change its procedures. When organization customizes the software to suit its needs, the total cost of implementation rises. The more the customization, the greater the implementation costs. Companies should keep their systems "as is" as much as possible to reduce the costs of customization and future maintenance and upgrade expenses.

Integration - There is a strong trend toward a single ERP solution for an entire company. Most companies feel that having a single vendor means a "common view" necessary to serve their customers efficiently and the ease of maintaining the system in future. Unfortunately, no single application can do everything a company needs. Companies may have to use other specialized software products that best meet their unique needs. These products have to be

integrated along with all the homegrown systems with the ERP suite. In this case, ERP serves as a backbone, and all the different software are bolted on to the ERP software. There is third-party software, called middleware, which can be used to integrate software applications from several vendors to the ERP backbone. Unfortunately, middleware is not available for all the different software products that are available in the market. Middleware vendors concentrate only on the most popular packaged applications and tend to focus on the technical aspects of application interoperability rather than linking business processes. Many times, organizations have to develop their own interfaces for commercial software applications and the homegrown applications. Integration software also poses other kinds of problems when it comes to maintenance. It is a nightmare for IS personnel to manage this software whenever there are changes and upgrades to either ERP software or other software that is integrated with the ERP system. For every change, the IT department will be concerned about which link is going to fail this time. Integration problems would be severe if the middleware links the ERP package of a company to its vendor companies in the supply chain. Maintaining the integration patchwork requires an inordinate and ongoing expenditure of resources. Organizations spend up to 50 percent of their IT budgets on application integration? It is also estimated that the integration market (products and services) equals the size of the entire ERP market. When companies choose bolt on systems, it is advisable to contact the ERP vendor for a list of certified third-party vendors. Each year, all the major ERP vendors publish a list of certified third-party vendors. There are several advantages to choosing this option, including continuous maintenance and upgrade support.

One of the major benefits of ERP solutions is the integration they bring into an organization. Organizations need to understand the nature of integration and how it affects the entire business. Before integration, the functional departments used work in silos and were slow to experience the consequences of the mistakes other departments committed. The information flow was rather slow, and the departments that made the mistakes had ample time to correct them before the errors started affecting the other departments. However, with tight integration the ripple effect of mistakes made in one part of the business unit passes onto the other departments in real time. Also, the original mistakes get magnified as they flow through the value chain of the company. For example, the errors that the production department of a company made in its bill of materials could affect not only the operations in the production department but also the inventory department, accounting department, and others. The

impact of these errors could be detrimental to a company. For example, price errors on purchase orders could mislead financial analysts by giving a distorted view of how much the company is spending on materials. Companies must be aware of the potential risks of the errors and take proper steps, such as monitoring the transactions and taking immediate steps to rectify the problems should they occur. They must also have a formal plan of action describing the steps to be taken if an error is detected. A proper means to communicate to all the parties who are victims of the errors as soon as the errors are detected is extremely important. Consider the recent example of a manufacturing company that implemented an ERP package. It suddenly started experiencing a shortage of manufacturing materials. Production workers noticed that it was due to incorrect bills of materials, and they made necessary adjustments because they knew the correct number of parts needed to manufacturer. However, the company did not have any procedures to notify others in case any errors were found in the data. The domino effect of the errors started affecting other areas of business. Inventory managers thought the company had more material than what was on the shelves, and material shortages occurred. Now the company has mandatory training classes to educate employees about how transactions flow through the system and how errors affect the activities in a value chain. It took almost eight weeks to clean up the incorrect bills of materials in the database.

Companies implementing electronic supply chains face different kinds of problems with integration of information across the supply chain companies. The major challenge is the impact automation has on the business process. Automation changes the way companies deal with one another, from planning, to purchasing to paying. Sharing and control of information seem to be major concerns. Companies are concerned about how much information they need to share with their customers and suppliers and how to control the information. Suppliers do not want their competitors to see their prices or order volumes. The general fear is that sharing too much information hurts their business. Regarding controlling information, companies are aware that it is difficult to control what they own let alone control what they do not own. Companies need to trust their partners and must coordinate with each other in the chain. The whole chain suffers if one link is slow to provide information or access. The management also must be concerned about the stress an automated supply chain brings within each organization. For instance, a sales department may be unhappy that electronic

ordering has cut it out of the loop, while manufacturing may have to adjust to getting one week's notice to order changes and accommodate those changes into its production orders.

ERP Consultants - Because the ERP market has grown so big so fast, there has been a shortage of competent consultants. The skill shortage is so deep that it cannot be filled immediately. Finding the right people and keeping them through the implementation is a major challenge. ERP implementation demands multiple skills -- functional, technical, and interpersonal skills. Again, consultants with specific industry knowledge are fewer in number. There are not many consultants with all the required skills.

Since the ERP market in the United States started approximately five years ago (and is growing at an astronomical rate), there are not many consultants with three or more years of experience. This has sent the compensation for skilled SAP consultants through the roof. One year's experience brings in \$70,000 to \$80,000 annually. Three to five years' experience could command up to \$200,000 annually. One might find a consultant with a stellar reputation in some areas, but he may lack expertise in the specific area a company is looking for. Hiring a consultant is just the tip of the iceberg. Managing a consulting firm and its employees is even more challenging. The success or failure of the project depends on how well you meet this challenge.

Implementation Time - ERP systems come in modular fashion and do not have to be implemented entirely at once. Several companies follow a phase-in approach in which one module is implemented at a time. For example, SAP R/3 is composed of several "complete" modules that could be chosen and implemented, depending on an organization's needs. Some of the most commonly installed modules are sales and distribution (SD), materials management (MM), production and planning, (PP), and finance and controlling (FI) modules. The average length of time for a "typical" implementation is about 14 months and can take as much as 150 consultants. Corning, Inc. plans to roll out ERP in ten of its diversified manufacturing divisions, and it expects the rollout to last five to eight years. The length of implementation is affected to a great extent by the number of modules being implemented, the scope of the implementation (different functional units or across multiple units spread out globally), the extent of customization, and the number of interfaces with other applications. The more number of units, the longer implementation. Also, as the scope of implementation

grows from a single business unit to multiple units spread out globally, the duration of implementation increases. A global implementation team has to be formed to prepare common requirements that do not violate the individual unit's specific requirements. This involves extensive travel and increases the length of implementation.

The problem with ERP packages is that they are very general and need to be configured to a specific type of business. This customization takes a long time, depending on the specific requirements of the business. For example, SAP is so complex and general that there are nearly 8000 switches that need to be set properly to make it handle the business processes in a way a company needs. The extent of customization determines the length of the implementation. The more customization needed, the longer it will take to roll the software out and the more it will cost to keep it up-to-date. The length of time could be cut down by keeping the system "plain vanilla" and reducing the number of bolt-on application packages that require custom interfaces with the ERP system. The downside to this "plain vanilla" approach is conforming to the system's mold, which may or may not completely match the requirements of the business.

For small companies, SAP recently launched Ready-to-Run, a scaled-down suite of R/3 programs preloaded on a computer server. SAP has also introduced AcceleratedSAP (ASAP) to reduce implementation time. ERP vendors are now offering industry-specific applications to cut the implementation time down. SAP has recently outlined a comprehensive plan to offer 17 industry-specific solutions, including chemical, aerospace and defense, insurance, retail, media, and utilities industries. Even though these specific solutions would be able to substantially reduce the time to implement an application, organizations still have to customize the product for their specific requirements.

Implementation Costs - Even though the price of prewritten software is cheap compared with in-house development, the total cost of implementation could be three to five times the purchase price of the software. The implementation costs would increase as the degree of customization increases. The cost of hiring consultants and all that goes with it can consume up to 30 percent of the overall budget for the implementation. According to Gartner Group, total cost of an outside SAP consultant is around \$1600 per day. Going for in-house SAP-trained technologists creates its own worries. Once the selected employees are trained after investing a huge sum of money, it is a challenge to retain them, especially in a market that is

hungry for skilled SAP consultants. Employees could double or triple their salaries by accepting other positions. Retention strategies such as bonus programs, company perks, salary increases, continual training and education, and appeals to company loyalty could work. Other intangible strategies such as flexible work hours, telecommuting options, and opportunities to work with leading-edge technologies are also being used. Many companies simply strive to complete the projects quickly for fear of poaching by head-hunting agencies and other companies.

ERP Vendors - As there are about 500 ERP applications available and there is some company consolidation going on, it is all the more important that the software partner be financially well off. Selecting a suitable product is extremely important. Gartner Group has Buy Smart program, which has more than 1700 questions to help a company choose a suitable ERP package. Top management input is very important when selecting a suitable vendor. Management needs to ask questions about the vendor, such as its market focus (for example, midsize or large organization), track record with customers, vision of the future, and with whom the vendor is strategically aligned. For a global ERP rollout, companies need to be concerned about if the ERP software is designed to work in different countries. Also, the management must make sure the ERP vendor has the same version of the software available in all the countries the company is implementing the system. Vendor claims regarding global readiness may not be true, and the implementation team may need to cross-check with subsidiary representatives regarding the availability of the software. Vendors also may not have substantial presence in the subsidiary countries. It is important to evaluate if the vendor staffers in these countries are knowledgeable and available.

If there is a shortage of skilled staff, bringing people from outside could solve the problem, but it would increase the costs of implementation.

Selecting the Right Employees - Companies intending to implement an ERP system must be willing to dedicate some of their best employees to the project for a successful implementation. Often companies do not realize the impact of choosing the internal employees with the right skill set. The importance of this aspect cannot be overemphasized. Internal resources of a company should not only be experts in the company's processes but also be aware of the best business practices in the industry. Internal resources on the project

should exhibit the ability to understand the overall needs of the company and should play an important role in guiding the project efforts in the right direction. Most of the consulting organizations do provide comprehensive guidelines for selecting internal resources for the project. Companies should take this exercise seriously and make the right choices. Lack of proper understanding of the project needs and the inability to provide leadership and guidance to the project by the company's internal resources is a major reason for the failure of ERP projects. Because of the complexities involved in the day-to-day running of an organization, it is not uncommon to find functional departments unwilling to sacrifice their best resources toward ERP project needs. However, considering that ERP system implementation can be a critical step in forging an organization's future, companies are better off dedicating their best internal resources to the project.

Training Employees - Training and updating employees on ERP is a major challenge. People are one of the hidden costs of ERP implementation. Without proper training, about 30 percent to 40 percent of front-line workers will not be able to handle the demands of the new system. (n6) The people at the keyboard are now making important decisions about buying and selling -- important commitments of the company. They need to understand how their data affects the rest of company. Some of the decisions front-line people make with an ERP system were the responsibility of a manager earlier. It is important for managers to understand this change in their job and encourage the front-line people to be able to make those decisions themselves. Training employees on ERP is not as simple as Excel training in which you give them a few weeks of training, put them on the job, and they blunder their way through. ERP systems are extremely complex and demand rigorous training. It is difficult for trainers or consultants to pass on the knowledge to the employees in a short period of time. This "knowledge transfer" gets hard if the employees lack computer literacy or have computer phobia. In addition to being taught ERP technology, the employees now have to be taught their new responsibilities. With ERP systems you are continuously being trained. Companies should provide opportunities to enhance the skills of the employees by providing training opportunities on a continuous basis to meet the changing needs of the business and employees.

Employee Morale - Employees working on an ERP implementation project put in long hours (as much as 20 hours per day) including seven-day weeks and even holidays. Even though

the experience is valuable for their career growth, the stress of implementation coupled with regular job duties (many times employees still spend 25 to 50 percent of their time on regular job duties) could decrease their morale rapidly. Leadership from upper management and support and caring acts of project leaders would certainly boost the morale of the team members. Other strategies, such as taking the employees on field trips, could help reduce the stress and improve the morale.

Related Studies

According to Pearl Zhu of *Future of CIO Website*, these are the things to consider in developing Enterprise Architecture.

Fitness for Purpose - Consistent definition and understanding of EA as a discipline adds to challenges. Most organizations stand up EA to "fix" an organization without giving it any purpose. Often, consultants/contractors try to sell the Titanic of EA before they can prove a sailboat which can float. This is what often results in annoying the clients and has led to the view of EA being shelf-ware.

Senior executives buy-in and continuous focus and support upon the EA program - This is like a chicken and egg issue. Executives would have continuous support if EA can deliver value, but EA need continuous executive supports to show value. EA is in a domain where you don't find too many quick wins. In addition, a successful EA would often lead to corporate culture change. Without strong senior executives' commitments, corporate culture change just won't happen. Many feel that time and money is being wasted till they start seeing in the results.

Understand Stewardship and Ownership differences - Too often an EA attempts to take ownership of a business process and ends up getting blamed. An EA is a Steward to practice strategic EA Leadership & Operational Stewardship --> alignment of execution with Strategy is extremely critical for EA success.

EA Maturity - EA engagement model and governance, this gears toward corporate processes, politics and people issues. Enterprise Architecture is simply a heavy burden to a lot of people and projects if EA engagement and governance model is not efficient and effective. Somehow, fragmented EA engagement model and governance process is very common at work place. It seems taking forever to streamline. In other words, Governance and Compliance inward is extremely important.

Organizational Maturity - A mature organization is base to start a successful EA program; on the other side, an effective EA program improves organizational maturity. Too many organizations try to institute an EA program when the organization is not prepared to do so. Often, leadership hears or gets the pitch that EA will save the day and they start a program, without supporting the program, thinking that "doing" EA will fix everything. EA requires wide preparation and active participation.

Business/Architecture Alignment - This has to be earned by EA Team and should not be considered a blank check or an entitlement, as this would require relationship management and transparency in delivery to match the business priorities. PMO and Architecture team are critical for earning and establishing the trust.

Move from Vendor/Group/Institute-centric EA to Customer-centric EA - Advance from just being DNA or “enterprise genotype” (a full nomenclature of enterprise artifacts) to provide a formal link with “enterprise phenotype” (a set of observable characteristics such as performance) and business ecosystem.

Constant jockeying with "tactical project savings" vs. "sustainable strategic advantage" argument(classic misalignment of project team goals with architecture team goals) - Starting too big, that the EA initiative doesn't get success as originally intended. It is extremely important to start small and produce results to gain trust. Planning and prioritizing some quick wins to demonstrate what change a complete EA can bring to an enterprise. Though it is very difficult since it can backfire at times, still, EA needs to

demonstrate directly quantifiable value contribution to company's bottom line or direct savings as a result

Mature EA Team – The EA team which don't just believe in Framework and Technology but also has the capability to carry the business with them and got a thick skin to sail through the politics and policies Staff. Also, it is not about the "chief architect," it is about the team of architects/support staff, a mature EA team.

EA Skills/Talent - Architecture is more of an art than a science and requires more skills than certifications. Enterprise Architect requires broad knowledge from many aspects of, business domains knowledge, technologies project management experience, and organizational skills. There are many channels to mature as an Enterprise Architect. Enterprise Architects with different maturing paths may see the same organization with very different challenges. –

According to Dean Griffin of *Accenture*, enterprise architecture has entered the mainstream. For practitioners, this raises a whole new set of challenges as they must now play a role in helping the enterprise achieve high performance.

A decade ago, we in enterprise architecture spent a great deal of time explaining just what enterprise architecture was. Things have changed, and today we are increasingly getting a lot of attention across the business. This new-found importance is being driven by 10 important factors, each of which in turn creates a set of substantial challenges that enterprise architecture must successfully address.

In order to meet these challenges successfully, Accenture is convinced that enterprise architects will have to take a holistic view of the entire enterprise, spanning the infrastructure and the business strategy as well as the external environment in which the business competes.

Compliance - The first set of challenges centers on regulatory compliance. Enterprise architects are well placed to help identify systems and processes that are impacted by compliance requirements and regulations. Enterprise architects must have a fundamental knowledge of the regulatory climate and context for the organizations they serve. Whatever

the particular regulation might be—Code of Federal Regulations, Sarbanes-Oxley, Control Objectives for Information and Related Technology (CoBIT), or Basel II certification—enterprise architects must get it right, must recognize impediments and weaknesses in the current state, and be able to envision and articulate architecture enhancements. We must be able to address the question: “How do we introduce new technology and processes without jeopardizing our compliance standing?”

Security - The old days of hard and crispy on the outside and soft and chewy in the middle are long since gone. Extending the enterprise and empowering the organization with technology has come at a price, and security breaches are as likely to come from within as from without. This creates huge challenges for the enterprise architect—the architecture must be sufficiently pliant to accommodate modern business’s need for its systems and processes to integrate with business partners and customers, while protecting it from competitors and hackers. Failure here can cause catastrophic damage to the company’s reputation, often resulting in irrecoverable loss of trust and market capitalization. We must develop more than a keen eye to avoid establishing or institutionalizing vulnerabilities and threats vis-à-vis our architectural visions and plans. The threats are constantly shifting, which means that the enterprise architecture for which we are responsible must have the ability to be quickly hardened against new risks while continuing to be the engine of innovation, service and productivity.

Privacy - Enterprise architects must also get right the protection of privacy—we must see ourselves as instrumental in keeping the social compact (and often legal contract) of preserving privacy. We must develop acuity in identifying when information is exposed that should remain proprietary, private and privileged. This means having more than a passing knowledge of information life cycle management. In some cases there are serious legal liabilities for breaking the bonds of privacy (the Health Insurance Portability and Accountability Act in the United States, for example). More often, our companies are damaged by the exposure of information on which their market differentiation is based. A corporation’s right to privacy is compromised not only by single points of vulnerability in process and technology, but by maintaining archives of data that should not have been

preserved in the first place. We must have increased data and informational architecting competency. These are not new concerns—it just that the price of failing to prevent inadvertent and intentional privacy breaches has never been higher.

Technology Refresh - Accenture's research and conversations with leading CIOs instructs us that organizations are in a deep period of technology refresh and that the investment cycle in IT has moved from revitalizing and retooling the financial, enterprise resource planning, and other key back-office systems to reengineering the systems that support core business processes, such as customer relationship management and supply chain optimization.

For enterprise architects, this process is compromised by architectural components that have long since passed their sell-by dates, systems built in languages that are now as extinct as Latin, and systems implemented in the bygone era when the world was program-centric and data were just the necessary glue. The pressure on architects is to be able to extract business logic from these rusting hulks, not just retrofit lump by lump the old with the new—the aim is also to provide much higher platform robustness for the enterprise. In short, the technology refresh must be done not only with cheaper, faster, and better in mind, but it must be non-disruptive, affordable, and be done with smaller-than-galactic budgets.

In fact, Accenture believes that architectural refresh must be done with fully funded retirement plans. Historically, architectural oversights have precluded getting rid of the rust, even while new things are being plugged in and lit up. The architect must leverage industry knowledge to develop prowess in technology lifecycle management. The architect must anticipate when architectural elements will expire, and ensure the enterprise is ready, willing, and able to introduce replacement elements on the fly without causing interruption.

Productivity - Being able quickly and accurately to model “what ifs” is an increasingly central role for the architect. Globalization and scaling is driving the potential for increased complexity in the organization. We must find smarter and cleverer ways to plan and deliver never-fail modes of operation for our organizations. It is no longer just an inconvenience when the architecture fails—it threatens the business. Our architectures must be able to deal with the fact that in a global world the sun never sets. When is a good time to shut down the technology that underpins the business? (A bit of bright news—gone are all those long, lonely

Saturday nights and Sunday mornings at the data center bringing new releases and systems into production!)

The last economic downturn produced a prolonged period of austerity; cost was king. Enterprise architects must continue to identify powerful new means to enable cost avoidances and earnings enhancements. Every cent of eliminated organizational cost drops directly into the purses of the shareholders for commercial companies and extends government agencies' ability to add services to citizens. This has, however, become necessary but not sufficient for successful enterprise architecture planning. Finding achievable, actionable architectural enhancements that propel top line growth are now at least as important in measuring the value of enterprise architects as their finely honed ability to identify cost reducing breakthrough ideas for the organization.

Time to Market: The skillful enterprise architect must find novel ways to achieve architectures that can integrate with the business services and processes of the organization. There is no shortage of great ideas in the enterprise, only in the capacity to bring them to market. Our legacy environments have frequently become so complex that cloning becomes the only way to get the architecture to support new ideas and changes in the business. The increased complexity of these spaghetti-bowl implementations not only starves the enterprise of crucial capital—human and fiscal—needed to create new value in the enterprise, but in the end, it prevents the organization from becoming agile in the market.

The accelerated pace of business change and the heightened need to be first to market with new services, features, and differentiating market offerings make it essential for architects to look beyond the purely tactical. Resist the temptations and lures of the latest technology hype, and look to solutions that are coupled with long-term vendor strategies in line with the strategic needs of the enterprise. The enterprise expects us to have laid foundations that will allow it to make affordable, swift responses to the new market threats and opportunities without adding substantial risk and complexity to either the process or systems environments.

Getting ready for Service-Oriented Architecture (soa) - It's in all the papers—you can't afford to not be doing something about SOA in your enterprise. Yet, most enterprise architects have not done much of either substance or significance in this area. Today, much

of the clamor surrounding SOA continues to be driven by technology providers, and much of this is still focused more on enterprise integration than on service definition and architecture. As a consequence, most of what enterprise architects have addressed in this space concerns aligning IT with the business and governance.

The fact is enterprise architects have been focusing on aligning IT with business for decades. What has changed is the promise of abstracting services that can be reused, while the concept of business architecture has matured to become a recognized element of high-performance businesses. In turn, this has broadened the scope of enterprise architecture beyond mere technology—but enterprise architects have been slow to recognize this sea change.

Enterprise architects need to take back the high ground here—and that must be done in 2007. Failure to do so will mean that much of what we do as practitioners of the craft will be ceded to others, and our scope will be restricted to IT—in essence we will have become technical architects. Today's enterprise architect must re-engage with all the principals in the enterprise by making a case for seeing service and technology architectures as one.

Convergence, Content, and Communications - Hardly a day goes by that there is not another step forward in the convergence of communications, content, and the devices that make convergence possible. Richer, more intelligent, but also more perishable, content has profound implications for the enterprise and its architecture. User expectations also have grown remarkably in recent times: ease of use, seamless access, and near-real-time information.

Enterprise architects have much to offer in helping find new ways to deal with convergence and the resulting flood of information. The problem goes far beyond the stress on infrastructures when dealing with the increasing flow. More serious, most architectures offer little help in finding patterns and prioritizing. As a result, organizations tend to be data-rich but information-starved, and without much ability to manage knowledge and share wisdom.

Enterprise architects must confront this head on. Our customers, employees, and managers must have the freedom to use converged devices that may be unplugged or loosely connected, and yet still have their needs of near-real-time content addressed. We must excel

at information architecture and begin to create knowledge architectures that meet these challenges.

Openness - Moving toward architectures that have high degrees of independence is an unmet challenge today. Beyond the physical computing platforms and transport layers of our architectures, very little is open. And while standards have emerged that would allow more independence on proprietary solutions, we must recognize that for most providers, openness is antithetical to their business models. Enterprise architects must develop a battle plan that moves the enterprise toward openness but which takes into account the constraints of the real world. For example, the notion of architecting around an enterprise service bus may seem to solve many problems—but nearly all the available implementation options are, at their very heart, proprietary in nature. The architect must contemplate the unintended consequences of getting wrapped around yet more proprietary axles. If moving to open architectures is to meet the business needs of our enterprises, we as enterprise architects must have a stronger perspective and point of view on how best this can be done in our specific environments.

Exception and Event Processing - Not too long ago, the world was prepared for an imminent data tsunami produced by the perfect storm of Moore's law and nearly free bandwidth. In this brave new world, it seemed that smart sensors everywhere on everything would be the order of the day.

But then, as often happens, a disruptive idea got in the way. At the risk of being overly simplistic, one could say that classic architectures were predicated on repeatedly being told, for example, "The building is not on fire . . . The building is not on fire . . . The building is not on fire." With affordable and active smart sensors, it was realized that we would now be able to architect based on an early warning that the building may be on fire. This in turn led to the notion of exception processing, based on the availability of near-closed-loop analytics. This allows the creation of a flexible architecture that can respond to critical events within business processes that are, for some reason, exceptions—and not to events that are "normal." This changes everything—it will free up our clogged data pipelines and computing fabric to do more exciting, value-oriented things.

Enterprise architects must lead the charge on architecting beyond the company's physical boundaries, to leverage intelligent device integration, and to accommodate distributed analytics within their architectures. We need new ways to model these abstract extensions, and new tools and methods to govern and manage them.

These challenges, including the five that appeared in part one of this story in the last issue of A&G, are significant for enterprise architects. With the increased visibility that practitioners have gained, we must successfully confront them head on. The need to stay abreast of the fluid nature of our business environments has never been as critical to doing our jobs. The need to embrace new ideas and emerging technology has been and will continue to be critical to our success. Overcoming the challenges is not just about our credibility, but the very well-being of our enterprises. Now that we are in the C-suite, we need to have crisper messages—we need to have something important to say. Enterprise architecture has come a long way in a short time, but there is much to be done. Perhaps that is its allure for those of us who have chosen this craft.

Antoine de Saint-Exupery said, "If you want to build a ship, don't drum up people to collect wood and don't assign those tasks and work, but rather teach them to long for the endless immensity of the sea."

Enterprise architecture was conceived some 25 years ago to address the increasing complexity of IT systems and their poor alignment with business goals. The same problems still exist today, amplified by the accelerating pace of technology change.

Why is it that EA programs are more likely to fail than succeed? Here are eight typical failure modes, followed by recommendations on how to avoid them.

Lack of Sponsorship - Your architects need three tools to do a good job: access, leverage and goodies. *Access* means the ability to interact with the appropriate stakeholders, often at the C-level. *Leverage* includes the right place in the reporting chain, involvement in governance, ability to influence the technology budget, and authority to stop inappropriate

technology implementations. Sometimes even the seemingly small change of a title from technical architect to chief enterprise architect can make a significant difference.

Goodies include the ability to give out new technologies for testing, "lend" technology experts to struggling projects, and get access to exclusive information that can be traded for favors.

Well-sponsored architects will be able to build trust by consistently delivering meaningful results. Lack of sponsorship will destine even the best architects to fail.

Hiring Or Promoting The Wrong Person -The skills that earn someone the EA position don't necessarily make the person a strong EA. Often the most technical people get promoted when they lack other important skills. These include interest in the business, the ability to translate technology into simple business outcomes, and the ability to listen, communicate, present and market infectious enthusiasm for new technologies.

Building an Ivory Tower - Some EA programs hire a bunch of brilliant architects who retreat for a long time and return with sophisticated frameworks. They then present them to key members of the leadership and the organization, most of whom will have no clue what the architects are talking about, so their complex reference architectures will be ignored.

Ivory towers tend to increase the complexity and upset the stakeholders. The new CIO will gain immediate recognition among his business partners by firing the EA team, with the result that enterprise architecture becomes a "bad word" deeply embedded in the institutional memory. Roger Sessions wrote a great white paper on driving simplicity through connected enterprise architecture.

Policing And Insensitivity To Culture - I have seen a project manager burst into tears in the crossfire of enterprise architects' questions during a technical design review. I have been on a 2 a.m. call struggling to comply with unreasonable and obsolete technology standards just to get the chief architect's signature and meet the budget deadline.

In that particular case, the turning of enterprise architecture into a policing function resulted in its failure. It takes a lot of effort to convince, and regularly re-convince, your business and IT partners of the value of enterprise architecture. A gentle approach makes the function

more likely to succeed. The best architects I've known spoke softly and carried a really big carrot. They followed Exupery's advice.

Maintaining The EA Artifact Factory - Some EA teams keep busy documenting as-is states. They have an incredible array of diagrams at their disposal to represent the various aspects of everything. The world of diagrams is addictive, and perfect is the enemy of good when it comes to diagrams.

Instead, these teams should focus on producing frequent, meaningful and measureable business outcomes.

It isn't easy to come up with good KPIs to measure enterprise architecture. This GAO report clearly shows the challenges of defining good EA metrics in the government sector.

Clinging To A Particular Framework Or Tool - There are more than 80 EA frameworks, and you'll find no silver bullets among them. The best approach is to read all of the major frameworks, discard most of what you have learned, and blend the remaining 10% in a way that fits your organization's culture, maturity and business goals. As an example, here's a lightweight, blended approach for tree huggers. When it comes to tools, go fancy if you have the money. But most of the time fancy isn't necessary. Visio, Excel, Word, FreeMind, Prezi and a collaboration team site works well. Limit the time spent on selecting tools and frameworks and instead focus on using them.

Thinking Enterprise Architecture Equals Technology Architecture - Most EA programs are initiated by IT and never progress beyond the technology domain. Although technology standards, technology roadmaps and solid engineering practices will produce simpler, cheaper, portable, reusable and more supportable solutions, they don't align your IT investments with business goals and won't power your business with technology innovation.

Taking the "Enterprise" Word Literally - "Enterprise" does not necessarily mean the entire enterprise. It means stepping back and taking a look at the higher-level context before making a decision. Moving architecture to the real enterprise level requires a mature and

committed organization. If you try to push the enterprise aspect too far too early, you'll crash and burn.

According to *Challenges of Involving Stakeholders When Creating Enterprise Architecture*, research study by Agnes Nakakawa, Patrick van Bommel, and H.A. Erik Proper, Successful architecture creation is perceived as designing architecture, gaining stakeholders' acceptance of the architecture, and being able to implement it with their support and commitment. It is reported in that although 96% of enterprise architects closely collaborate with organizational stakeholders during enterprise architecture creation, 90% of them face challenges when delivering products of enterprise architecture creation. From the survey, architects reported the following as the challenges they face when delivering the architectural products. In brackets, the percentage of architects who face each challenge is indicated.

- 1) Some organizations lack a clear decision making unit, leading to a loud applause but no action (44%). In other cases architecture may be too complex for the decision making unit or organization maturity level (29%).
- 2) Since architecture is often perceived to be about only technology, some organizations lack a governance process for ensuring architecture compliancy (44%).
- 3) Architecture conclusions may sometimes conflict with personal ambitions or agendas (37%).
- 4) The client organization may change its business plans (37%).
- 5) Using the right language such that every stakeholder understands the architecture (34%), and making a short and clear description of the architecture to all stakeholders within a short time (13%).
- 6) Lack of commitment from people who were not earlier involved in the architecture process (24%). In other cases concerns arise from other stakeholders who were not seen as stakeholders before (21%).
- 7) Difficulty in translating enterprise architecture products to program starts architectures (17%).
- 8) Architecture products do not often deliver what has been promised or what was required (11%).

9) Other issues include cases where stakeholders do not want to (or are not able to) follow the advised architecture, or where the created architecture shows that the impact of the business strategy is higher than anticipated (3%).

Challenge 4 can be addressed using guidelines in the architecture requirements management phase of TOGAF ADM. In our view, other challenges listed above are byproducts of the quality of, and the preparations for, stakeholders' involvement (i.e. collaboration between enterprise architects and organizational stakeholders) during architecture creation. For example, delivery of models that are too complex often indicates that the architecture function is not properly integrated in the organization and this is due to, among other factors, the problematic nature of collaboration between architects and stakeholders.

Analysis

Enterprise architecture is a tool to help executives think about the organization as a whole. Enterprise architecture captures a wide variety of information, establishes relationships among the various documents and diagrams and stores all of the information together in a single repository, so that managers can then see relationships, ask questions, identify problems, or run simulations to help make decisions about changes they are considering.

I have tried to go beyond our general description of enterprise architecture to suggest that there will be problems along the way and disagreements about how to best represent or align different elements. The organizations that succeed in spite of these problems will be those that clearly understand the ultimate value of the enterprise architecture and persevere.

Change keeps occurring faster all the time. Successful organizations need to be very flexible. Thus, every organization needs tools that help its manager deal with the problems involved in analyzing and implementing potential changes. In the course of the next few years, the enterprise architecture will evolve into one of the major tools of that organizations rely upon to manage change. It will provide the focus around which business and IS managers met to discuss organizational goals, business processes, and organizational alignment. The enterprise architecture will assure that all necessary information is located in one place, and

indexed to business processes. The simulation abilities provided by enterprise architecture software tools will further assure that managers can quickly run simulations to evaluate the implications of any specific change scenario. In other words, the enterprise architecture is the first step toward an enterprise that can respond in real time. It provides managers with the foundation they will need to quickly make the key decisions they will face in the future.

Conclusion

Information enterprise architecture is similar to software system architecture although there are differences in the form of requirements, the focus of concern, and the level of abstraction. The main causes of the problems with enterprise architectures are the lack of efficient solutions to manage changes accumulated across an enterprise, the lack of an efficient and precise way to describe, analyze, and communicate the architecture, architectural mismatch, poor abstraction, and poor support for legacy, component-based and multi-paradigm systems. So far, practitioners made more progress in developing the area of enterprise architecture than researchers. However, working in the similar area – software system architecture, the research community took a more systematic and better founded approach. Most of the directions in software system architecture can be extrapolated into the enterprise architecture field.

The directions that can highly impact the enterprise architecture progress are as follows:

- Development of enterprise architecture definition languages.
- Bridging work-flow languages so that precisely and completely described work-flow can be used as requirements for enterprise architecture.
- Development of enterprise prototyping and modeling techniques.

Recommendation

For the sponsor of the Enterprise Architecture function: Make sure that the organization is ready for an architecture-driven approach and that the Enterprise Architecture function is well sponsored.

For the Enterprise Architecture: Make sure you have what it takes to do a good job. Take into account your own abilities, the company culture, the level of organizational maturity and the level of sponsorship.