CENTER FOR INFORMATION SYSTEMS RESEARCH

Sloan School of Management

Massachusetts Institute of Technology

Cambridge Massachusetts

Creating a Strategic IT Architecture Competency: Learning in Stages

Jeanne W. Ross

April 2003

CISR WP No. 335

MIT Sloan School of Management Working Paper No. 4314-03

☑ **Research Article:** a completed research article drawing on one or more CISR research projects that presents management frameworks, findings and recommendations.

☐ **Research Summary:** a summary of a research project with preliminary findings.

☐ **Research Briefings:** a collection of short executive summaries of key findings from research projects.

☐ **Case Study:** an in-depth description of a firm's approach to an IT management issue (intended for MBA and executive education).

☐ **Technical Research Report:** a traditional academically rigorous research paper with detailed methodology, analysis, findings and references.

CISR MISSION

CISR was founded in 1974 and has a strong track record of practice based research on the management of information technology. As we enter the twenty-first century, CISR's mission is to perform practical empirical research on how firms generate business value from IT. CISR disseminates this research via electronic research briefings, working papers, research workshops and executive education. Recent and current research topics include:

2002 Projects

- The IT Portfolio – Benchmarks & Performance
- Assessing IT Governance Effectiveness
- Architecture-Driven Business Strategies
- Converting Customer Data into an Asset
- Strategies for Web Service

2003 Projects

- Business Models and IT Investments
- Governing IT for Different Performance Goals
- Assessing Architecture Outcomes
- Infrastructure as Variable Cost
- Managing IT Related Risks

CISR has recently embarked upon a new phase of industry-sponsored research, under the leadership of Peter Weill. Peter comes to CISR from Melbourne Business School and brings a strong practical research background in IT portfolio and IT infrastructure management.

CISR is co-located with MIT Sloan's e-Business@MIT initiative and the Center for Coordination Science to facilitate collaboration.

CISR is funded in part by Research Patrons and Sponsors.

CISR gratefully acknowledges the support and contributions of its current Research Patrons and Sponsors…

CISR RESEARCH PATRONS

Accenture
Gartner
Hewlett-Packard Company
IBM Corporation
Microsoft Corporation

CISR SPONSORS

Aetna Inc.
Campbell Soup Company
Celanese
Det Norske Veritas AS
EMC Corporation
Freddie Mac
The Gillette Company
The Guardian Life Insurance Co. of America
ING
Intel Corporation
International Finance Corp./World Bank
Marsh, Inc.
Merrill Lynch & Company
MetLife
Mitsubishi Corporation
Mohegan Sun
National Kidney Foundation (Singapore)
Nomura Research Institute, Ltd.
Ortho Biotech Products, L.P.
Pfizer Inc.
PFPC, Inc.
Qwest Communications
State Street Corporation
TRW, Inc.

CONTACT INFORMATION

Center for Information Systems Research
MIT Sloan School of Management
3 Cambridge Center, NE20-336
Cambridge, MA 02142
Telephone: 617/253-2348
Facsimile: 617/253-4424
http://web.mit.edu/cisr/www

Peter Weill, Director	pweill@mit.edu
David Fitzgerald, Asst. to the Dir.	dfitz@mit.edu
Jeanne Ross, Principal Res. Scientist	jross@mit.edu
George Westerman, Res. Scient.	georgew@mit.edu
Jack Rockart, Sr. Lecturer Emer.	jrockart@mit.edu
Chuck Gibson, Sr. Lecturer	cgibson@mit.edu
Chris Foglia, Center Manager	cfoglia@mit.edu
Julie Coiro, Admin. Assistant	julieh@mit.edu

CISR Working Paper No. 335

Title: **Creating a Strategic IT Architecture Competency: Learning in Stages**

Author: **Jeanne W. Ross**

Date: **April 2003**

Abstract: IT architecture is often assumed to follow business strategy, to align IT with the business's strategic objectives. Increasingly, though, many business strategies depend on specific underlying IT capabilities. To develop a synergy between business strategy and IT architecture, firms must develop organizational competencies in IT architecture. My research has identified four IT architectural stages, each with its own requisite competencies. The "application silo architecture stage" consists of IT architectures of individual applications. The "standardized technology architecture stage" has an enterprise-wide IT architecture that provides efficiencies through technology standardization. The "rationalized data architecture stage" extends the enterprise-wide IT standards to data and processes. And the "modular architecture stage" builds onto enterprise-wide global standards with loosely coupled IT components to preserve the global standards while enabling local differences. Each stage demands different organizational competencies to implement the architecture and prepare the firm to move to the next stage.

18 Pages

Creating a Strategic IT Architecture Competency: Learning in Stages

Jeanne W. Ross, Principal Research Scientist
Center for Information Systems Research
MIT Sloan School of Management

At United Parcel Services (UPS), strategic planning involves discussions about the opportunities the firm's IT capabilities present. For example, as the Internet started gaining steam in the mid-1990s, IT executives noted that UPS' package tracking capability was easily transferred to the Web. Later, management observed that package tracking data made new products—like guaranteed delivery—affordable. Package tracking data also led to the creation of new customer services, such as allowing a customer's customers (package recipients) to view an online summary of expected delivery times from selected suppliers. These IT-enabled business opportunities have been unanticipated sources of value for UPS. CEO Mike Eskew calls them "happy surprises."

My research suggests that few firms experience such "happy surprises." UPS creates business opportunities by leveraging its centralized package data, low-cost processing environment, and integrated core applications. But most firms' IT capabilities limit rather than create new business opportunities. Their limitations come from their history of applying IT as a response to specific business needs. The business needs are isolated and their solutions rarely combine to create a strategic capability.[1] Consequently, when buffeted by changing market conditions, most firms see their IT architectures as competitive liabilities.

But that is not always the case. My colleagues and I have written 40 case studies[2] of firms that are evolving their IT architectures from sets of isolated solutions to planned capabilities that support their strategic business processes. This evolution has followed a learning process. The firms have not derived value simply by linking IT to their business processes. Rather, they have learned how to benefit from IT by developing a competency in creating and evolving an enterprise IT architecture.

What is an IT Architecture?

The term *IT architecture* lacks a universally accepted definition. In fact, the terms *architecture* and *infrastructure* are sometimes used interchangeably, with *architecture* seen as the plan for the next

[1] Broadbent, M. and Weill, P. "Management by Maxim: How Business & IT Managers Can Create IT Infrastructure," *Sloan Management Review*, Spring 1997, pp.77–91, describes how IT infrastructures result from either maxims, which focus individual IT investment decisions on the firm's strategic intent, or deals, which build IT infrastructure through a series of isolated decisions.

[2] See Author's Acknowledgement at the beginning of this paper for a description of the data collection and analysis approach.

Author's Acknowledgement:
The conceptual framework for this paper resulted from a project with Peter Weill in 2001 that examined IT architecture through case studies at eight global firms. I refined the framework based on several other research studies, including a project in 2002 with David Robertson, George Westerman, and Nils Fonstad, which involved 16 case studies on the relationship between IT architecture and business strategy. A 2002 project with Cynthia Beath and John Mooney explored three new cases on Web services implementations. Between 1998 and 2003 I wrote 13 additional case studies that assessed IT architecture in the context of e-business implementations, ERP implementations, mergers, service level agreements, and IT governance. I am indebted to all the research colleagues who participated in this research and shared their insights. I am also indebted to Cynthia Beath, Jack Rockart, John Mooney, Leslie Willcocks, and Bob Zmud for timely, insightful comments. I am grateful to the managers who participated in this research and shared their experiences and insights. This research was made possible by the support of CISR sponsors and especially CISR patron Microsoft Corporation. This paper will be published in MISQ Executive, Volume 2, Number 1, March 2003.

infrastructure.[3] More often, IT architecture refers to a firm's list of technology standards. But viewing IT architecture only as technology standards does not connect it to business requirements.

The *enterprise IT architecture* concept, though, does place technology standards in the context of business requirements. Consultants and researchers often refer to an enterprise IT architecture as a kind of city plan that details policies and standards for the design of infrastructure technologies, databases and applications.[4] The city plan concept has given birth to a breed of IT architects who develop detailed drawings of the interconnections between processes, infrastructure, data and applications.[5] However, these detailed drawings often provide only the technologist's perspective of the relationship between IT and business processes. The resulting architecture does, indeed, identify the mass of complex linkages among technology components, but it does not highlight the few IT capabilities critical to enabling the firm's strategic objectives.[6] Accordingly, the city plan metaphor has failed to capture the strategic potential of enterprise IT architecture.

In some firms the enterprise IT architecture acts as a tool for aligning IT and business strategy.[7] This alignment focuses on the IT components that enable critical business processes. Thus, at the enterprise level, an IT architecture is *the organizing logic for applications, data and infrastructure technologies, as captured in a set of policies and technical choices, intended to enable the firm's business strategy.* Accordingly, the enterprise architecture implies certain IT capabilities. These capabilities *are the objectives of the IT architecture, specifying what the architecture enables the business to do*. IT capabilities would include, for example, being able to access specific data for new applications, quickly add channels to existing processes, integrate data from related processes, ensure secure processing for electronic transactions, provide an extended online customer service or replicate systems in new locations. Rather than develop an exhaustive list of possible IT capabilities, a well-designed enterprise IT architecture highlights the IT capabilities that are most critical to a firm's strategic objectives.

What is an IT Architecture Competency?

A competency in enterprise IT architecture is the ability of a firm to create a mutually reinforcing pattern of evolving, tightly aligned business strategy and IT capabilities. The logical sequence for developing an enterprise IT architecture is assumed to be as follows:

1) Define the firm's strategic objectives.

2) Define key IT capabilities for enabling those objectives.

3) Define the policies and technical choices for developing the IT capabilities.

Completing this sequence is challenging, at each step. A major difficulty in the first step is obtaining the firm's strategic objectives. One firm's chief architect described a common scenario among firms trying to align business strategy and enterprise IT architecture:

---

[3] Weill, P. and Vitale, M. "What IT Infrastructure Capabilities are Needed to Implement E-Business Models," *MISQ Executive* (1:1), March 2002, pp. 17–34, define IT infrastructure as *the base foundation of budgeted-for IT capabilities (both technical and human) shared throughout the firm as reliable services, and centrally located.*

[4] Keen, P.G.W., and Cummins, J.J. *Networks in Action,* Wadsworth, Belmont, California, 1994, p. 279.

[5] Most proposed frameworks link technology to business process (see, for example, Zachman, J.A. "A Framework for Information Systems Architecture," *IBM Systems Journal* (26, 3), 1987, reprint G321-5298, and Sowa, J.F., and Zachman, J.A. "Extending and Formalizing the Framework for Information Systems Architecture." *IBM Systems Journal* (31, 3), 1992, reprint G321-5488). However, these frameworks do not help distinguish the relative importance of processes. The output of the architecture process is often volumes of detailed drawings that are overwhelming in their volume and scope. This output may be the cause or a result of the architecture function often being buried in lower levels of the IT organization.

[6] See Goodhue, D.L., Kirsch, L.J., Quillard, J.A., and Wybo, M.D. "Strategic Data Planning: Lessons from the Field," *MIS Quarterly* (16:1), March 1992, pp. 11–34, for a discussion of how detailed planning of data architecture can overwhelm planner with volume and cause them to lose focus. The result is little value from architecture activities.

[7] For additional discussion of how IT architecture aligns IT with business strategy, see Sauer, C. and Willcocks, L.P. "The Evolution of the Organizational Architect," *Sloan Management Review*, Spring 2002, pp. 41–49.

> *So we started working on understanding the business strategy, and what we discovered in that process was that they really didn't have a business strategy. What they had were a lot of promises. "We are going to grow. We are going to use branding. We are going to run our plants more effectively. We are going to increase our volume." But they hadn't figured out exactly how they were going to do it… And what I said was, "It is very difficult for me to write an IT strategy to support your business strategy when you don't have that defined."*

The second step, defining a set of critical IT capabilities with lasting value, is equally challenging. Once strategic objectives have been defined, they generally demand multiple IT capabilities, which are likely to be interdependent, possibly contradictory and perhaps unachievable given the firm's legacy.

For example, in 1991, John Reid articulated the vision for Citibank to include continuous innovation, agility in meeting customer needs and attention to cost.[8] Citibank Asia Pacific pursued this strategy by developing four IT capabilities: a low-cost, high-volume processing environment, global look-and-feel to Citibank access points, global accessibility to customer systems and electronic access to all customer systems. But some capabilities were not immediately achievable. For example, Citibank relied on a mainframe to build its low-cost processing environment. But, at that time, no mainframe software offered global accessibility to customer systems. Although the bank ultimately achieved its targeted capabilities, it could not achieve them all in the short term.

The third step highlights yet another difficulty in building IT capabilities. The policies and technical choices for developing IT capabilities must reflect organizational realities and thus inevitably require tradeoffs. Security policies provide a common example of the tradeoffs firms face, as one IT architect describes:

> *The security function is working very, very hard at locking down the corporation so that we can't be penetrated and put out-of-business by hackers, viruses, and the like. But if we really do that job to the extreme, we can cripple our ability to compete on the Web.*

Thus, the process of developing an enterprise IT architecture is not as orderly as assumed. More importantly, defining and developing IT capabilities to support business strategy is merely a starting point. The objective is to get to the point where IT capabilities shape business strategy while business strategy shapes IT capabilities in response to changing market conditions and organizational realities. To do this the firm must develop an IT architecture competency to dynamically adjust strategies and technologies.

Our case studies illustrate that firms hone their ability to define and align IT and business strategy by accumulating architecture-related experiences. When used to enrich organizational learning, these experiences can create enterprise IT architecture competencies. Johnson & Johnson offers one example of this cumulative learning process.

An Example of Developing Enterprise IT Architecture Competencies: Johnson & Johnson

In 1995 Johnson & Johnson, a respected pharmaceutical, health care and medical devices firm, had over 150 operating companies generating total revenues of approximately $15 billion. Analysts both inside and outside the firm attributed J&J's success in large part to its autonomous management structure, which held managers accountable for the financial results of their individual operating

[8] Details are available in Brand, A., Weill, P., Soh, C. and Periasamy, P. "Citibank-Asia Pacific: Positioning IT as a Strategic Resource," Melbourne Business School, 1999.

companies.[9] Despite its virtues, this decentralized approach frequently left customers frustrated. Many of them had to deal with multiple sales calls, multiple invoices and multiple contracts with J&J operating companies. They wanted a single point of contact.

Management vowed to respond by presenting a single face to its key customers. However, its IT capabilities had developed around the decentralized business model. IT supported the individual needs of the operating companies, not the demands of global customers. To meet these new customer demands, senior management not only needed to implement technology that would provide a single view of the customer but they also needed to reorient everyone in the firm to think about IT—and organizational—capabilities at the corporate level as well as the operating company level. The technology and organizational change efforts proceeded in parallel.

One of the first IT initiatives to align the strategic reorientation and a more integrative IT environment was a series of training sessions for small groups of IT managers from the various J&J operating companies. These training sessions, which took place over 18 months, explained the role of IT in enabling the corporate vision and proposed corporate-wide IT standards. Early participants thought the idea of corporate standards was radical and dysfunctional. Participants in the later sessions, though, arrived for the training already aware that managers were trying to operate differently. They had *learned* the value of corporate standards and were looking for ways to facilitate integrated communications across the operating companies.

An early corporate initiative involved installing a single global network and desktop configuration. J&J had traditionally funded IT initiatives within the operating companies. Senior management recognized that this funding model would delay implementation of the corporate infrastructure, so J&J provided some corporate funding (with eventual chargeback) to stimulate the standardization. Through this early infrastructure initiative, management started to *learn* how to assess and fund corporate-wide IT investments.

Over the years, J&J has continued to evolve its enterprise IT architecture, reflecting organizational learning about viable strategies and emerging IT capabilities. J&J did not dismantle its operating company structure. Its strategic objectives continue to foster strong operating companies, while leveraging cross-company synergies where appropriate. Thus, IT capabilities—and accompanying policies and technical choices—must reconcile sometimes competing IT needs. J&J has also implemented a shared services organization to introduce the efficiencies of a standardized IT environment. It has created committees to establish and monitor technical standards. New organizational units, such as *sectors*, create formal structures that link operating companies that have shared customers and markets. Some sectors are introducing common systems to standardize critical data across their operating companies. Through these efforts, J&J has evolved its business strategy, its IT infrastructure and its technology management practices toward a more strategic enterprise IT architecture competency.

J&J's journey is not unique. Despite differences in industry, culture, IT requirements and organizational structure, firms attempting to design, implement and leverage enterprise IT architectures share common experiences. I have identified four distinct stages that capture evolving architectural designs and their changing strategic implications and managerial demands. These stages help us understand why firms cannot simply "declare" that they will use IT strategically. They must continuously build their competency to do so.

[9] See Tanouye, E. "Johnson & Johnson Stays Fit by Shuffling Its Mix of Businesses," *Wall Street Journal*, December 22, 1992, p. A1; also Weber, J. "A Big Company That Works," *Business Week*, May 4, 1992, pp. 124–132; and also Ross, J. "Johnson & Johnson: Building an Infrastructure for Global Operations," CISR Working Paper 283, 1995.

Four IT Architecture Stages

Firms' common experiences in evolving their IT architectures suggest four distinct stages of increasing enterprise IT architecture competency. These stages differ in the logical design of their applications, data and infrastructure; the IT capabilities they provide; the strategic opportunities they present and the IT management and governance processes they demand. The four stages are:

1) An ***application silo architecture—***The architecture consists of architectures of individual applications rather than an architecture for the entire enterprise;

2) A ***standardized technology architecture***—The IT architecture becomes enterprise-wide and provides efficiencies through technology standardization and, in most cases, centralization;

3) A ***rationalized data architecture***—The enterprise-wide IT architecture expands to include standardization of data and processes;

4) A ***modular architecture***—The architecture builds onto enterprise-wide global standards with loosely coupled applications, data and technology components to preserve the global standards while enabling local differences.

The evidence from my research suggests that firms can generate significant business value at each stage when they capitalize on the architecture's benefits. Organizational learning at each stage helps them understand how to realize those benefits and how to position themselves for the next architectural stage. Firms that attempt to skip stages consistently find that either the benefits are severely delayed or they must backpedal to acquire the missing organizational competencies. Following are the characteristics of each stage and their benefits and risks.[10]

The Application Silo Architecture Stage

Firms in the application silo architecture stage focus their IT resources on delivering individual applications. Typically, IT develops or buys an application to address a specified business need and hosts each application on the best available technology platform. This approach lets them develop superior applications for IT-enabled processes. But, in most cases, these processes are limited to a single function or geography.

In this stage, firms thus allocate their IT resources primarily to application development. They might have a centralized data center for transaction processing, but they have few shared infrastructure services. And they rarely manage data apart from transactions. Each new system defines its own data. Firms in the application silo stage rarely think of an enterprise architecture. Business users focus on the value of their applications—occasionally complaining about high operations costs. For the most part, the IT unit is responsible for systems implementations, although business users are usually expected to generate the benefits.

Benefits and Risks of the Application Silo Architecture Stage. The strategic goal of the application silo stage is local optimization. Organizationally, applications align naturally with the firm's functional or geographic structures. The architecture encourages innovation, because it imposes no constraints on development. Developers can satisfy end users by pursuing full functionality without regard to other applications or organizational units. Consequently, functional, plant and geographic managers often respond positively to applications developed in their silos. Application silos can

[10] Based on the characteristics described here, I assigned each of our 40 case sites to an architecture stage. My classification put 8 firms in the application silo stage, 22 in the standardized technology stage, and 10 in data rationalization. These results might be slightly skewed to the right relative to the general population. Discussions with consultants in early 2003 suggest that 80–90% of firms are in either the application silo or standardized technology stages. I did not attempt to secure a representative sample in my selection of firms because my goal was to learn the practices of leading-edge firms.

compete for capital funding using simple cost-benefit analyses. System benefits are predictable (albeit frequently overstated), and outcomes are measurable.

Despite its benefits, the application silo architecture is largely outdated. Over time, the applications form the firm's legacy, which consists of independent applications on multiple technology platforms with embedded data. The developers' freedom to innovate becomes offset by the difficulty of linking new applications to related systems. The applications become as much a burden as a blessing. A plant manager at Dow Corning, a $2 billion manufacturer of silicon products, described the limitations of his firm's legacy applications prior to implementing an ERP system:

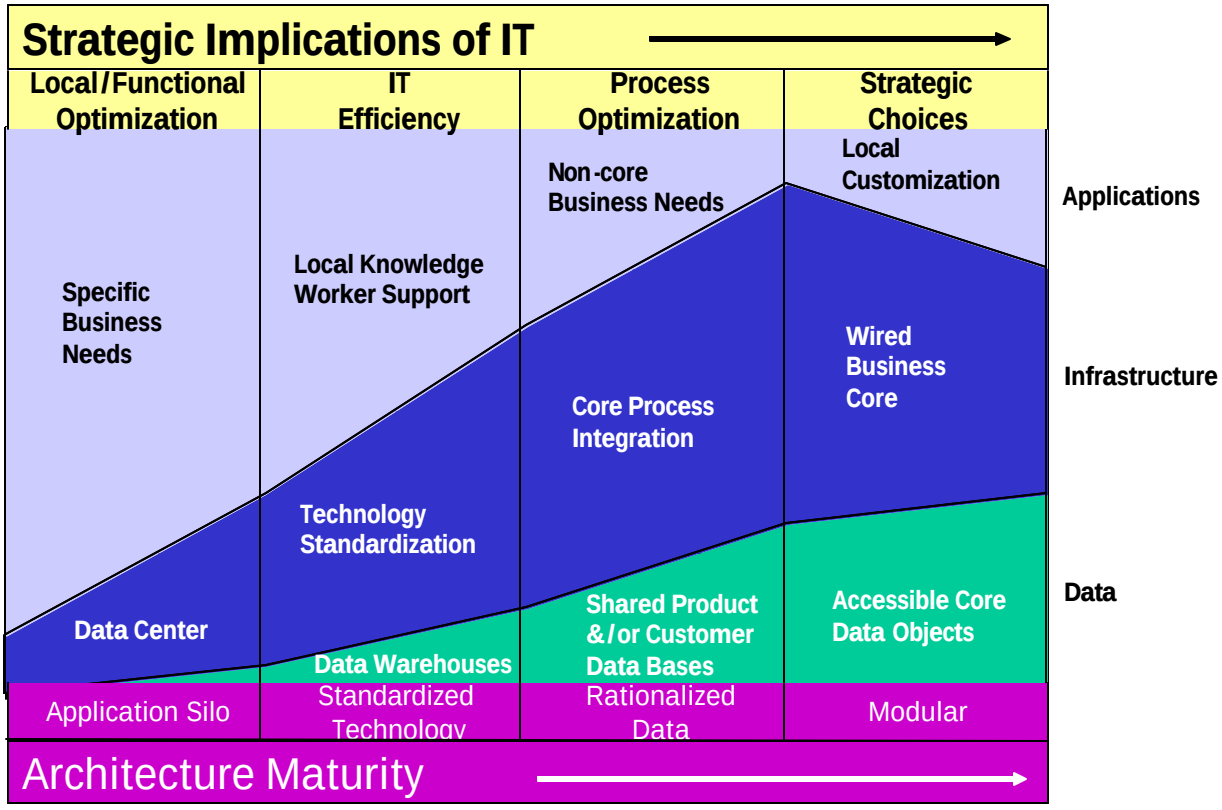
> *When I went to the Midland Plant in 1992,…[the legacy] was becoming an enormously ugly patchwork quilt. The systems wouldn't talk to each other. Nice functionality, but they wouldn't talk to each other.*

By allowing variety in technology platforms, application silos are expensive and difficult to maintain. More importantly, multiple data definitions make development of electronic linkages between related applications cumbersome. Many IT professionals are quite adept at making disparate systems look integrated, but the code required to link applications becomes increasingly complex and ultimately extends a new system's time to market. A systems manager at an investment bank commented on the complexity of the code required to link applications: *"Everything we do revolves around straight-through processing with no manual intervention, but it's a miracle our systems work."*

The Standardized Technology Architecture Stage

The standardized technology architecture stage is the most common among the forty firms in my sample. These firms have shifted resources from application development (in their application silo stage) into a shared infrastructure. (See Figure 1 for a graphic of how IT resources are allocated during each stage.) They have established technology standards to limit technology choice and reduce the number of platforms they manage. This standardization also significantly reduces the number of vendor packages that perform similar functions. For example, one firm reduced the number of order management systems from 28 to four. Technology standardization, however, does not overcome the application silo problem of application-specific data. Firms in this stage do introduce data warehouses to share access to data, but the transaction data is still embedded in the individual applications.

Figure 1: Changing Resource Allocations Across Architecture Stages



Most IT organizations in this standardized technology stage do conceptualize an enterprise architecture for the shared infrastructure. Even those that do not often hire an IT architect to lead the standardization effort. Business managers rarely participate in developing the enterprise architecture. They defer to the IT organization to set the technology policies and standards. However, senior business managers are anxious for IT cost savings, so they support the CIO's efforts to standardize and centralize infrastructure technologies by mandating compliance with the technology standards.

Benefits and Risks of the Standardized Technology Architecture Stage. The goal of the standardized technology architecture stage is IT efficiency. Firms often move to this stage because senior management believes the IT costs have gotten out of line. Standardizing and consolidating technology platforms can lead to significant cost savings. Several IT managers reported up to 20 percent reductions in their IT operations costs. Furthermore, by reducing complexity, technology standardization also increases IT maintainability, reliability and security.

One IT architect noted that the standardized technology architecture has given him the right to say "no," when a vendor product is off-standard. In the past, every application request resulted in lengthy debates and fact-finding efforts between IT architects, vendors and users. The authority to eliminate off-standard technologies greatly simplifies the lives of architects and developers.

A key risk of the standardized technology stage, though, is managerial resistance to both the concept of standards and, in some cases, the dictatorial approach used to implement standards. In the silo stage, business people would never allow IT's concerns to constrain their business solutions. The migration to a standardized technology architecture fundamentally changes firms' approaches

to solutions delivery. Instead of defining the solution and looking for the best technology, firms in this stage negotiate the best possible solution among the acceptable technology platforms. At first, business unit managers and developers cling to the belief that business needs should drive technology choices. For many, their initial encounter with technology standards is the first time management allows IT, in any way, to shape business decisions.

As the benefits become apparent, though, most managers became resigned to the standards. One CIO noted that in leading the charge to standardization, he won over business unit leaders by demonstrating cost savings:

> *We've had successes where we've been able to reduce people's costs by bringing in standardization. That has given us credibility. Their jaws hit the table when they see the impact of standardization on their bottom line.*

Although some firms justify technology standards based on economic arguments, most firms rely on a senior management mandate that empowers the CIO to establish and enforce technology standards. This managerial approach sometimes comes as a culture shock, as one CIO described:

> *I come in and I pull every IT resource out of every closet and every back room. Then I centralize it. I tell them ahead of time this is going to hurt, but it will only be temporary. I have got to bring it all into a central location, look at it, and figure out what is there, what do they do and why are they doing it. That takes about a year and a half.*

The standardized technology stage also introduces risks in managing the new standardized environment. For example, firms need a process for recognizing when a business need justifies an exception to a standard. In addition, IT managers need to monitor and periodically upgrade standards to avoid obsolescence. They have to clarify the costs and benefits of these upgrades because business unit managers do not want to pay to replace something that already works.

Firms in the standardized technology stage also face new challenges in investment decisions. Funding for a shared infrastructure demands that management consider investments with longer payback periods than other classes of applications.[11] Infrastructure development costs lead to frequent debates over funding algorithms. Business units have different needs for shared infrastructure at different points in time. Most firms want to link funding to value received, but relative value provided by a shared infrastructure is difficult to assess.

Managers in firms with standardized technology architectures have found that, after a few years,[12] early battles and mistakes are forgotten. People no longer question the commitment to standards or the sharing of infrastructure. This evolution positions firms for the data rationalization stage, where standardization practices expand to incorporate data and sometimes even business processes.

The Rationalized Data Architecture Stage

Firms that have learned how to manage a standardized set of infrastructure services are positioned to apply similar discipline to their core data and processes. Data rationalization refers to distinguishing the subset of the firm's data that must be unfailingly timely and accurate for the firm to consistently meet customer demands. Standardizing and integrating that critical data subset stabilizes the firm's core activities and increases predictability of outcomes.

[11] Weill, P. and Broadbent, M. *Leveraging the New Infrastructure*, Harvard Business School Press, Boston Massachusetts, 1998, lists four classes of IT investment with differing payback periods. Infrastructure investments had a slower payback than the three application classes. See also Ross, J. and Beath, C.M. "Beyond the Business Case: New Approaches to IT Investment," *Sloan Management Review* (43:2), Winter 2002, pp. 51–59 for a discussion of the different approaches to applications and infrastructure investment decisions.

[12] Managers' estimates varied from two to six years for the elapsed time between starting technology standardization and fully absorbing the change culturally and technically in their firm.

In the data rationalization stage, resources are shifted away from application development and into data management and infrastructure development. Data management resources are used to develop centralized data stores for the data that powers core activities. As a rule, data embedded in application silos must be extracted and made easily accessible to all activities that depend on it. Numerous tools support data rationalization, including middleware, ERP, CRM, and internally developed customer information files or product files, such as UPS' package level data file. These tools also make data available to the applications that need it.

Infrastructure activities in the rationalized data stage involve integrating the activities of the firm's core processes. To retain data integrity while integrating core process activities, most firms introduce some process standardization[13] because when carried out effectively, process standardization ensures the quality of the central data stores. As long as the data is reliable, core process activities become predictable—a given input always generates the same output. The business rules for core processes are thus in effect "wired" into the firm's infrastructure. They ensure consistency in customer response and become the basis for future innovation.

Appropriately defining the firm's core processes is thus critical to creating an effective, rationalized data architecture. Correctly "wiring the core" requires a dialog between IT and senior business managers to ensure that the core processes are indeed central to the organization and that the business rules are stated definitively. At a high level, managers can come to consensus on core processes fairly easily.

For example, at both Air Products and Nestle USA, management decided to wire the supply chain using ERP. Both firms defined their business rules and built those rules into the ERP package. The vendor set up the package so that data flowed automatically to related processes. Citibank Asia Pacific established a core set of standard personal and commercial banking processes that could be replicated as new banks were acquired or opened.

In defining a core process, management must determine which activities are included and which are not. Management must also be explicit about the data these activities rely on, and how they share that data. For example, at Delta Air Lines, management determined that the firm's two core processes were customer experience (reservations, gate check-in, seat assignment, baggage claim, boarding, rewards miles, etc.) and airline operations (allocating resources, loading, flight departure, flight arrival, unloading aircraft and cleaning aircraft). These two processes relied on nine databases: customer, maintenance, location, schedule, equipment, employee, aircraft, supplies and ticket. Delta created a layer of middleware that provided a publish-and-subscribe environment, so that when a piece of data changed, a message about that change was sent to all applications that "subscribed" to knowing the change. The result was single sources of data for many systems, which meant that all systems were simultaneously updated.

Two factors limit which processes and data belong in the core. First, the business rules for a core process must be rigid. If the firm envisions regular exceptions, then the process is better suited for customization than standardization. Second, someone must be accountable for the data. The predictability of core processes depends entirely on the quality of the data, so accountability for data must rest with persons who are in a position to ensure disciplined processes and data monitoring—i.e. business, not IT, people. One IT leader described how data ownership shifted with the implementation of ERP:

[13] Firms can standardize processes by implementing a single instance of an application or by implementing multiple instances of the same application. Similarly, while some manufacturing firms may install an ERP package to standardize the entire order-to-cash process, other firms may rely on one module of a customer relationship management system to limit process standardization to a small set of functions in their call center. Differing needs determine the extent of standardization. See Davenport, T.H. *Process Innovation: Reengineering Work through Information Technology*, Harvard Business School Press, Boston, MA, 1993.

> *Historically within the company, we in IT owned the data. Not only were we custodians of it, we were the ones who got beat up whenever it got corrupted. In today's business process environment, the business owners and the process owners are learning that they really own the data. We in IT can assist them, we can make it available and we can set some standards, but they own the data. There has been little argument on this. Once we organized around business processes, they started to realize and recognize the value of data and the importance that data plays in this company.*

Firms that moved into this third stage put a stake in the ground with regard to defining the business. Once wired, changing the business core has become harder—nearly impossible—while building on that essence to create new products and services has become easier and faster. Schneider National, a large trucking firm, wired its operations from dispatch to delivery. In doing so, the firm can readily add new services, such as satellite tracking and advance customer notification. But this wiring did not position Schneider to enter the logistics business. Fully aware of what its architecture did and did not support, Schneider designed a parallel IT architecture when it added a logistics business.

Benefits and Risks of the Rationalized Data Architecture Stage. The rationalized data stage provides significant business process efficiencies, but the primary objective of a rationalized data architecture is process optimization. In particular, implementing a rationalized data architecture involves embedding core processes in the firm's IT infrastructure. They become part of the definition of the firm. In exchange for taking the risk of "permanently" wiring core process, firms gain a platform positioned for innovation.

Extracting data from a firm's legacy applications is a nontrivial technical challenge, and thus a risk. More overwhelming still are the management challenges of adopting data and process standardization. First, management must clearly explain the concept of "core" as well as the data driving that core. Firms that "get it right" can then move faster than their competitors. Dell's business model offers an example of a firm that wired its core process to how it planned to do business. Many fallen dot-coms did not.

A second risk is an implementation risk. A rationalized data architecture requires disciplined processes and a strong central organization. In many cases, the data architecture dictates a fundamentally different way of working. At many firms, standardizing core business processes has involved ripping away control of business processes from local business unit leaders. Business process standardization is thus much harder to sell to local managers than technology standardization. One CIO described the discomfort of installing ERP and accompanying process standards:

> *It became very clear that what it was going to take to do this [implement ERP] was basically senior executives telling the businesses they were going to do this. That was a huge culture change. We're taking the keys to the car away from you so we can go build this new car.*

This CIO said process standardization was "the most top-down thing we've ever done in this organization."

Another implementation risk is the risk of taking on more change than the organization can absorb. For example, one manager whose firm attempted to jump from an application silo to a rationalized data architecture through an 18-month ERP implementation said his firm found the organizational change requirements overwhelming. "We have exceeded our capacity for change," he explained.

Firms that move too aggressively to change technology and organizational habits greatly increase their risk of failure.[14]

To implement change of this magnitude, senior management must establish priorities for transforming the IT architecture. Successful efforts usually involve leveraging existing capabilities while building the most critical new capabilities. Successful firms focus on a small set of priorities. As one senior executive described her firm's transformation:

> *We [senior management] as a team were committed to the vision and committed to each other to do three or four things very, very well and not try to do 400 things.*

This focus on a small set of priorities is critical because IT architectural changes demand significant managerial resources. Senior management commitment to the change effort is important to avoid confusion and resistance. Regardless of the level of commitment, though, change management is always a difficult task.[15]

Senior and IT business managers in firms in the rationalized data stage have learned how to articulate strategy to define IT capabilities and how to identify strategic opportunities the IT capabilities create. The architecture allows the firm to protect its core processes while identifying opportunities to leverage those processes. Leveraging a rationalized data architecture eventually involves moving to a more modular architecture.

The Modular Architecture Stage

The rationalized data architecture enables process optimization through judiciously applied data and process standardization. The modular architecture, on the other hand, enables strategic agility through customized or reusable modules. These modules extend the core processes, which have been wired into the infrastructure during the rationalized data stage. Citibank Asia Pacific is nearing the modular stage. Its rationalized data architecture allows it to quickly implement its core products (e.g. checking accounts, personal loans and credit cards) in banks that it opens in new countries. Over time, Citi will be able to provide alternative channels and interfaces to its back-end processes through reusable or locally developed front-end modules.[16]

Although no firms in this study have migrated to the modular stage, those with rationalized data architectures provide insights into the promise they see in modularity. Top management has seized control of data and core processes from local managers, and has defined and standardized the core of the business. With a wired core, IT management can provide agility in two ways.

The first is to create reusable modules and allow business units to select customer-oriented processes from a menu of options. Web services, for example, offer modules as reusable business services.[17] Firms will be able to select Web services modules from internal and external sources.

The second way to provide agility is to give business units greater discretion in their local processes, as long as they can connect to the wired core processes. One financial services institution is

[14] Cohen, W. and Levinthal, D. "Absorptive Capacity: A New Perspective on Learning and Innovation," *Administrative Science Quarterly* (35:1), 1990, pp.128–152, describes the concept of organizational capacity for change. The authors note that an "organization needs prior related knowledge to assimilate new knowledge." (p. 129)

[15] Brown, C.V. and Vessey, I. "Managing the Next Wave of Enterprise Systems: Leveraging Lessons from ERP Projects," *MISQ Executive* (2:1), 2003, describes the change effort involved in ERP implementation. ERP implementation is a good example of the change required in any implementation of a rationalized data architecture. See also Robey, D., Ross, J.W. and Boudreau, M-C. "Learning to Implement Enterprise Systems: An Exploratory Study of the Dialectics of Change," *Journal of Management Information Systems* (19:1), Summer 2002, pp. 17–45, for a description of the learning challenges associated with ERP.

[16] See the full case write-up: Brand, A. Weill, P., Soh, C. and Perisamy, P. "Citibank-Asia Pacific: Positioning IT as a Strategic Resource," Melbourne Business School, 1999.

[17] For a description of the potential of web services, see Hagel, J. and Brown, J.S. "Your Next IT Strategy," *Harvard Business Review*, October 2001, pp. 105–113.

experimenting with this model. To ensure reliable, low-cost processes, management specified systems to support some back office processing. However, management is encouraging local development of new process support systems, anticipating that some new modules may eventually be offered firm-wide. Teaming a standardized core with localized development can provide rapid innovation, and perhaps lead to reuse of locally-developed modules.

Modules allow for local customization, but they do not reduce the need for standardization. The enterprise architecture for a modular architecture would require an ongoing dialog between senior management and IT executives to clarify which processes have one standard and are required, which processes have multiple standard versions to provide local choice and which processes may be developed in the business units for maximum local flexibility. To continue to provide all the benefits of standardization in the rationalized data stage—efficiency, single face to the customer and process integration—modularity architectures extend, rather than replace, rationalized data architectures. Because few firms have adopted rationalized data architectures and because these data architectures are difficult to master, only a few modular architectures may be built in the next few years.

Benefits and Risks of the Modular Architecture Stage. Modular architectures create the opportunity for strategic agility. By ensuring the predictability of core processes, they leverage the firm's distinctiveness. By enabling local customization, they encourage innovation and customer responsiveness. But to benefit from modular architectures, firms need to learn how to quickly identify the strategic opportunities that best leverage their core, and then quickly develop or reuse modules that extend that core. Reusable modules will build a thicker, denser core, providing greater efficiencies while allowing local customization. Custom modules will allow experiments to respond to changing market conditions. In the modular stage, firms will almost certainly reuse their expertise in process, data and technology standardization.

The greatest risk in the modular stage is that firms will rush to introduce modules before they have completely rationalized their core data. Modules can restore the autonomy and innovativeness of the application silo stage. But without a solid process base, modules run the risk of also restoring the anarchy of hundreds of unmanaged applications.

How Organizational Competencies Change Across the Architecture Stages

Figure 2 provides a summary of the characteristics and types of learning in each architecture stage. Each stage defines a dramatically different relationship between IT and business executives, and between IT architecture and business strategy.

The *application silo architecture stage* allows an arms-length relationship between IT architecture and business strategy. Business people can define strategy without IT input, and IT can deliver solutions without understanding the business strategy. A firm can generate value in the application silo stage and position itself for subsequent stages by starting a dialog on IT value between IT and business managers. Specifically, IT and business managers can jointly estimate, measure and communicate the value of IT-enabled business processes. To institutionalize this learning, management formalizes the use of business cases and post-implementation reviews.

Figure 2: Characteristics of the Architecture Stages

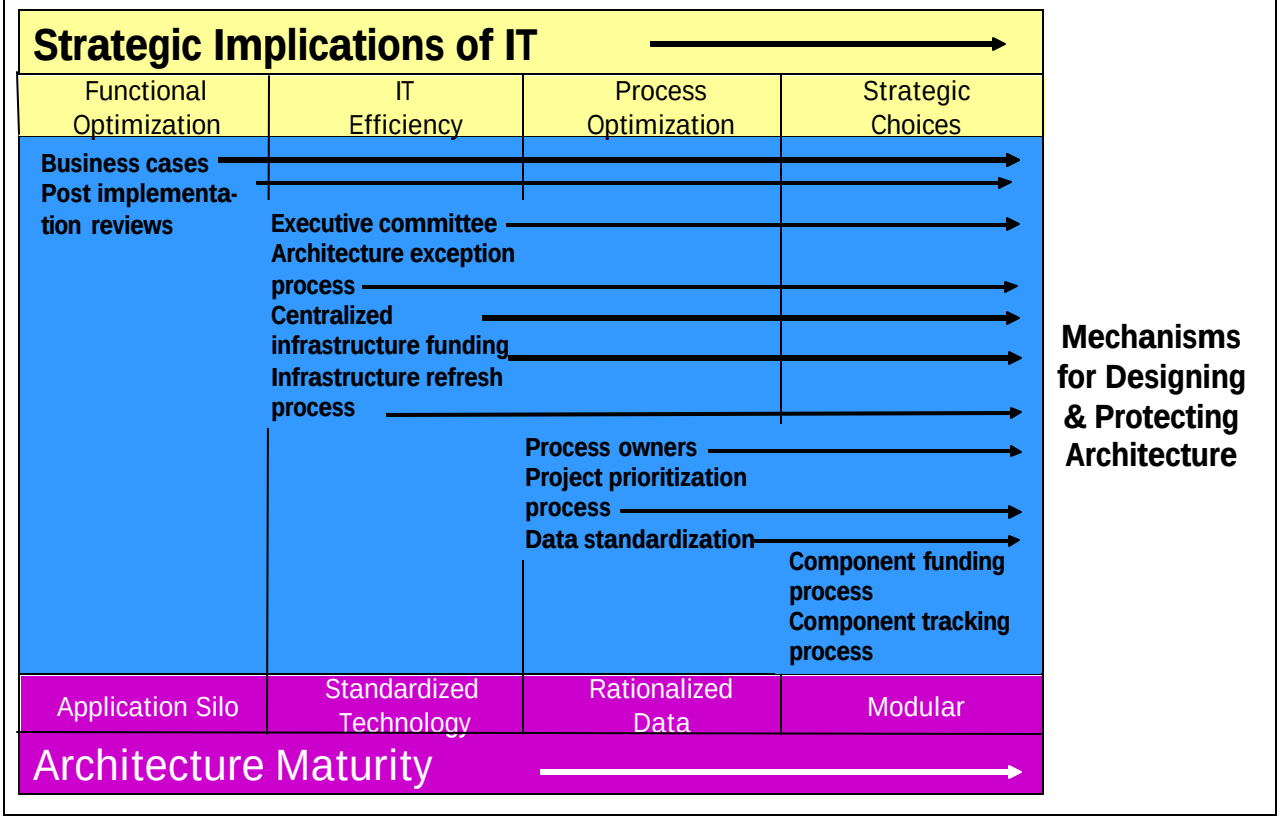
	Application Silo	Standardized Technology	Rationalized Data	Modular
IT Capability	IT applications serve isolated business needs	Firm-wide technology standards	IT focused on wiring core process	Modules enable business model extensions
Key Management Innovation	Technology-enabled change management	Standardization and exception management, refresh	Recognizing essence of the business	Practices facilitating reusability
Business Case for IT	ROI of applications	Reduced IT costs; interoperability	Improved business performance; integration	Speed to market; Strategic agility
Locus of Control	Local control	Senior management support of CIO	Senior management, IT, and process leadership	Senior mgmt, IT, process, and local leadership
Key Governance Issues	Estimate, measure, communicate value	Establish (local/ regional/ global) standard setting, exception & funding processes	Determine core processes and funding priorities	Define boundaries for business experiments

In the *standardized technology architecture stage*, business and IT managers build on their ability to communicate IT value. They make decisions on IT standards based on their negotiated understanding of the impact of IT on business strategy. They also negotiate funding models for the shared infrastructure, including replacing and upgrading technologies before they become obsolete. At this stage, IT and business managers develop governance structures, such as executive committees, to formalize funding for the shared infrastructure, both for new infrastructure development and replacement (refresh). The executive committee also debates the appropriate organizational level for IT standards. Architecture committees, typically populated with IT people, establish processes for developing, monitoring and granting exceptions to standards. These governance structures enhance learning by formalizing the negotiation process.

In the *rationalized data architecture stage*, negotiations become more sophisticated. IT capabilities shape, as well as respond to, business strategy. IT and business managers clarify strategic intent, critical IT capabilities and the target enterprise architecture. These discussions eventually produce consensus on the firm's core processes and the data that drives them. The executive committee continues to address strategic IT prioritization and investment issues. The firm applies its learning about standards to standardizing data and processes. Management institutionalizes learning in governance mechanisms, such as project prioritization processes.

Finally, the *modular architecture stage* introduces the challenges of componentization, customization, strategic experiments and reuse. In this stage, IT and business management apply learning

Figure 3: Key IT Governance and Management Mechanisms



from the earlier stages to discussions about strategic direction. They introduce new governance mechanisms to encourage component reuse, and they retain governance mechanisms that support funding, standardization, and IT value assessment.

Figure 3 shows how governance mechanisms accumulate as firms advance through the four stages. These governance mechanisms create and track organizational readiness for the various stages. Technologies, such as middleware, Web services, and enterprise systems allow firms to replace huge sections of their existing uncoordinated architecture with a more capable architecture. Although firms have transformed their architectures, they have not been able to benefit from new technical capabilities until their managerial capabilities catch up. In fact one CIO noted that his firm had attempted to leapfrog from an application silo architecture to a rationalized data architecture by installing an ERP system. They failed—twice. Two other firms skipped from application silos to rationalized data architectures, but took many years to receive payback on their IT investment. The managers were not able to internalize the goals and objectives of the firm's architecture-related activities.

Lessons for Creating a Strategic IT Architecture Competency

Creating a strategic IT architecture competency is a long, difficult process. It involves ongoing negotiations about a firm's business strategy and about how IT both shapes and responds to that strategy. It also involves defining a target technology architecture (i.e. applications, data and infrastruc-

ture technology) and doggedly pursuing that architecture even when immediate business needs argue for leniency. Another step in building out a strategic IT architecture involves identifying the stage that best defines the firm's architectural competency. A firm will want to excel both technically and managerially in that stage. Then, in many, though not all cases, the firm will want to start working its way to the next architecture level.

The architecture stages model offers a number of lessons:

First, focus architecture efforts on key business processes. Architecture exercises that attempt to establish links among applications, data and infrastructure for all of a firm's business processes will almost certainly stall. Focus on just the core ones.

Second, don't skip or rush through stages. Skipping stages leads to either failures or delayed benefits. Firms benefit more from making improvements in their existing stage than from transformational efforts that abruptly move them into foreign waters.

Third, recognize that complex organizations have multiple architectures, which may be at different stages. Like J&J, a firm may have a corporate architecture, as well as divisional architectures and business unit architectures. Because these different architectures have different objectives, they will likely be at different stages.

Fourth, institutionalize learning about architecture in appropriate governance mechanisms. Governance manages the architecture for value. Without governance, executives may find themselves with an expensive, but limiting, technology base.

Fifth, continue the dialog. Enterprise IT architecture is never complete. Ongoing dialog enables management to continuously zero in on what matters. New people need to understand strategy and IT alignment. Markets change. Learning and architecture atrophy if ignored. Any firm can lose its strategic edge if management does not regularly check its assumptions about its IT capabilities.

Sixth, keep an architecture capability in-house. The architecture task is difficult enough that management might want help. But the negotiations that lead to understanding the links between business strategy and IT architecture require a close working relationship between business and IT. [18]

The payback for enterprise IT architecture efforts is strategic alignment between IT and the business. Alignment will generate a higher return on the firm's IT investments and focus the firm's project portfolio on initiatives likely to have strategic impact. Ultimately, enterprise architecture leads to "happy surprises."

[18] On the other hand, a number of firms had outsourced significant numbers of IT services with no apparent impact on the quality of the architecture.