Lessons Learned Helping Organizations Make Smart Information Technology Decisions

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Introduction

Since its inception, the State Information Technology Consortium (SITC), as a part of the Software Productivity Consortium (the Consortium) located in Herndon, Virginia has worked with state information technology (IT) organizations to sharpen and enhance the technology capabilities of member organizations. The Consortium has done the same with its corporate members and federal government agency affiliates. SITC's mission is threefold: (1) reduce IT risks facing state governments, (2) advance state IT management and acquisition processes, and (3) promote technology integration across state agencies and borders. The Consortium's mission is to serve its members, affiliates, and the national interest by providing highly leveraged system and software technology and services to increase productivity, profitability, and competitiveness. The Consortium is a leader in providing reduced-to-practice technology for the development of systems and software and the essential vehicle for its members and affiliates to adopt, implement, and improve their processes, methods, and technologies for developing software-intensive systems.

Working with technology professionals at all levels of industry and government, the Consortium and SITC have identified many lessons learned that can apply to other organizations with software-intensive systems. The lessons learned and the knowledge gained from working with various types of organizations, and diverse areas of software-intensive systems, vary depending on the particular area of concentration of the organization. Regardless of whether the industry is aerospace or delivery of government services, a common theme continues to immerge: the reality and impact of change.

A pervasive lesson to be learned and shared with technology organizations is that the most predictable aspect of the technology environment is that it is truly unpredictable and is always in a state of change.

This paper discusses three areas related to lessons learned in responding to change: (1) the reality of the concept of change, (2) managing the response to change, and (3) migrating in response to change. This paper draws on the wide and varied national, state and local, and academic relationships of both the Consortium and SITC and includes substantial interaction with senior industry executives through the Consortium's Board of Directors and a range of technical advisory boards and groups that interact with both organizations.

The Reality of the Concept of Change

The most dreaded words that the technical support staff can hear from their program management is "we need to talk." Often, this comment is the precursor to a general discussion resulting from policy, congressional, or state legislative mandate; a new product announcement; a contract award; or an agency directive that will necessitate changes in existing software systems.

In the corporate world, change manifests itself in many ways. The requirement for change could result from a new business endeavor, an imminent merger of divisions, a new product line that may necessitate a technology response, or a new emphasis on product quality standards. In the world of government, the ever-present reality of policy shifts results in a constant movement in some new direction, whether the expansion of services, or focus on a particular demographic group. In industry or government, the demand for change can cause a significant ripple in the sea of technology.

Across the enterprise of government organizations, something is always changing. Most federal agencies have an associated state agency or department that deals with the delivery of services to the citizens of the country. This structure provides the opportunity for sources of change to come from several major directions, and

more often than not, to come from different directions at the same time, all focused on the need for technology to support the changes.

Over the last several years, the Consortium's work with some of the largest corporations and federal and state IT organizations has revealed that, in reality, there are many sources of change for the IT organization. Consensus is that little can or will be done to arrest the potential for change, so the successful IT organization of the 21st century will be the IT organization that embraces the reality of the inevitability of change and builds a process for leveraging change.

Managing the Response to Change

In our work with many major industries, leading commercial companies, and federal and state technology organizations, we have found that management styles and concepts of adaptation vary widely among organizations. Regardless of the type, style, or energy that an organization uses in response to change, how an organization manages the inevitability and reality of change directly impacts the success of the organization.

In many organizations today, success or failure, measured by profit or loss, is driven by time-to-market. In many contracts, the ability to deliver a product before a competitor manifests itself in extremely aggressive schedules and timeframes. In the government arena, the struggle exists to complete work before sanctions are applied. Today, the typical IT support group finds itself constantly in a state of flux with "do or die" ultimatums under extreme pressure to produce.

With many IT support organizations currently at 100 percent of support capacity and higher, the interjection of change is perceived, for obvious reasons, as a major

negative factor; therefore, the ability of the IT management to leverage change is a critical success factor for the organization. One of the lessons learned in working with organizations in the field of software engineering and technology is that the organization that anticipates, embraces, and manages change will deliver successful projects and support. The creative and successful project managers in today's fast-paced and dynamic time are successful by building an organization around proven and successful processes and methods that anticipate, accommodate, and accept the ebb and flow associated with the interjection of change.

The Consortium has worked with many groups to share processes and methodologies that provide a stable management process equipped with the flexibility to accommodate change yet ensure productivity and quality. The Evolutionary Spiral Process (ESP) methodology, for example, teaches that project management is a concept and a process, not a one-time event. The ESP process was developed with three goals in mind: (1) understand and manage the risks on the project, (2) keep the end user involved, and (3) manage the changes so that the product and service can be successfully deployed to the customer or end user. These changes can be technology changes, requirements changes, or budget changes. The consistent ability to "feel the pulse" of the project, understand the true progress, and adjust schedules accordingly offers the enlightened project manager vital tools for success in today's marketplace. The Consortium teaches and supports the application of risk management concepts and conducts risk management workshops in many national corporations across the country. This effort centers on recognizing that risk exists in all projects, and IT management needs to plan for the mitigation of risk in a proactive manner. The ability to use processes and methodologies to maximize technical capabilities provides IT decision makers their best opportunities to leverage the impact of change on the organization.

Over the past 15 years, the Consortium has developed a set of technologies based on the needs of member companies such as AT&T, Lockheed Martin, and Xerox. These technologies include processes and process improvement techniques that allow these corporations to become more efficient in developing and managing software-intensive systems and reducing time-to-market for new products.

In the last 3 years, SITC has worked with over half of the states to bring the lessons of industry to the government arena. We have learned that the majority of the processes and techniques that we developed for private industry are adaptable to the state IT arena. Specifically, we have transferred Risk Management, Project Management, and Process Improvement processes and techniques to multiple states with success. We have also adapted our system migration process from the federal agency IT environment to the state IT environment.

As a rule, the SITC member states face similar problems in the development and procurement of software-intensive systems that the Consortium corporate membership has faced in the past.

Based upon extensive work within a wide range of small and major IT projects within states, the major problems observed have involved process rather than technology. The primary reasons for this can be summarized as involving a lack of the following: (1) wide-ranging IT management experience; (2) management experience in dealing with large complex IT systems; and (3) user/customer participation in the project processes. Process problems found include management of development, procurement, deployment, and user expectations.

As the software industry has developed in the past 30 to 40 years, the emphasis has evolved from dependence on the individual technical expert to emphasis on management and process. Most firms that are dependent on software development for their core business have learned significant lessons on how to

manage the development and deployment of large, complex software systems. The states, as a general rule, are very early on this learning curve and should profit from the lessons that industry has learned. Another challenge that state IT organizations confront is the absence of substantial experience and organizational maturity necessary to deal with corporations that have developed a mature software process and comparable technical and management skills.

We have also learned that the processes we developed to understand the core technical and related management needs of the Consortium corporate membership could be used to understand the problems and needs faced by state IT organizations.

Whether the change is welcomed or scorned, the successful software technology organization of the future will master the ability to align the technology of the organization with its business and policy needs. Achieving the ability to continually meet changing business needs means mastering the ability to migrate. One specific area where we have adapted a Consortium technology to the states' environment involves migration.

Migrating in Response to Change

In the IT world, migration is the movement of an application system to a new environment, motivated by a need to serve the business of the enterprise more effectively. Migration helps protect the current investment in critical data and functionality and establishes a path for growth. When carefully managed, migration provides an opportunity for the enterprise to better position itself for the future, not just to react to a crisis of obsolescence.

An enterprise can accomplish a migration in one or more steps. The size and number of steps depend on the amount of change the enterprise's business and automated systems must undergo and the need to "rest and recover" along the way. As in nature, this movement is never-ending. Migration is adaptive maintenance, sometimes chosen as a path of last resort when there is a large gap between what the business needs and what IT can deliver. This happens when maintenance actions to remove defects (corrective maintenance) or improve performance (perfective maintenance) are no longer effective in meeting business needs.

To facilitate the decisions that need to be made, the process of systems migration is based on a process framework. This framework is intended to allow the IT organization to achieve two objectives:

1. Reinvigorate and extend the useful life span of existing automated information systems (AIS). This allows the agency to retain the business value of existing IT investments and recast them into more flexible and adaptable structures.

2. Establish a basis upon which to address the larger, more compelling challenge: *co-evolution*. The new and existing IT applications and supporting infrastructure change in harmony with the rapidly changing business and technology environments, a constant mix of the old with the new.

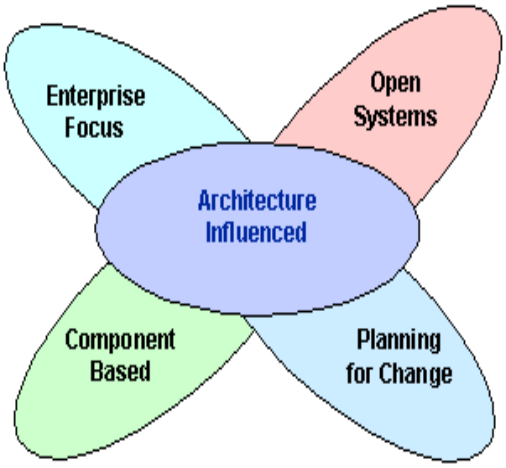
To address these objectives, the framework includes the following five principles:

1. Enterprise focus.
2. Open-system, standards-based development.
3. Component-based, distributed computing environment.
4. Planning for change.
5. Architecture-influenced decisions.

1. Enterprise Focus

Long-lived systems require that IT design and implementation decisions be made in a broad context, considering the entire enterprise. Consequences of decisions must be assessed against long-term goals, special interests, and currently available resources. Appropriate tradeoffs are made within this context. For flexibility in making these tradeoffs and minimization of imposed constraints, the scope should be as large as possible.

The enterprise figure depicts the notion of an enterprise and its boundaries. These boundaries are the limits of influence of the enterprise. This enterprise scope establishes the boundary where the enterprise has control over its technology and business decisions. This is reflected in the enterprise's business and IT delivery and support processes. The boundary helps to identify the immediate and wider environments of interest in which the enterprise participates. The boundary is used to identify the roles that participate directly or indirectly in the enterprise processes. Within the enterprise, alignment is necessary between the enterprise's overall business strategy and the IT strategy.



2. Open-System, Standards-Based Development

An open-system approach unifies technical and business strategy to establish a rational structure in which to make key AIS design and product purchasing decisions. The primary goal is to promote interoperability and integration of technology within and external to the IT organization. Portability may also be a significant design goal, particularly for portions of the applications that interact with the user. This may be driven by innovation in the types of user interface devices, such as information appliances and wireless or mobile computing.

Open-system concepts guide long-term evolution of technology in use by the IT organization. Nonproprietary, commercially supported specifications and standards with broad industry support are the basis of defining each organization's unique technology interfaces, formats, protocols, products, practices, and tools.

Standardization is not a set of absolute constraints. It represents guidelines that can be adapted by IT projects, under control of the IT organizations' architects, to

manage project IT life-cycle costs, deployment schedule, and performance tradeoffs. Standards are usually selected to implement a Technical Reference Model appropriate for the IT organization's business-technology environment.

3. Component-Based, Distributed Computing Environment

Monolithic applications, statically configured and linked, are giving way to highly distributed, loosely coupled applications based on technologies such as component object modules (COM), JAVA2 Platform Enterprise Edition (J2EE), and the Common Object Request Broker Architecture (CORBA). Applications and their constituent parts are considered reusable resources that, once introduced into the run-time environment, can be used in novel ways to compose additional applications.

AIS built with these techniques are capable of exhibiting the scalability and malleability needed to adapt in a rapidly changing world. Components may provide general services, be application-specific, or support specific vertical markets. They can be developed in-house, purchased, or leased as a Web service.

4. Planning for Change

A rapid rate of change in the business and technology environments is a compelling reason to consider not only satisfying current needs as quickly as possible but also anticipating future needs and changes. IT planning decisions must be influenced by an understanding of trends in the IT organization's business and technological environments. Uncertainty related to future business and technology factors will influence approaches used to select, adapt, develop, and

use technology. Technology decisions made today should not severely limit future choices.

Planning for change affects and interacts with the other principles. For example, the architects may establish interfaces to isolate and abstract some computer systems, allowing them to be replaced in the future with limited impact (e.g., wrappers). This software accompanies resources or other software for purposes of improving convenience, capability, or security. The scope of integration and interoperability can likewise be established to give the IT organization influence over decisions before they become levied as constraints, such as working with partner organizations on common network protocols or message formats.

5. Architecture-Influenced Decisions

The IT organization's strategic direction provides the basis for the technology vision. Decisions on the future use of existing IT resources provide the context. These decisions reflect the need to keep, discard, revamp, or reengineer the existing IT inventory, as well as to add new applications and capabilities. The technology vision and the decisions on the existing IT resources are used to identify the technology elements that the state IT organization must include in its inventory. The types of technology elements needed are organized according to the IT organization's Technical Reference Model.

Formal and ad hoc standards are selected by the IT organization's architects as the basis of designing individual technology elements. The standards are organized against the reference model. These standards are adapted to the needs of the organization, establishing a list of organization-specific standards, called the profile. The reference model and the profile are used as the basis of the IT organization's Technical Architecture.

The Technical Architecture establishes the organizationwide design blueprint, specifying the key platforms, services, internal and external interfaces, equipment, networking, data sources, and associated management and engineering practices. The Technical Architecture is the basis of technical guidelines that are imposed on each IT project. The Technical Architecture guides life cycle design and engineering practices to produce AIS and individual applications that conform to the architecture. Portions of the Technical Architecture can be at a summary level, or specific when needed, such as in the description of a specific API or coding convention.

Contractors, vendors, or internal organization IT development resources can be tasked to implement all or a portion of the organization's Technical Architecture. Existing legacy applications and data, new organization-unique applications, or vendor-preferred products can be chosen and adapted to realize the Technical Architecture. This integration of products results in the target architecture(s). The target architecture is the set of interoperating platforms upon which the applications will be delivered.

Solutions that address specific business application requirements are delivered by populating the target architecture with applications. Applications are composed from engineered or purchased packaged application solutions and/or application-specific components. As applications and their constituent parts are added to the target environment, they enrich the suite of services available and become a means to compose other applications.

The architecture approach allows for delaying implementation decisions until necessary and provides flexibility to choose products to fit within the structure. The architects control the organization's Technical Architecture; the AIS design

teams control the target architectures; and programmers control the composition of specific applications.

When advantageous, an organization may "standardize" on products, as in the case of proprietary standards or preferred applications (e.g., office productivity suites). The architecture framework allows for an enterprise to support this choice, to use the architecture relationships to determine the impact of the decision, and to assess the effect on the enterprise. The framework also allows for restricting functionality of products, as some features may circumvent organization-approved standards. Having an organizational Technical Architecture defined makes the rationale for selecting and using products visible for an analysis of risk, such as vendor "lock-in," to be made.

Conclusion

Throughout the Consortium's work with organizations diverse and complex in size and focus, the innate ability to respond to change and the mechanisms utilized to mitigate the impact of change are among the strongest lessons worthy of consideration by the successful technology support organization.

It is inevitable that change will come, usually at a most inconvenient time. Managing change, mitigating risks, and leveraging the process of migration often determine an organization's success in the business and government arenas of IT.

This paper discussed three areas related to lessons learned in responding to change: (1) the reality of the concept of change, (2) managing the response to change, and (3) migrating in response to change. The Consortium has learned that the technologies and methods that we have developed to support our leading industrial members in these areas are highly adaptable to state IT organizations.

We have also learned to listen to corporate members and the SITC state members and develop technologies, processes, and techniques that address their high-priority needs.