CHAPTER 11
ENTERPRISE IT AND TRANSFORMATION

RAHUL C. BASOLE AND RICHARD A. DEMILLO

ABSTRACT

Today’s enterprises are using information technology (IT) in virtually all aspects of their business. IT enables enterprises to provide seamless access to corporate data; streamline existing and create new business processes; design, improve, and deliver new products and services; and communicate and collaborate with customers, suppliers and other organizations across the globe. As enterprises undergo transformation of various kinds, IT can become a driving or inhibiting force to successful change. This chapter highlights some of the current enterprise IT trends, presents the fundamental drivers of the information economy, and suggests some basic architectural IT principles that can facilitate a smooth transformational process. The success and failure resulting from appropriately, and lack of, implementing these principles are illustrated in numerous examples and case studies throughout the chapter. The chapter concludes by introducing a novel concept of enterprise IT and transformational maturity and offering some practical guidelines.

INTRODUCTION

Information technology (IT) has been one of the key drivers of business in the twenty-first century. Enterprises in virtually all sectors of industry, commerce, and government are fundamentally dependent on information technologies. Enterprises in industries such as telecommunications, media, entertainment, healthcare, and financial services are increasingly digitizing their products, services, and offerings; often times their mere existence depends on the effective application of information technologies. Similarly, with the emergence of the Internet and electronic commerce, the use of technology is not only becoming an accepted, but also an expected way of conducting business. Consequently, enterprises are increasingly looking to use IT to improve their business operations and create new opportunities that enable them to achieve higher levels of efficiency and provide them with a source of competitive advantage.

Enterprises are using information technologies to seamlessly link their offices, factories, workers, suppliers, and customers around the globe. The use of IT has led to new business models, businesses, industries, and markets. It has become evident that business and IT are increasingly intertwined. Enterprise strategies,
processes, and procedures are often dependent on IT platforms, applications, databases, and networks. A change in any one of these elements often requires a change in the other components. As enterprises pursue transformations, they must therefore take current and future capabilities of their IT systems into consideration and effectively align them with their business strategies. Continuously changing market demands and environmental pressures as well as changing technological requirements will also impact an enterprises’ IT strategy throughout the transformation process. Before providing any strategic perspective, it is important to have an understanding of what constitutes enterprise IT, what underlying forces have and continue to shape enterprise IT, and have led to IT as a transformational enabler.

Information technology has become an increasingly integral component of today’s enterprises. IT is ubiquitous and enables a degree of connectivity that was difficult to achieve even a decade ago. Technology has evolved so rapidly that it is often the cause of enormous transformations. The growing interdependence between business and technology can be attributed to the soaring power and declining costs of information, communication, and networking technologies.

One of the most stimulating forces for businesses during the IT age has been the emergence of the Internet. The Internet provides an infrastructure that brings individuals and businesses together and enables global communication and information exchange using telecommunications and computing power. The Internet, simply stated, is a network of networks that spans the world. The Internet interconnects a myriad of different networks, systems, and computers. In an increasingly borderless world, the Internet provides its users with the tools to interact, communicate, and exchange information. The extraordinary growth of the Internet can be mainly attributed to a few phenomena that can be broadly characterized by three fundamental laws of the Internet age.

**Moore’s Law.** The first law is the familiar Moore’s Law, named after Gordon Moore, the founder of Intel Corporation. Moore’s Law states that every one and half years the number of transistors on a microchip doubles while cost remains constant. In other words, Moore’s Law states that computers will get faster, smaller, and cheaper over time. It has held true over the years and experts project that this phenomenon will continue for the foreseeable future as increasing supercomputing powers are being integrated into desktops, laptops, and mobile devices. Computer memory and storage capacity are two other areas that are experiencing a similar fate. This phenomenon makes it very affordable for individuals and small businesses alike to be equipped with the technological means to conduct commerce and transfer information as fast as large corporations can.
FIGURE 1. Moore’s Law states the number of transistors per chip doubles every 18 months while costs remain constant (Intel, 2005).

Metcalf’s Law. The second law is Metcalf’s law. It states that the value of a network equals the square of the number of users, while the value to the individual user is proportional to the number of users. To illustrate this law, consider the telephone. The telephone is of very limited use if only two users have one. If a whole city is on the telephone system, it becomes much more useful. If the system expands to an entire country or the world, the value of the system grows significantly. This concept applies similarly to other technologies and has been particularly true in the case of the Internet. The value of the Internet grew dramatically as more and more computers were interconnected on the network. The combination of Moore’s Law and Metcalf’s Law exemplify the exponential growth of the Internet.
FIGURE 2. Metcalf’s Law states that the value of a network scales as the square of the number of those connected to it.

**Law of Bandwidth.** As the demand for IT, communications, and the Internet has increased, the need for more bandwidth has also grown exponentially. Bandwidth refers to the transmission capacity of a communications channel. Similar to the progression of microprocessors defined by Moore’s Law, the speed and capacity of the transmission medium has soared while bandwidth cost has dropped tremendously. This trend is further amplified by the movement of enterprises towards Internet protocol-based applications, such as telephony, videoconferencing, and streaming media, which require significant amounts of bandwidth. Today bandwidth is rapidly turning into a commodity as companies have begun trading capacity through clearinghouses.

As time has progressed, these three observations have continued to be accurate. The growth of the Internet and use of IT by businesses has largely been driven by the prophecy of these laws.

**High-Performance Engineering**

As enterprises increasingly embrace the use of IT, knowledge becomes a central organizational asset that needs to be managed, stored, and disseminated. Particularly in information economies, enterprise productivity often depends on the availability of knowledge. IT has indeed increased productivity in a wide-range of industries, and led to the concept of high performance engineering. Through the use of high computing power and advanced software applications, enterprises are able to develop, design, and deliver products and services at a much higher rate. While traditional physical design methodologies required designers to develop individual models and physically test their models, the use of high-performance computing systems allows designers to design their product using sophisticated graphics and simulation software, test their prototypes, and make design modifications on the computer and avoid an expensive and time-consuming
development process. Boeing, for example, uses high-performance computers and computer-aided design (CAD) systems in simulations of computational fluid dynamics to dramatically shorten product development costs and time.

In the manufacturing industry, Ford Motor Company developed a product information management (PIM) system that unifies all aspects of product engineering, development, and manufacturing. This is a modern IT system that replaces many different IT tools in use at Ford’s major development centers. The connection to enterprise transformation is clear: the PIM enables Ford to shift resources among its product development centers to take advantage of changing transportation, energy, and labor changes and to adapt quickly to changing global market demands.

Another prevalent example of high-performance engineering is the use of computing power to facilitate the management of the product lifecycle. Product lifecycle management (PLM) solutions help enterprises innovate new products that meet and anticipate customer demands. Based on eXtensible Markup Language (XML), PLM solutions enable a seamless exchange of data between product lifecycle processes and increase the speed and agility of product development while reducing the associated risk.

One-to-One Marketing

IT has also introduced significant changes in the way enterprises conduct business. It has decreased the cost of creating, sending, and storing information while making information more widely available. Traditional business models required customers to visit physical stores to find out information about products and services. As such, the cost of comparing prices was high as customers had to travel from store to store to find the product or service they were looking for. The advent of the Internet changed this relationship drastically. As firms provided their product and service information, customers were instantly connected and informed. In other words, physical goods were unbundled from their traditional value chain channels and changed the way firms conducted business. The Internet enabled businesses to provide their products and services online, replacing some of the traditional channels, which had become inefficient and less economical, via electronic means. For example, in pre-Internet days, consumers who wanted to purchase books had to visit their local bookstore in order to obtain information about the latest book titles, prices, and their availability. Often times, bookstores had a monopoly on this information. When Amazon.com opened its gates as an online bookstore, it provided consumers the availability to search through a vast electronic catalog to find titles, along with table of contents, reviews and information about related books. Consumers were now capable of ordering books from the convenience of their computers. Because Amazon.com did not require the cost of physical stores, inventory, and other overhead costs traditionally associated to traditional bookstores, it was capable of offering its book selection at a significantly lower cost to consumers. The attraction to consumers was
undoubtedly apparent. Similar examples can be found in the financial industry, where banks now provide their services online or e-brokerages enable stock trading without the act of the middleman. The use of the Internet transformed businesses and business models as we traditionally knew them.

The attractiveness of the Internet to consumers is certainly related to the improvements in convenience it provided. However, the Internet also provided a shift in the information asymmetry that existed between the parties involved. As more and more firms offered their products and services online, consumers were now in the position to compare prices and offerings, and make a more informed decision. Similarly, businesses were now able to reach more customers with the availability of an e-presence. Geographical boundaries were not constraining enterprises to offer their products and services around the globe. As such, the Internet transformed the reach and richness of information provided to consumers and businesses.

With the use of the Internet, enterprises have also received a new weapon in obtaining more information about the customers. The Internet enables businesses to understand buying patterns, browsing behavior, and user preferences. Today’s websites can collect a range of information about their customers and aid enterprises in developing appropriate strategies targeting individual consumers. Amazon.com for examples provides customers personalized information on potential items they may be interested in purchasing. These suggestions are based on the browsing patterns and user characteristics that were carefully determined through sophisticated data mining techniques.

The ability to provide personalized and customized information to consumers can also be used in the backend of enterprises. Products and services can be customized to fit the individual customers’ needs before they even get created, built, or produced. The Dell Direct Model is a classic example of this type of one-to-one marketing strategy. Consumers build their desired computer online and have the ability to configure it according to their preference. As soon as they have finished “building” their system, the order to manufacturing is sent and the machine is custom built. This direct model enables Dell to minimize their inventory and provide customers real-time feedback to their computer buying experience. The Dell Direct Model has propelled Dell to the top of computer manufacturers today; the entire business has been built on the strength and advantages of IT and the Internet.

From this short list of examples it is apparent that IT has not only transformed the way enterprises conduct business but also transformed the relationships between the parties involved in the value chain. It has brought more information to the value chain participants and enabled them to communicate and transact more efficiently. In many cases, business models themselves have shifted as traditional intermediaries have now become unnecessary. Direct distribution channels have replaced traditional distribution channels. Consumers are far more involved in the product and service creation, delivery, and exchange process.
One such trend can be found in the creation of customer self-service, where Web and other network technologies are transforming the way customer service is conducted. Using the Web, many enterprises are targeting customer service to each individual consumer often without the need of a human customer support agent. Automated self-service can conduct support services at a fraction of the cost. Examples of these services are plentiful: the ATM machine, check-in kiosks at airports, and package tracking information. These services are accessed either at the physical location of the service or from the convenience of the computer at home. While the human component within this self-service is important, many of these Web services are directly integrated with large call centers.

It has become clear that the power of the Internet changes the way business is done and the way relationships are formed and sustained. The Web has transformed not only business-to-consumer (B2C) services and products, but also business-to-business (B2B) transactions. It has been estimated that in fact B2B represents more than 85% of all online commerce and transactions. The integration of the supply chain has been largely impacted by the use of IT. Enterprises are capable of selecting their suppliers and vendors on B2B exchanges, can collaborate and communicate via electronic means, and provide their products and services on electronic exchanges. Similar to the shift in the B2C arena, the use of the Internet has transformed the relationship between businesses.

The Information Economy

Today’s global economy is characterized by continuous change at an unprecedented rate. Fueled by technological innovations, we have seen a shift from the ‘Industrial Economy’, where manufacturing and blue-collar work dominated, to the ‘Information Economy’ where knowledge, data, and information play the central role. Analogies can be drawn from history. In the early 20th
century, industrialists leveraged electricity and telephone network infrastructures to transform the U.S. economy; today, enterprises are leveraging computer and communications technology to transform the global economy.

The advent of the ‘Information Economy’ has not only impacted the way business is done, but has had significant influence on society, culture, and politics. Through the introduction of the Internet, the global marketplace is increasingly accessible and visible to a growing number of participants. It is this transformation that has led to the growing importance of information. The power has shifted to those parties that have information. While there is no single definition on what constitutes the Information Economy, we experience it around us on a daily basis. Information goods, such as books, football scores, stock quotes, magazines, and music, surround us. We utilize computer and communications technologies to create, extract, exchange, and manipulate information for purposes of work, leisure, and entertainment.

Every enterprise – private and public – is immersed in the Information Economy. Intelligence and defense organizations exchange information, businesses collaborate using digital supply chains, consumers and enterprises alike buy and sell products and services, financial institutions process millions of transactions, entertainment and media broadcast news stories, educational institutions provide online learning, friends and families chat using e-mail and instant messaging, all of which is done through electronic means. The age of the Information Economy has brought forward the ability to access and transfer information from anywhere to anyone at any time. ‘Connectivity’ has become the life force for the future. The ability to access and exchange information has a significant impact on every aspect of life (Shapiro & Varian, 1999).

INFORMATION TECHNOLOGY AS A TRANSFORMATION ENABLER

Business Value versus Cost

Over the past decade, enterprises have spent an enormous sum of money on IT. Many firms in fact have increased their overall IT expenditures by double-figure percentages annually. Despite this trend, there is still a lot of skepticism and questioning of the payoff of large IT investments. Numerous studies on the return of IT spending provide contradicting results: some studies argue IT leads to a tangible productivity improvement; others have argued that IT has mainly delivered significant strategic benefits. Undoubtedly the views on the business value of IT are divergent. Still the question what IT investments deliver in return is still a gray area. Some have called it the “productivity paradox”. It is clear, however, that managers seek to measure the value of IT.

Historically, IT investments were considered an administrative expense rather than a business investment. As such costs and benefits were relatively easy to
identify and measure. Today, however, IT investments are far-more than mere expenses; they present strategic choices that impact the entire enterprise and have the ability to transform business and industry structures, and change the way organizations interface with their supply chain, products, services, and markets. Understanding the business value and associated cost with such investments is therefore far more difficult than the traditional approach (Ward & Peppard, 2002).

While the cost of IT investments is often difficult to assess, understanding the flip side of the equation - assessing the value of IT investments - is often considered much tougher. For years, researchers, scholars, and managers have attempted to identify and obtain measures for the business value of IT. However, concrete measures of IT business value have not been identified. This difficulty is primarily associated with the fact that IT investments and their associated benefits often span many different organizational boundaries. IT investments furthermore do not directly create business benefits, such as cost savings or increased revenue. This is particularly the case when technology is applied to enhance the company image, customer service, or advertising effectiveness.

Another critical aspect is that the business value of IT can vary from organization to organization. This indicates that the business value of IT is not a mere function of the technology itself, but the environment it operates in, the organization that uses it, and the process by which it is implemented, adopted, and diffused. As such, organizational culture, leadership vision, and organizational practices such as learning and training, all contribute in assessing the business value of IT. Organizations in the process of adopting IT must therefore consider a wealth of factors and carefully evaluate the business value versus cost tradeoff.

Enterprises make investments in IT for a variety of reasons. The underlying purpose of these investments is to improve business performance measured in tangible aspects such as productivity and profitability. However, the use of IT brings forth a range of other, intangible benefits, such as quality, responsiveness, and coordination, which may not be immediately reflected in a tangible benefit such as profitability. Furthermore, the overall business value of IT varies significantly from organization to organization. Traditionally, many enterprises have used financial measures, such as return on investment and cost, to qualify their investments in technology. However, as IT budgets are shrinking, decision makers are increasingly looking towards the business value side of the value-cost tradeoff. Historically, IT investments too often focused on how to reduce costs rather than on the question of how IT can deliver the best value for the lowest cost. Today’s economic climate, shrinking IT budgets, and increasingly competitive environment has shifted this thought of many executives. In order to address these questions, firms have turned their focus to understanding whether a firm’s investment in IT is aligned with its overall strategic objectives. The alignment of IT capabilities and business strategy enables enterprises to intelligently make IT investments. Proper alignment delivers direct value as strategic aims and objectives are met with the use of IT. The tradeoff between cost and business value is therefore critical. To deliver value, the IT infrastructure must be capable
of providing enterprises the opportunity to increase revenue, improve customer satisfaction, and support business strategies.

**Key Processes and Transformational Events**

The chapters in this book highlight the multitude of different types of enterprise transformations. Transformational events are triggered by forces that are either internal to the firm, external to the organization, or a result of environmental changes. These events lead to enterprises needing to quickly adapt to the changes and transform their key processes in order to remain competitive. Enterprise-wide processes exist because organizations come to depend on a flow of documents, information, events, decisions, and outcomes. Enterprise transformations, by definition, affect systems and processes. Therefore, the extent to which an organization successfully exits from a transformational event depends in large measure on how well the dependencies that are required to deliver value have been preserved or defined. In fundamental transformations like mergers and acquisitions, for example, many business processes can be successfully carried out in parallel. Other transformational events, such as updated value chains, new products or markets, and unexpected sales demands, for example, require a rethinking of supply processes, customer relationships, and sales processes. New technology investments must therefore keep strategic objectives of the enterprise in mind when restructuring, designing, aligning, and implementing new business processes.

**The Role of Architectures**

The discussions above clearly highlight the need for IT. It also shows the growing interdependence between IT and business objectives. It is therefore important to build an IT infrastructure that supports the changing needs of the enterprise. This becomes even more critical during times of transformational events.

An enterprise’s IT infrastructure must be capable of adapting to changes in the environment, changes to business processes, and the introduction of new products and services. Changes can also come from the emergence of new technological innovations and opportunities. When faced with new technologies, an IT infrastructure may be required to be upgraded, replacing existing infrastructure with new ones. Technological change is inevitable and hence enterprises must be continuously prepared to meet these challenges, anticipate changes, and provide an infrastructure that is both flexible and cost effective. Arguably the most critical task in developing an adaptive IT infrastructure, and one that can aid in meeting these challenges, is the development of an appropriate and flexible IT architecture.

While there is no universal definition of architecture, in general terms, an IT architecture represents a blueprint and/or roadmap for the information and
technical requirements of the enterprise. The development of an IT architecture is beneficial for several reasons. As summarized in Table 1, it enables enterprise increased flexibility and a “faster adaptation to changing technological requirements and environments; it streamlines and optimizes business processes; provides enterprise-wide integration through data sharing; and enables a faster evolution to new technologies” (Cook, 1996).

At the high level of IT, an enterprise-wide IT architecture primarily provides a set of standards for the enterprise. Similarly, standards are important at the technical level of implementation, such as networking protocols, platforms, etc. Using a standards-based approach to IT architecture ensures that processes and information can be interconnected across business units enabling a seamlessly networked enterprise.

**Maturity Measurement and Six-Sigma Models**

The impact of transformational events requires enterprises to re-design, implement, and optimize new types of processes that integrate various back-end, legacy, and third-party applications. Processes should be designed and implemented in such a way that the broader strategic objectives of the enterprises are satisfied. This in turn should drive the overall technology strategy and investments. An understanding of current processes is therefore an important prerequisite. Many enterprises utilize IT maturity models to assess their current level of process maturity, identify a desired state of enterprise processes, and develop a gap analysis highlighting the areas of people, process and technology to invest in for better alignment with the overall strategic objectives.

<table>
<thead>
<tr>
<th>Benefits of an Enterprise IT Architecture (Cook, 1996)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased Flexibility to Changing Requirements and Environments</td>
</tr>
<tr>
<td>Streamlined and Optimized Business Processes</td>
</tr>
<tr>
<td>Enterprise-Wide Integration through Data Sharing</td>
</tr>
<tr>
<td>Rapid Evolution to New and Emerging Technologies</td>
</tr>
</tbody>
</table>

**TABLE 1.** Benefits of an Enterprise IT Architecture (Cook, 1996)
Enterprises must seriously consider all aspects of process maturity in order to best deliver services to the rest of the enterprise. Maturity models enable organizations to self-assess the maturity of various aspects of their processes against benchmarks and are typically constructed with five levels. Each maturity level is a plateau in which one or more processes have been transformed from a lower level to achieve a new level of capability. Each maturity level provides a new foundation of practices on which subsequent levels are built. Two common IT maturity models include the Capabilities Maturity Model (CMM) and Six Sigma.

The CMM describes the principles and practices underlying software process maturity. It is intended to help enterprises improve the maturity of their software processes in terms of an evolutionary path from ad hoc, chaotic processes to mature, disciplined software processes. The focus of CMM is to establish repeatable practices with low variability that are continuously improved to enhance process capabilities.

Another frequently used method for process analysis and design is Six Sigma, developed by Motorola engineers in the late 1980s. The Greek word “sigma” is a mathematical symbol used to denote standard deviation and – in the case of processes – measures how far it deviates from perfection. Thus, the fundamental idea behind Six Sigma is to bring a process-oriented view to enterprises in order to detect and reduce unintended outcomes. The fundamental objective of the Six Sigma methodology is the implementation of a measurement-based strategy that focuses on process improvement and variation reduction.

Maturity models and measurement practices enable enterprises to assess their current state of business processes and implement consistent policies, procedures, and practices throughout the organization. In doing so, the enterprise becomes increasingly flexible and can rapidly adjust to transformational changes. Using a quantitative approach provided by these methodologies, enterprises can assess their current practices, form a baseline, and continuously improve its business processes.

**IT ARCHITECTURE AND TRANSFORMATION**

Enterprise-wide processes exist because organizations come to depend on a flow of documents, information, events, decisions and outcomes. Organizations that undergo significant change rarely escape with unchanged systems and processes. Therefore, the extent to which an organization emerges successfully from a transformational process depends in large measure on whether (and, significantly, how well) key value-producing elements of enterprise-wide processes have been preserved or redefined.

There are many cases in which the right IT strategy plays a pivotal role in major transformational events. During mergers, for example, customers expect
that value in the form of products and services will continue to flow. So post-merger automated systems that record customers, orders and payments must at least capture the status of the previously independent customer records. Loss of even partial customer data can lead to loss of cash that dramatically alters the viability of the merged companies. In the short run, many business activities can simply be carried out in parallel without change to operational processes, even as major new manufacturing facilities are introduced as a result. On the other hand the catastrophic loss of customer data resulting from natural or geo-political disasters, can rob even stable, healthy businesses of the capability to continue operations.

Cisco, for example (Nolan, Porter, & Akers, 2001) suffered just such a catastrophic loss of data in January, 1994. The company shut down while ERP systems for manufacturing, ordering and finance were brought back on line. Faced with a near-term continuity problem, Cisco management of course recognized that significant resources would be required to recover. It is significant; however, that the team of senior managers who were responsible for leading the recovery effort went beyond the immediate project needs to establish an architecture that solved a much more general problem. In effect, Cisco’s IT and business managers realized that massive failure of business systems is only one kind of transformational event. By investing in a standards-based, scalable architecture, Cisco in essence systematized change as a core business process. This was a decision that carried Cisco through its dramatic growth in the late 1990’s as it acquired companies, anticipated the changing nature of its market, and became a model for how a company can start with well-articulated business goals and build an IT infrastructure that aligns with it.

The validity of systematic approaches like Cisco’s has been demonstrated many times. By 1999, Hewlett-Packard was well into a massive reorganization that led to the spinout of Agilent Technologies, its former instrument division, and, under the leadership of Carly Fiorina, HP’s new, change-minded CEO, the consolidation of over 80 business units into four (with consumer-facing and business-facing sales organizations to unify the company’s interface to its customers). The year 2000 fourth quarter results for HP shocked senior management and investors alike: HP had missed its own earnings estimates by nearly ten cents per share (Money, 2000). When HP closed its fiscal year 2000 books, the design of the corporate financial system that was to integrate the data from dozens of previously independent product, marketing and sales organizations (and which was being used to forecast results) was seriously behind schedule and the true status of the integration project has not yet been reported to senior management.

At virtually the same time, Cisco was relying on a standards-based, internet-enabled IT architecture to consolidate all applications (not just finance, as in the case for HP) for its far-flung R&D and marketing organizations in a massive reorganization into just three lines of business. The entire integration was carried out in 60 days at a cost of less than one million dollars.
It is very difficult to “project manage” change at the scale of an enterprise. In addition to the inherent problems in all large IT projects, enterprise transformations require transparency and predictability. Even a well-managed project can fail because critical project specifications do not take into account organizational complexities, external factors or (as in the case of HP) the tendency of line managers to resist change (Herbold, 2004) by maintaining specialized applications, shadow systems and fiercely protected local control of operational data. Just as architecture has been a competitive enabler for technology companies, IT architecture can enable capabilities that greatly increase the likelihood of successful transformation.

**Transformational Events**

There are a numerous events that can transform a large organization. These events can be the result of changes within organization. Other transformational events can be triggered by environmental changes. Some examples of transformation events are shown in Table 2.

**TABLE 2. Examples of Transformation Events**

- Large-scale structural change such as mergers, acquisitions and divestitures
- Internal reorganizations such as management changes and moving organizational boundaries
- New business strategies such as geographic expansion
- Updated value chains that disintermediate traditional suppliers of value
- Emerging, more agile competitors
- Cost reduction that requires focusing on a few core skills
- Unexpected sales demand that invalidates operational models, forecasts and supply chains
- New products and product cycles such as those requiring significant investment shifts for manufacturing or R&D
- New markets where existing product or service portfolios may be ill-matched to actual customer needs and preferences
- New business processes
- Regulation such as section 404 of the Sarbanes Oxley act that mandates new controls and reviews
- Geo-political events and disasters such as the terrorist attacks of September 11, 2001.
Structural changes such as mergers, acquisitions or divestitures are usually apparent to outsiders. These are transformations that tend to impact all enterprise systems and processes. Internal reorganizations, by contrast, may be transparent. Moving from centrally managed and funded to distributed research laboratories may have a dramatic impact on product costs and quality but customers and shareholders may not be aware that a change has taken place. Sometimes, as in the case of the formation of the Department of Homeland Security in the Executive Branch of the US Government, an internal reorganization is actually a sequence of large mergers.

Strategy changes are seldom anticipated, although companies shift business strategies all the time. Strategy shifts that are transformational and successful are relatively rare. This is in part due to business fundamentals that have little to do with technology. On the other hand, some transformations are profoundly affected by the underlying IT architecture. For example, a company that grows through geographic expansion from regional to national or international scale acquires employees, customers, suppliers and partners.

The most dramatic examples of the transformational power of changing value chains are in the communications and technology sectors. Brand value for components like microprocessors that can command premium prices has been rapidly eroded by commoditization. As a result manufacturing capabilities are decoupled from customer acquisition and product delivery. Transformations like these have had a huge effect on the personal computer industry. The internet boom of the late 1990’s made it clear that incumbents have to be wary of innovation that can undercut established products with cheaper, more appealing and sometimes less capable new products. Less well understood is the role that IT plays.

However, while large enterprises rely on processes and systems to gain economies of scale, smaller, more agile competitors often rely on people rather than processes. This means that established competitors can be locked into legacy systems and ways of doing business that are ultimately harmful. Shrinking margins, international competition, increased energy costs; shareholder demands are a few of the forces that put severe pressure on costs. These pressures rarely fail to provoke large-scale transformations as companies focus on core capabilities and either eliminate or purchase capabilities that contribute to overall financial performance.

EXAMPLES OF ENTERPRISE IT TRANSFORMATION

Cisco

John Chambers joined Cisco as CEO in 1991. By 1993, the Cisco top management team had articulated a business strategy that the company adheres to even today:
- Make Cisco a one-stop shopping destination for all business network needs.
- Systematize acquisitions as an efficient business process.
- Drive networking standardization and license technology to key suppliers
- Be strategic in picking partners.

When the company began to re-architect its IT infrastructure to recover from the catastrophic failure of its central database, it adopted a hierarchical approach to technology standardization that has become a model for enterprises that want to seamlessly adapt to change in scale, structure and markets.

At the lowest layers of the hierarchy are the common computer, operating system, Internet access and productivity tools that are deployed throughout the company. On top of this base technology Cisco relies on a common suite of application packages that are used worldwide. A key element of the architecture is the ability to maintain a common Oracle database image accessible by the Internet (using the ubiquitous TCP/IP protocol). Hosting these capabilities at the enterprise level are Unix servers, the large-scale systems that are capable of high-speed transaction processing and networking. The architecture also recognizes that smaller groups need common capabilities as well. Windows™ based servers that are less expensive to acquire and operate serve these smaller groups. These capabilities are stitched together in a worldwide network supporting not only data but also voice and multimedia services.

Technology standardization has enabled an IT architecture that is designed specifically to accomplish the company’s business strategy:

- Using IT infrastructure to enable key processes to operate in real time rather than according to an artificially imposed calendar.
- Providing everyone in the company the same view of data that is readily available
- Ensuring that computers and network access are universally available to Cisco employees
- Using Internet browsing as the common application and data access mechanism
- Deploying a global phone book to enable employees to reach each other and key suppliers and partners from within the browser
- Using Internet self-service websites to replace receptionists, HR specialists, and purchasing agents
Home Depot

Like Cisco, Home Depot uses open architectures and web interfaces that allow new applications and features to be added easily to implement a new business strategy (Levinson, 2004):

- Focus on dramatic improvements in the shopping experience for customers
- Gain efficiency by streamlining the stores’ back office.

The scale of retail operations for Home Depot is enormous. The retail stores process over 100 million transactions daily. The infrastructure consists of 8000 servers and network capacity for 400,000 PC’s that together host over 2000 applications. The underlying data warehouse contains over 4 trillion bytes of data.

Home Depot’s digital architecture strategy is reflective of a continuously changing value chain. Like Cisco, Home Depot aims to replace its existing technology platform with a new one. The architecture anticipates future gains in productivity and effectiveness by new technology introduction, so the open architecture is critical to their strategy. Customers have the most intimate contact with back-office systems at point-of-sale terminals, so Home Depot chose to concentrate on that aspect of operations.

Self-checkout was one of the first new applications to be deployed. Besides the cost and competitive advantages of being first in this retail segment with such capabilities, the architectural advantages were validated because self-checkout uses the same software as the other point-of-sale functions. The new architecture also specifies a common database of transactions in an enterprise data warehouse. This enables measurement of cashier performance and an online price/code catalog. However, it also aims at improved customer experience since returns can now be made to any store.

HP/Compaq Merger

By contrast with Home Depot and Cisco the massive integration of Hewlett-Packard and Compaq systems was viewed as a series of massive IT projects which began immediately upon closing of the May 2002 merger.

The value of the HP/Compaq merger was defined by an extraordinarily contentious proxy fight as the value captured by integrating complementary businesses. It is therefore understandable that the focus of top management in both companies was on business process architecture. The goal of rationalizing the IT demands of the combined entities was capturing the economies of scale that a single company could provide. Unfortunately, the combined company’s systems did not grow from a single company. Between the two companies, there were 70 or more supply chains to be migrated to an integrated ERP environment. Many of
those systems were legacy infrastructure that Compaq inherited from the acquisition of DEC, a merger that failed to provide value to Compaq shareholders. In other words HP managers were trying to integrate and standardize systems from at least three large companies as well as separate supply chain and ordering systems from geographic regions such as Australia that produced their own products and therefore were not part of the US-based supply chains.

The project management approach was consistent with the overall goals of the integration teams: capture the value of synergistic businesses. From a people standpoint, significant efficiencies could be gained by winnowing multiple engineering, marketing and sales teams to a smaller number. The idea for IT was similar: reduce the 35 pre-merger ERP systems to four. Across all entities, the companies ran for 3,500 applications. To capture the synergies, this number would have to be reduced to by 60 or 70 percent.

The four ERP systems had code bases spanning all three market-facing divisions (consumer, enterprise and small-medium business), several distinct fulfillment modes and many geographic regions. The technical goal of migrating from separate legacy HP/Compaq/DEC systems to a new SAP system was frustrated by historical silos and business. This complexity proved to be too much for HP project managers when data integration complexity met an unexpected demand in orders (Bouchard, 2005). By the third quarter of 2004, $120 million worth of enterprise server order backlog had accumulated. Ultimately, these integration problems cost HP’s new enterprise server division $400 million in revenue and $275 million in profits.

ENABLING CAPABILITIES

These examples really highlight two views of how IT relates to transformational events in large organizations.

Project View. The overriding principle in this view is that IT is a critical resource for enterprise-wide processes and needs to be managed. However, a project approach to IT leads to a much narrower perspective on the issues at hand. Using a project view, enterprises try to manage the transformational events and apply IT project principles. In many cases, the lack of a holistic perspective by a project approach has resulted in disconnected and inefficient silos of technology, information, and business processes. The integration of supply chain management systems at HP/Compaq is an excellent example of a project approach to large scale IT integration gone bad (Koch, 2004). Using a pure project management approach, HP’s IT managers did not anticipate the complexity and uncertainty associated with the enterprise transformation. While contingency plans were in place, changes in the environment caused a significant and costly delay of system integration and rollout. A project perspective only allowed managing what had been initially planned for; in other words, the project was dependent on the
parameters of the event itself, and not for change in general. In order to deliver on the larger vision of the enterprise, a more holistic approach must be taken. Particularly in times of transformation, a holistic perspective to IT enables enterprises to be agile and adapt to changing requirements caused by external events.

**Architectural View.** An architectural view of IT provides a more holistic perspective on enterprise IT. It approaches the role of IT from the ground-up and establishes a common blueprint for all elements within the IT infrastructure. With this view, IT is not merely managed as set of resources to meet specific project objectives, but rather is focused upon as a strategic asset that can deliver value for the long-term. In doing so, an architectural perspective on IT provides a framework that focuses not only on the technical requirements but on the overall business goals of the organization as well. The major advantage of using an architectural approach is that while change is coming and transformational events may be difficult to foresee they can be anticipated and prepared for.

Hence, the use of a well-defined and established IT architecture provides the ability to reduce the complexities of technology maintenance and development, decreases the risk of technology obsolescence, and ensure that various parts of a solution in fact integrate and work together. In other words, an IT architecture enables to deliver applications now and into the future (Morris & Ferguson, 1993). The value of a well-defined and established IT architecture can be illustrated using a simple net present value (NPV) versus options value (OV) comparison. While the initial cost of developing and implementing a long-term oriented IT architecture may be greater than merely implementing individual enterprise systems and technologies using a project-based approach, its future, or option value, provides enterprises a range of new opportunities and offers the ability to quickly adapt to change and uncertainty. The establishment of an IT architecture hence provides enterprises the flexibility to adapt and exercise a range of critical and strategic options in the future.

Architectural principles clearly contribute to an organization’s ability to navigate transformational change. Such principles can be a source of competitive advantage for corporations, but even government agencies, universities and non-profit organizations can benefit from the experience cited above. These principles include:

- Open Standards and Interfaces
- Composition and Modularity
- Data Consistency and Integration
- Network Access and Applications
• Scalability

• Service-Oriented

• Human-Centered Technology

Open Standards and Interfaces

An optimal IT architecture that is based on a well-defined standard is often visualized as an hourglass shape as shown in Figure 4. The narrow waist of the hourglass depicts a specific standard, such as the Internet Protocol (IP) for example, and enables the support of wide variety of applications above based on a range of different technologies below.

FIGURE 4. Hour-Glass Shape of IT Architecture
An enterprise that uses an hourglass shape approach to its IT architecture can quickly deploy and implement new applications and ensure the support of emerging technologies. While open standards enable the deployment of new technologies and applications, an equally important aspect is the integration of systems and applications. Using an open interfaces principle, enterprises can interconnect existing systems and avoid costly integration problems. Hence, an IT architecture based upon open standards and interfaces enables rapid integration, interconnection, and deployment.

**Composition and Modularity**

An important principle of IT architecture is decomposition and modularity. It has been shown that the use of a composite and modular approach enables enterprises to reduce the complexities of the overall IT architecture. A good architecture decomposes the system into modules, which can be easily maintained, upgraded, and replaced. The use of a modular approach to architecture provides enterprises the ability to group functionalities within each module, resulting in greater internal dependency, and low external dependency. Modularity also leads to reusability of components, which are highly configurable and can meet more generalized needs of the organization.

**Data Consistency/Integration**

A central issue facing enterprises today is the management of their growing data sources. While sophisticated data warehousing and management tools are available today, a fundamental obstacle facing IT managers is the existence of inconsistent data. Data inconsistencies occur when similar entries appear in multiple systems. When enterprises face transformational change, data from a variety of locations and sources need to be integrated. Maintaining duplicate entries of the same data leads to inefficiencies and increased maintenance costs. Keeping data up-to-date and consistent is, thus, a fundamental requirement for data management systems. Consistent data ensures a high level of data quality, reliability, and maintainability.

In large enterprises, the need for sharing and integrating data is considerable. Traditional applications are deployed as functional silos, where each application draws from its own database. While daily synchronization mechanisms can mitigate the problem, small inconsistencies can cause significant business errors. The need for integrated and consistent data is further demonstrated by the fact that enterprises demand a common and overall picture of resource status, processes, and customers and their behavior.
Network Access and Applications

Many early business applications were generally targeted to be installed on a single terminal and used by a single user. They typically shared data with other applications on the terminal through a database or file system. However, as the number of users increased, these applications become inefficient and posed problems in scaling beyond a single terminal and user. With the emergence of corporate networks and the Internet, users were now able to access applications from their personal computers. By distributing applications across a number of servers, applications could now be accessed by an increasing number of users, leading to an increase in efficiency and performance. Today’s enterprises operate in a global environment without borders. Enabling access to network applications provides enterprises with a powerful means to extend their business across geographic borders. It also enables workers to access critical information and applications from remote locations. Network applications also allow businesses to collaborate and transact electronically, integrate their supply chains, and interact with customers through websites. While traditional corporate networks and the Internet limited users to fixed-terminal locations, the emergence of wireless networks and advanced mobile devices now provide the means to access applications virtually anywhere and anytime. From these observations, it is evident that as enterprises become increasingly networked, more nodes within an enterprise value system can be reached and scalability, efficiency, productivity and reach benefits can be achieved.

Scalability

A scalable IT architecture permits an enterprise to size its computer systems based on actual needs, continually add resources and users, and enhance business processes. It should be noted that scalability differs from performance as a scalable architecture does not increase performance but, rather, provides the same level of performance given a higher user or transaction load. Performance, thus, reflects system response time under a typical load while scalability refers to the ability of a system to increase that load without degrading response time. As enterprises transform it is likely that the amount of resources and users accessing the system will change. The system must therefore have the capability to accommodate the flux in resources without degrading performance and response time. A scalable IT architecture provides enterprises with this capability.

Service-Oriented Architecture

A service-oriented architecture provides a flexible and reusable framework for developing and integrating multiple applications. While several definitions of a
service-oriented architecture exist, it can be broadly described as an application architecture in which all functions are defined as independent services that are connected by well-defined interfaces that can be called in defined sequences to form business processes. In other words, functions are defined as services, which are “black boxes” that function independently of each other. The resulting main benefits of a service-oriented approach are its flexibility to quickly deploy new applications and its reusability to leverage investments across multiple applications. Service-orientation enables enterprises to adapt to changing business requirements and processes and ensure efficient and effective use of system resources.

**Human-Centered Technology**

All too often IT system design begins with a set of technological capabilities and functions rather than the needs of human users. Early users of Microsoft Windows™ who wanted to connect personal computers to the Internet were forced to enter inscrutable parameters and codes into six or seven control panels. Worse yet, a mistake in one of those entries could cause a computer to freeze, requiring an expensive service call to restore it to a useful condition. The latest release of Windows consolidates that complexity in a single “Wizard” that guides even novice users through the process of establishing network connections for their personal computers. There is an emerging science of information systems that begins with a set of human needs and designs interfaces that shield end users from the underlying complexity of the information infrastructure.

This “human-centered” technology is well suited to changing environments because it allows architects and designers to concentrate on enterprise-wide processes. Employees need to be paid, even in the midst of a merger. A brittle information architecture would require employees of an acquired company to re-establish payroll information, either manually or by using self-service applications of their new parent, a process that might require additional training and expense. A human centered architecture would recognize that payroll is an enterprise-wide capability in both companies and absorb new employee data with minimal impact on people.

Human-centered technology is at the heart of IBM’s adaptive, self-healing systems which shield system managers from the increasing complexity and costs of modern networks by building “self-management” and error tolerance into the technology (Ganek & Corbi, 2003). Human-centered technology is also driving NASA to build a new generation of pilot-oriented flight control systems that amplify the abilities of a human operator in extreme environments (NASA, 2005). By concentrating on how people work, the spaces in which work is carried out and models of communication and reasoning, designers of human-centered systems create new approaches to IT.
TRANSFORMATIONAL MATURITY

We believe there is an evolving consensus on the elements of transformational maturity in enterprise IT systems. We are not yet able to measure, in precise terms, the ability of IT infrastructure to enable transformation or its capacity to impede change, but as the examples in this chapter illustrate, there are some common threads in both successful and unsuccessful transformations:

- **Explicit process dependencies.** Even though complete documentation of key processes is unlikely to be undertaken in the course of normal operations, the successful architectures are those that take into account dependencies between processes. In mature organizations, this is accomplished by modularization and standardization. In organizations that are less mature, the dependencies multiply and, left undocumented, become brittle and the source of failures.

- **Defining information that most affects the business.** Customer data, supply chains, and financial records are clearly critical, but modern IT architectures make novel use of often humble information to accelerate decisions and processes. Therefore, Cisco’s adopting of company-wide white pages and yellow pages is a key link in their collaboration infrastructure, which enables web-based access to critical data by anyone in the company.

- **Shared understanding of boundaries, roles and how they change.** Horizontal processes are not changed lightly even during massive transformations, whereas vertical process change is more likely to be subject to cost or even political decisions that are ultimately not made in strategic fashion. The existence of an IT architecture that reflects essential boundaries (e.g., internal versus external) and is indifferent to organizational labels is, as experience shows, a better predictor of transformational maturity.

- **Reduced latency of time-sensitive data.** The relevance of *when* information is recognized as being important becomes obvious during change processes. Recognizing a development *before* it has a chance to impact operations is so important that mature organizations invest heavily in infrastructure that eliminates or reduces the latency of such data.

With these concepts in mind, we can begin to see the outlines of a model of transformational maturity that IT managers can use as a tool of strategy (see Figure 5).
FIGURE 5. Transformational Maturity.

An enterprise at Stage 1 – for example a vertically integrated traditional manufacturing company with “stove piped” IT infrastructure – is least able to adapt (Haeckel, 1999). Few horizontal processes exist and to the extent that information dependencies are understood at all, they are understood within a set of organizational assumptions that may not be valid tomorrow. There may be great expertise about how to perform within a set of defined parameters but little knowledge about how the larger organization behaves outside those stated assumptions.

A Stage 2 enterprise, on the other hand, has adopted many of the architectural principles we have been discussing. Such a company uses horizontal processes supported by cross-company tools and methods and is not bound to a predetermined set of applications that define the current business. These companies use web-based technologies, modern software design methods, sufficient computing power and electronic marketplaces to achieve efficiency and flexibility.

A company at Stage 3 in this maturity matrix (see Table 2) is in a position to use transformation as a strategic tool (Robertson & Sribar, 2002). Such a company may have real-time data capabilities that enable predictive production, 1-to-1 business or other optimizations that a less capable company cannot achieve. Elements of Stage 3 companies can be found in some of our examples. Other aspects of Stage 3 companies await the discovery of new systems and engineering principles.
CONCLUSION

The productivity gains due to advances in information and communication technology over the past decade have been impressive. Driven by the exponential growth in capabilities summarized by Moore’s Law, IT has extended the reach of enterprises beyond their premises, often beyond recognizable geographic boundaries. This has enabled not only new businesses but also new business models as global competition aided by IT marketplaces to spring up wherever value can be added to existing businesses. The growth of electronic commerce and the impact of the Internet and web-based technologies are examples that are by now familiar to all.

<table>
<thead>
<tr>
<th>Maturity Stage</th>
<th>Description</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Traditional Compartmentalized Enterprise</td>
<td>▪ Emphasis on vertical organizational boundaries&lt;br&gt;▪ Highly leveraged economies of scale&lt;br&gt;▪ Predictable market demands&lt;br&gt;▪ Predictable economic and competitive pressures</td>
</tr>
<tr>
<td>2</td>
<td>Lean, Flexible Enterprise</td>
<td>▪ Externally focused on customer needs&lt;br&gt;▪ Production strategy matched to markets and business needs, not to predetermined organizational roles&lt;br&gt;▪ IT is used to enhance marketing precision, understand contexts and shifts</td>
</tr>
<tr>
<td>3</td>
<td>Optimized</td>
<td>▪ Transformation is driven by strategy&lt;br&gt;▪ Quantitative understanding of external forces&lt;br&gt;▪ Predictability in execution under varying assumptions&lt;br&gt;▪ Key processes are measured and results are fed back to decision-makers</td>
</tr>
</tbody>
</table>

**TABLE 2.** Transformational Maturity Matrix
Competing in such a rapidly changing environment has required IT professionals to concentrate on the role that architecture plays in the modern IT landscape. The rush toward open interfaces, standards based solutions and platforms have been driven by a few simple economic forces. First, in a networked world, the value of IT infrastructure is measured by how many ways it can be used. Second, it is almost impossible to predict the applications and requirements of the future, so current design investments should make as few assumptions about the future as possible. Third, the cost of owning an IT system increases dramatically with the complexity of the system.

This is the attractiveness of web-based technologies. They allow organizations to deploy a common access technology (the web browser) that makes very few assumptions about the physical nature of computers and networks. Web-based technologies also make few assumptions about applications, so an IT manager is not “locked” into a large investment that is specialized to the applications of a single vendor. Finally, web-based technologies are conceptually simple and do not require the same level of maintenance as more complex integrated systems.

These are also advantages for enterprises undergoing transformation. The architectural view of IT infrastructure has proved to be a key component of IT strategy for companies that adapt and change successfully. The architectural principles that time and again are cited in studies how IT enables successful transformation include:

- Open standards and interfaces
- Composition and modularity
- Data consistency and integration
- Network access and applications
- Scalability
- Service-orientation
- Human-centered technology.

An organization that has invested in enterprise-wide deployment of systems that have these characteristics is in a better position to adapt. In fact, organizations that want to make transformation a core competency set out to explicitly build their information and communications infrastructure according to these principles.
Does that mean that a company that does not use standards based architectures and web applications cannot survive transformation? There are clearly examples to contrary. On the other hand, without an architectural basis for change, company leadership is forced to contend with change processes as a (usually complex) change “project” that has to be carefully and successfully managed. The more complex the change, the more projects there are to manage and the more complex each project becomes.

This has led us to a model of transformational maturity that classifies the inherent capability of organizations to change. The least mature enterprise has a fixed compartmentalized structure of a vertically integrated manufacturing company, i.e., a company that has been designed functionally well in a predictable competitive and economic world. A more mature enterprise is lean and flexible and makes use of IT to enhance understanding of its customers and of the large-scale forces that affect it. At the upper end of the maturity scale is the enterprise that is optimized from a transformational standpoint. An organization at this level of maturity has invested in “options” that essentially make transformation a core business competency. Not only are such companies able to accurately predict the impact of change (often with quantitative precision), they can do so under varying assumptions, can measure the effect of change on key processes and feed that data back to decision-makers who can alter the strategy accordingly.

REFERENCES


NASA. (2005). from [http://is.arc.nasa.gov/HCC/](http://is.arc.nasa.gov/HCC/)


