Global Text

The CIO Handbook

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The Global Text Project is funded by the Jacobs Foundation, Zurich, Switzerland

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Introduction

In this chapter we will discuss the role the CIO plays within an organization. The CIO can often wear many hats within an organization depending on its structure, size and industry. Our goal is to understand how a CIO functions to accomplish IT (Information Technology) initiatives aligned with business objectives. As we will discover, few IT projects and functions are performed without the objectives of the business in mind. The CIO is a key executive within most organizations and we'll examine further how this role became a key part of the modern organization. We will also explore how the role of the CIO differs among various industries and organizations, and we will discuss the important factors of IT that CIOs focus on most often.

Learning Objectives:

- Understand how and why the CIO role came to be prevalent in global organizations
- Learn the key responsibilities the CIO has within the organization
- Understand how the role of the CIO differs between organizations and various industries
- Identify the key differences and similarities between the CIO and the Chief Technology Officer (CTO)
- Identify the key challenges of the CIO role and how they are handled
- Learn to identify risk in an IT project from a management perspective
- Obtain the knowledge to determine whether or not you would be interested in being a CIO

Key Chapter Concepts:

- History: How did the CIO role evolve?
- What is a CIO: What is the primary function of the position?
- Strategic Uses of IT: How is the CIO's role aligned with business and organizational purpose?
- “There's No Such Thing as an IT Project”: How does this concept relate to an executive who's role is focused heavily on technology?
- Fit Within the Organization: What role does the CIO have with respect to the other C-level executives and board members within an organization?
- Staying Current: How does the CIO ensure that business and IT initiatives are in line with industry trends and newly developed technologies?
- The CIO as a Change Agent: What role does the CIO play in guiding the organization?

A Little History: From Director of IS to CIO

The role of the CIO is a relatively new one in the context of the global organization maturity time line. Prior to the advent of the Internet and the explosion of IT initiatives that enabled advanced business processes, the leader of the IT organization within most organizations was commonly referred to as a Director or Vice President of Information Systems. The Director or Vice President of Information Systems often reported to a Chief Operating Office (COO) who oversaw the operations of a organization from a business perspective, which included technology based processes.

As technology and information systems were developed to the point at which they were considered to be the backbone of business operations, it became apparent that the level of responsibility and accountability required to effectively operate, develop and derive business value from these systems warranted a C-Level title. Also part of this transition to the CIO as the head of all IT initiatives was a need for the CIO to be a true business leader within the organization. The key characteristic of the new CIO role was that it no longer encompassed only the knowledge

of technology and operations, but now included, and with a heavy emphasis, the knowledge and acumen to lead large organizations and to understand the business well enough to ensure that business and IT grew more aligned for the advantage of the firm.

This transition did not happen uniformly among all industries or geographies. It started earlier within organizations that relied more heavily on technology or that were closer to the development of technology itself. The industries that have been more traditionally technology-centric such as financial services, software development, and high tech manufacturing started this trend, as other industries such as health care and retail followed more slowly.

There are certainly exceptions to this rule, however in general we consider the role of the CIO to be one that evolved out of a need for broader and more business centric technology management. Many other C-level roles have been newly created in recent decades as well, some examples include Chief Marketing Officer, Chief Investment Officer and Chief Nursing Officer. Like the role of the Chief Information Officer, these C-Level titles also arose from a need for executive leadership in the functions that serve as the organization's core competencies.

Today the existence of the CIO role is prevalent among organizations in all industries, which tells us that IT has become a core competency for organizations across various industries and fields of study. While the role of the CIO originally came from the business world, the role now exists at universities, hospitals, public schools, governments, and non profit organizations as well as many others. The role is now critical to any type of organization that heavily leverages technology to meet its objectives. Interestingly, the 44th President of the United States, Barrack Obama, announced after his inauguration in 2009, that he would create the position of the first ever CIO of the United States of America. Now we see that the role of of CIO has now reached the highest levels of world government.

As a result of this transition we now see technology playing a more important role than ever before, and in part the role of the CIO has further developed the notion of IT being a major factor in an organization's success.

What is a CIO?

The CIO performs many functions within an organization that are both directly and indirectly related to IT. The CIO is considered to be the highest level executive within the organization's IT function and usually has a number of people within the organization that report to him or her on tactical projects, IT initiatives, and operational functions relating to technology. It is often noted that the key role of the CIO is to ensure that technology operations are running smoothly and within budget, and that processes running on technology are functioning in alignment with the business objectives of the firm. In many ways the CIO is the key translator between the business and IT functions within the firm. This is in part because, traditionally, executives have failed to understand technical issues and need someone who has expertise in business as well as technology.

A Real World Example: FFF Enterprises

When FFF Enterprises Inc. grew sales by 400% in four years, the need for IT to support this rapid growth began mushrooming out of control. So executives sought out an IT leader to restore order. "We called in the Marines," laughs Kit-Bacon Gressitt, FFF's vice president of marketing.

Specifically, they hired Bob Coates.

Coates became the first technology executive at the Temecula, Calif., distributor of biopharmaceutical products. The ex-Marine[1] even exemplifies the basis for the organization's name: the Latin fortuna favet fordibus, or fortune favors fortitude.

Now, a little more than a year into his tenure as vice president of technology, FFF estimates that nearly a dozen new IT initiatives contribute to the firm's continuing growth of about 20% per year. That's no small feat in an industry besieged by supply shortages and widely fluctuating pricing, not to mention the threat of drug counterfeiting.

Early on, Coates brought business intelligence to FFF, whose primary business -- the distribution of human plasma products -- is most susceptible to those threatening market forces. He pioneered an electronic tracking application that demonstrates the integrity of the supply chain through which FFF distributes those products. He engaged

[1]"Marine" refers to a member the US Military branch known as "The Marine Corps"

technology with many familiar industry acronyms: CRM, HRIS, VoIP. He brought discipline to the process of evaluating technology offerings. Yet Coates is no drill sergeant. Colleagues attribute his success to listening, teamwork and process. CEO Patrick M. Schmidt calls him "indispensable, innovative and essential." (McCrory nd).

Where Do CIO's Come From?

CIO's come from a wide variety of backgrounds within technology and business. Some rise from technology management roles within a firm, and thus have an extensive background in the hands-on management of networks, software applications, databases, servers and data storage, while others have backgrounds in management consulting, business development, and operations. Very often a first time CIO will come from a senior role on the management team of an organization.

While it is important for a CIO to be educated in the field of IT, it is also important that the CIO have a detailed understanding of the firm's business and industry. For this reason, many CIOs evolve from positions that center on business functions. For example, a CIO in the health care industry may have a background in health care consulting or even as a physician. He or she may have developed a background in IT through projects undertaken in the past or through roles played in previous careers. These are typically the best candidates for CIO positions because they have experience that spans IT, business, and management.

As we see from the real world example of FFF Enterprises, the skills required to be an effective and productive CIO can be acquired through a number of means and experiences. In the example we could attribute Mr Coates' leadership and process management capability to his experience as a United States Marine. The important thing to remember for students who one day aspire to be CIOs is that currently there is no specific career path designed to prepare a would-be CIO. In our quest to achieve the role of CIO we just need to be certain that our career experiences contribute to the development of skills that relate to IT, business management, and equally important, organizational leadership.

Key Responsibilities of the CIO

The responsibilities of a CIO will vary between organizations but in order to define the core purpose of the CIO role we'll get a little help from the Info-Tech Research Group, an organization based in Ontario, Canada that provides research on a wide variety of IT related topics. The Info-Tech Research Group has provided this explanation of a CIO's job description:

“The Chief Information Officer’s role is to provide vision and leadership for developing and implementing information technology initiatives. The Chief Information Officer directs the planning and implementation of enterprise IT systems in support of business operations in order to improve cost effectiveness, service quality, and business development. This individual is responsible for all aspects of the organization’s information technology and systems.” (IT Business Edge 2010)

This is one of the most concise accounts of what a CIO's role is within a given organization that we've seen.

There's No Such Thing as an IT Project

This sounds ludicrous! Or does it? How could there be no such thing as an IT project when so many businesses depend on IT for their day to day operations and the delivery of their products or services? If you enter the field of Information Technology you will likely hear this phrase again at some point in your career. All that is being said here is that no technology project should be undertaken if it does not support a business purpose.. Technology can do many great things, it can even provide some functions for businesses and consumers that are just plain cool. However a CIO should never engage a project “just because”. The project or initiative must serve a business purpose. The business purpose or objective could be a wide variety of things, the most common are cost cutting, enabling productivity, streamlining manual processes, increasing marketing effectiveness, delivering products or services electronically and enabling communication between employees, customers or both. While this concept is relatively simple, it is inherently very important to how IT is aligned with the business, and how IT projects in and of themselves need to be aligned with the business objectives they are designed to achieve. We'll identify this again and briefly recap the topic in our next section on CIO challenges, however it would be appropriate at this point to look at an example of how IT and business should be aligned. We will see in the following example how functions of IT projects need to be prioritized in terms of their alignment with the business, and this process will be discussed again in more detail in chapter 4. Let's look at a table (Figure 1) that is designed to lay out a decision model around a business focused IT project and its components:

Business Objective	Technology Focus	Functions	Expense	Required (Yes/No)
Attract New Customers Collect information from potential customers who visit the firm's website so we can see what products they are most interested in and so the firm can follow with custom, direct marketing material and product information.	Firm's website and associated database, JAVA and graphics technologies, all leveraging web based forms.	**WEB FORM** - to capture customer information	$$	**YES**
		DATABASE – to store and analyze prospect information	$$$$$	**YES**
		WEB COOKIE – track user navigation patterns on the site	$	**YES**
		REPORTING TOOLS – to distribute demographic and preference data to marketing	$$$	**YES**
		EMAIL MARKETING SOFTWARE – to create specific marketing emails based on preference data	$$$$	**YES**
		ERP PLUG IN – to add prospect information into the ERP customer database	$$$$$$	**NO**

Table 1: Figure 1

As we can see here the business objective was to allow the firm to collect information from prospective clients who visit the firm's website looking for information on the organization and about its products. All of this is to serve the overarching business objective of **attracting new customers**. The firm wants to know who the potential clients are (name, address, phone number, email), and what pages on the site are visited by them so the marketing group can send them specific information related to their interests via email or direct mail. This is a very common type of web based marketing project.

Based on our business objective we can determine that a web based form for customers to enter their names and contact information is essential. Without this functionality we would not be able to capture the information we need to send out our marketing material to the prospective customer. The database component is also critical because we have to store the prospect's information in a logical format so we can use that information to send out our material and to easily determine where our prospects are located geographically. This will help tell us in what region prospects seem to be most interested, and what regions we need to market more based on limited interest and site visitation. Third, the web cookie is another key component for us to understand where a user visits on the site. Let's say our products and services are categorized on different pages of the site, thus we need to know which pages the prospect visited so we can determine what products they are interested in, and the cookie helps us do that. The fourth component, reporting tools, is also essential because we need the ability to pull the right information from the database in order to let our marketers know what material to send to which prospect. One

prospect may be interested in software whereas another may be interested in services. We need to know which prospects are interested in which offerings so we can provide them with the most relevant information. The next critical component is the email marketing software. This software allows the marketing group to feed reports from the database into the email system and have specifically targeted marketing information sent directly and automatically to each of the prospects. The final component listed in the functions column, the ERP plug in, is really not necessary. Why is that, wouldn't it be good to have this information in our customer database as well? The answer is that it might, for several reasons, but the fact is that these names and usage habits we are collecting are for new prospects, not existing customers. A current customer would not fill out the form we've designed for "new customers" and since the prospects aren't customers yet, we do not want to confuse things by having non customers in our customer database. This is also identified as one of the most expensive parts of the project, and therefor would be a significant waste of financial resources.

Thus in moving forward with our project, the CIO would choose to pursue only the portions of the project that were absolutely necessary in order to achieve the business objective of adding new customers. We can now see that this project and all of its approved components are critical to achieving the business objective, and those not critical to the business objective are left out. If a new business objective arises and the ERP portion becomes relevant we will examine it again, but for now that functionality will not be included in our project. This is in general what we mean when we say "there's no such thing as an IT project", we mean that no project is undertaken just because a technology exists that makes a function feasible. The function must serve a specific business purpose. We can also see that even if a project overall is designed to serve a business function, a portion of that project proposal may not be specific to serving the business need, and therefor we must create decision tables like these to evaluate what a CIO should and should not pursue.

Challenges Faced by the CIO

CIOs today face many challenges in implementing strategic technology systems and in keeping critical operational systems up and running efficiently. The challenges range from leadership of large and diverse organizations with complex employee reporting structures to dealing with technology complications and service outages. Let's identify several specific but common challenges faced by CIOs:

Business and Technology Alignment

Keeping IT initiatives aligned with business objectives is no small task. The CIO must ensure that new system implementations or changes in applications or infrastructure are designed to serve one of the many business objectives a firm may have. Business initiatives can be associated with cost cutting, increases in service levels, revenue generation or operational effectiveness. A technology project must serve a business purpose and should be planned, executed and evaluated for its impact on the business objective.

Managing Costs

Most of us who use technology on a regular basis understand that there is often a significant investment required to leverage new technology. The costs associated with IT initiatives include the acquisition of software and hardware, operational personnel, training and other expenses such as power to run the systems and cooling (essentially air conditioning) for larger data centers. Because a CIO is responsible for ensuring alignment with business objectives, he or she must closely manage the costs of IT operations. A CIO must also perform various types of financial analyses in order to determine the total cost of ownership (TCO) and Return on Investment (ROI) for a given technology implementation or project. This helps the organization understand whether or not a proposed technology initiative is a worthwhile investment. We will go into much greater detail in the section on managing risk.

Managing Change

Very often organizations get into comfort zones with respect to technology for a number of reasons. Users of organizational systems become accustomed to how they work and are well trained, and they also understand what level of effort and time it may take to complete a process on a given system. These are not bad qualities for users to have at all, to the contrary these are good traits!

However, eventually the business and technology landscape can change in a manner that may result in a necessary adjustment of some sort within the organization's IT department. This change could be related to a new business process that has come about as a result of increased competition, or perhaps a new technology that has enabled functionality that can save the firm a great deal of money. Whatever the new requirement, it is often difficult for an IT organization to embrace change in their environment, in part because what exists today was such hard work, why would they change it? Well, sometimes they have to do so, and the key agent of change for organizations who embark on new technology initiatives in order to bring about change is typically their CIO.

When an organization recognizes that a change within IT needs to happen they often look to the CIO to validate what options are available and to select the proper vendors and implementation partners. Also, the CIO is often

responsible for the execution of the new project and its overall success. Large business changes requiring IT efforts bring to the CIO the highest levels of accountability within the organization. When multi-million dollar budgets are being proposed for changes in IT, it is crucial that the CIO is managing the change in accordance with the desired business benefits. So you can see that even where projects are focused heavily on technology, they must still be in alignment with the business objectives.

Managing Risk

As we now understand, information is often viewed as a organization's most critical asset, and it is the CIO's responsibility to ensure that a businesses' information is secured from competitors, protected from natural or operational disaster, and available at all times for personnel to manage the business and continue operations. For this reason, CIOs constantly evaluate and test systems that are designed to allow businesses to continue operations should the primary operational location become in some way incapacitated. Today there are literally dozens of means, and hundreds of software applications available to backup and protect business critical information. Given the wide variety of technologies available to accomplish this goal, CIOs must be certain that the technologies and processes implemented by an organization provide the right level of protection at the right cost. Many CIO's have employee teams dedicated to risk analysis to help alleviate the impact of an unforeseen event that limits access to information.

Another element of risk that is inherent to the CIO's daily management function is project execution. Because IT is a relatively complex function in most large organizations, the undertaking of large software or hardware based IT projects comes with great financial risk. The risks associated with chosen projects include more than just the investments organizations make to purchase software or services. They also include how the project impacts operations, revenue, employee resources and customer satisfaction.

Problems with software implementations can have other negative effects that may not be seen in the bottom line for some time. For example, if this system were customer facing, some customers may not have been able to deal with the delays and problems and may have taken their business to a competitor. Some employees frustrated by the problems may have resigned from the organization and good managerial or operational talent could have been lost. Finally, the issues created by the project may have cost the organization valuable capital that was better invested elsewhere, and the organization may have been detracted from its daily operations which could have the impact of increased costs and reduced revenue in other lines of business. The impacts of an IT project failure may be so far-reaching that they can often be difficult to quantify directly, beyond the obvious impacts we're able to account for in our simple financial model.

This appears to be a rather extreme example of an IT decision mishap doesn't it? Well, it may certainly seem logical that if the risks posed could be so severe, why would any CIO decide to move forward with such a project? The fact is that business decisions up and down the organization are often very political in nature and sometimes lack the proper analysis to identify the inherent risk ahead of time. If the CIO is convinced that a project is the right move, few of his or her direct reports may challenge the opinion of their manager.

To throw in some startling reality regarding this topic let's look at a few numbers from a Harvard Business Review article on IT management written by Andrew McAfee, published in 2006 (McAfee 2006). This article identifies that in a research study conducted by the IT consulting organization, CSC, and the Financial Executives Research Foundation in 2005, respondents revealed that 51% of large-scale IT projects were completed later than originally intended and as a result the same number of projects ran over budget. In addition, the same study revealed that only 10% of businesses engaging in these projects saw high returns on their investments and 47% said that the returns from such projects were either low, negative or unknown. Regardless of the expected or realized return, a project of any significance should include a post implementation review in order to determine the return from the project and the source of any success or failure, either with a piece of the project or for the project as a whole. Post implementation reviews will be covered in more detail in chapter 4.

Therefore the risks associated with the CIO position and the challenges faced in managing those risk are very extreme. This is often the reason cited for the statistic that an average CIO's tenure in a large firm is less than three years. That sounds like a very negative figure, and it can certainly be negative if a CIO encounters a major project failure in his or her career. It's not all grim though, as we've seen plenty of CIOs who have interesting and very prosperous careers.

Strategic Uses of IT

What constitutes a “strategic” use of information technology? It is important to note that what is strategic to one organization may not be strategic to another depending on how their core competencies may differ. So is there a right answer to this question? The answer is that like many other subjective aspects of IT, it all depends. There are certainly some common uses of IT that may be strategic among certain organizations but an organization's primary business model often dictates how they use IT as a strategic differentiator.

Today there is also some question and debate as to what aspects if IT constitute "strategic advantages". For example, does an Enterprise Resource Planning (ERP) system provide a strategic advantage for a given organization? It may of course but as this text is being written (in the year 2009), ERP and Customer Relationship Management (CRM) systems are becoming somewhat ubiquitous in many, if not all large organizations across a wide variety of industries. Let's take an example of a technology that we might consider to be a little more basic: email has been a prominent technology for more than a decade in the United States and other more technologically advanced countries. Now that all large and most small organizations operate, at least in part, using some type of email system, whether it be a large scale email server system such as Microsoft Exchange or IBM's Lotus Notes, or perhaps a free email account from Google or Yahoo, these organizations have found that this type of communication is no longer a strategic advantage, but more a necessity to do business in today's world.

This is not to say that the use of IT is no longer strategic, but that certain elements of IT in themselves may no longer be so. Many business scholars argue that strategic advantages are not found in technologies that are ubiquitous, but in those that are actually more rare. Creating a website may be part of a growth or competitive strategy for a small business that is looking to expand beyond its current market or is attempting to streamline communications with its customer base. However, the website itself is not inherently strategic, yet the functionality it provides may in fact be very strategic. So from this small example we can conclude that while technology is not a strategy in and of itself itself, what CIOs and other business leaders do with technology in order improve business relationships, cut costs, service customers and market products all constitute strategic elements that can be carried out through the creative use of Information Technology and associated business processes.

How is IT Used as a Strategy in organizations Today?

Now that we've covered how IT can be part of a business strategy, we can discuss some examples of the types of technology innovations lend themselves to specific business strategies.

- **United Parcel Service –** United Parcel Service, or more commonly known as UPS, uses Global Positioning Systems (GPS) to create routes for its delivery drivers that consist mainly of right turns. The effect of this new process, enabled by technology that is relatively new in business and consumer applications, allows the drivers to complete their routes in less time because the system reduces the amount of time spent in traffic and waiting at stoplights in heavily populated areas. It also results in less fuel required to complete the route which provides significant cost savings.
- **Fresh Direct –** This US provider of grocery delivery services uses the Internet to allow customers in New York City to shop for groceries online instead of having to walk or take a bus or taxi to obtain items traditionally sold in grocery or convenience stores. By using an extensive ERP system in conjunction with a web based shopping interface, Fresh Direct can deliver groceries the same day as ordered without having to bear the high costs of New York City storefront real estate or open air refrigeration. The result is a cost effective management of inventory with a high level of customer convenience and satisfaction.
- **MySpace** – This online social network allows users to share words, ideas, photos and video in a collaboration format that is friendly and fun to use. Users have the ability to create groups based on common interests and share posts of various content related to a specific topic. MySpace has given users functionality that was previously rare on the Internet prior to 2003. MySpace derives revenue from advertisements posted on the site that can be targeted to specific users based on their interests and preferences.

These three examples highlight how companies can use IT to drive efficiency (UPS), revolutionize an industry (Fresh Direct), and to give users functionality that draws them to certain types of advertising (MySpace). So now we can understand that organizations select technologies and implement projects based on how they can effectively use IT to facilitate a given strategy. In these examples, each organization has used IT differently to achieve its goals.

What are the Most Common Technology Applications managed by CIO's in Businesses Today?

In the first part of this section we mentioned a few common technologies that now serve as the foundations for business operations in larger organizations. While we identified that these technologies may not be "strategic" given their prevalence in the marketplace, they are no less important as they have become fundamental to operations and decision making for organizations on a daily basis. You will learn about these technologies in more detail in the course of the following chapters but it would be a good to start to identify the core technologies that our CIOs are responsible for from an operational perspective. Here are few types of IT systems that are considered to be mission critical:

- **Enterprise Resource Planning Systems (ERP):** These systems are a combination of software, hardware (servers and data storage) and services that enable organizations to manage large scale operations in an automated fashion. ERP systems may include information from suppliers, vendors, personnel and other sources to align businesses process for the purposes of manufacturing, distribution, inventory management and other business critical operations. They are often highly complex and

contain specific work flow functions that help businesses achieve their goals. Some of the most commonly used systems are provided by organizations such as Oracle and SAP.

- **Customer Relationship Management Systems (CRM):** CRM systems help organizations organize customer information in a manner that is designed to improve customer service and to track important pieces of information related to sales, marketing and service or product delivery. These can also be complex and are sometimes incorporated into larger ERP systems. The common developers of CRM applications are the same as ERP systems with a few additions. They include Oracle, SAP, Microsoft and one of the newest and fastest growing CRM providers, Salesforce.com, which provides its software directly to clients over the Internet through a process called Software as a Service (SAAS). We'll learn more about SAAS in the coming chapters.
- **Email Systems:** Email is now very common, as we mentioned earlier. This form of communication allows users to send and receive typed messages in electronic format on their workstations as well as on mobile devices such as smart phones and personal digital assistants (PDA's). This technology has become so inherent to corporate productivity that it is now categorized as mission critical. Email is as important to organizations today as telephones and fax machines have been in previous decades.
- **Purpose Built Applications:** This phrase refers to software applications that are developed by an organization internally or by a third party software developer or systems integrator and are designed to provide a specific function or set of functions that are critical to an organization's operational model. For example, a health care concern may develop a system that stores specific patient data in a particular type of database that can be accessed by doctors, nurses, and other medical care providers. Another example is an application that stores images of checks or statements for customers of a financial institution that can be accessed via the Internet. Other examples include financial reporting, stock trading, and advertisement tracking applications. These are just a few examples from a list that is literally endless because new purpose built software applications are being designed, written and implemented on a daily basis around the world.

We can conclude from the many examples described above that technology and strategy are very much intertwined. We also see that how a firm uses technology as part of its strategy is dependent on what the organization's business objectives are and what constraints may exist in terms of human resources and investment capital. Many students have been under the impression that technology has completely changed the way organizations view business strategy. While this is a common notion, it couldn't be further from the truth. The advancements that businesses have made in terms of technology actually make the fundamentals of competitive and operational strategy all the more important because technology literally puts customers “one click away” from the competition! Hence we now have a clearer view of why business acumen is so important to the role of the CIO.

What is the Difference Between a CIO and a CTO?

This is a question often asked because some organizations have both of these positions, and others have one or the other. In general, organizations who rely on technology as part of their key product or service strategy may have a CTO in addition to a CIO. The acronym CTO, refers to Chief Technology Officer. Organizations with this position usually leverage the CTO role to help define a direction for the technologies an organization is going to use to deliver a product or service to their customer base. For example, a CTO may decide that an organization is going to build its products to be compatible with certain server operating systems, or use certain web languages and technologies such as HTML or JAVA. Much like the CIO, the CTO is also responsible for staying ahead of current trends in technology and business in order to ensure that the organization's direction in terms of technology will enable future growth and serve target markets more efficiently.

While the CIO role evolved from what was previously known as the Director of IT, or Director of IS, the CTO role's roots lie in the leadership of research and development. The CTO became a standard role primarily during the dot.com boom of the 1990's. Since so many of the new organizations founded at that time were firms that sold software, hardware or services that leveraged technology, the chief role of the research and development departments of these firms became known as the CTO. In less than formal terms the CTO may have often been referred to as the “Head Geek” of the organization, describing a person who's passion, execution, and visionary approach to technology is paramount to that of others.

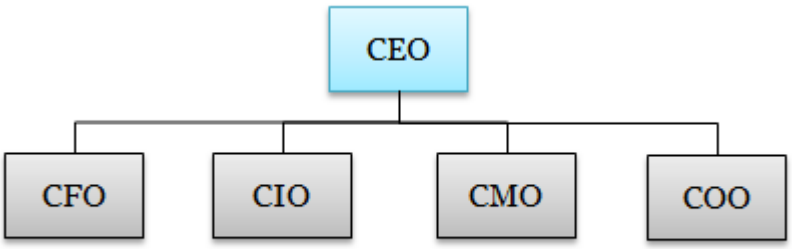
In many cases the traditional roles of the CTO and CIO overlap within organizations. In some cases the CIO and CTO roles are performed by the same individual that carries one of these titles. For example, the CIO of Harrah's Entertainment, the largest casino operator in the United States, is a man by the name of Tim Stanley. Stanley operates under the title of CIO and Senior Vice President of Innovation (Hoover, 2007). The title, and the role suggest that Stanley wears more than one hat in his organization. For all intensive purposes the Vice President of Innovation is much like the traditional CTO. Information Week magazine gave Stanley the honor of Chief of the Year in 2007, for his role as an innovator and key business manager for Harrah's. Stanley is not only responsible

for the day to day operations around gathering customer data and performing business intelligence initiatives that help Harrah's marketing efforts, he's also involved in making key decisions about how technology will be used to grow the business and what acquisition targets the organization should be considering. A great example of an initiative that Stanley was working on at the time he received the award is the use of Radio Frequency Identification Device (RFID) technology in the firm's casino chips in order to track the flow and whereabouts of all the chips used to gamble in the casino. This allows the firm to track the performance of tables in the casino much more accurately than ever before. In another initiative using the same technology, Harrah's is exploring roulette kiosks that allow customers to gamble electronically on any roulette wheel in the casino, without being at the table. One of the reasons this could be so attractive is that only a certain number of players can physically fit around a roulette table in the casino. In order to serve more customers the casino has to open more tables, which requires more human resources. By allowing customers to gamble electronically on an existing game, the casino leverages its resources to increase play while allowing customers greater options. If a customer is having bad luck on one of the tables they can easily switch to another active game without ever leaving their seat. And the fact that the games being played are real games, not purely electronic, the skepticism some players have with purely electronic gambling is eliminated. Stanley is leveraging technology to increase revenue, while laying out a key strategy for the use of technology in Harrah's business.

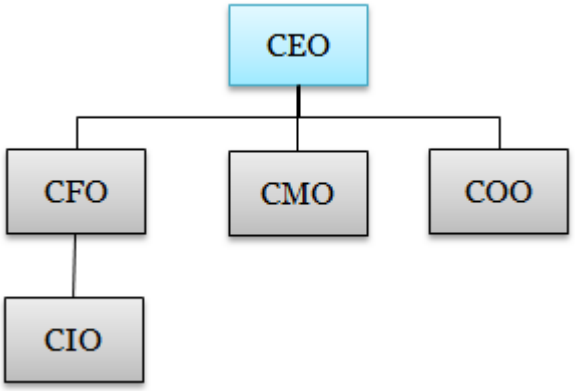
This example is one of the finest in illustrating how the roles of CIO and CTO come together within certain organizations. The roles and their definitions depend not only on the culture of the organization, but also on the ideals and aspirations, strengths and weaknesses of the individuals that hold these roles.

How Does the CIO Fit Within the Organization?

Many organizations have different reporting structures for the CIO. While we've established that the CIO is commonly the head of the IT organization within a firm, the executive the CIO reports to can vary from organization to organization and from industry to industry. In some cases the CIO will report directly to the CEO of the organization and will be a peer of the CFO (Chief Financial Officer), COO (Chief Operations Officer), CMO (Chief Marketing Officer) and the other C-level roles a firm may have. In other organizations a CIO reports directly to the COO or CFO. The first model described might look something like this (Figure 3A):



The second model described might look something more like this:



The second example here is actually more common in today's large corporate environments. The lines from the CFO and COO to the CIO represent the fact that the CIO could report to one or both of these C level executives because the CIO's role and organization is one with both operational and fiscal responsibility. Some CIOs candidly refer to their role as "The C level title that no other C level executive wants to have", and even in today's world of rapidly advancing dependence on technology, CIOs often struggle for acceptance and equality with regard to the executive management team within a organization.

IT and the Board of Directors

Both diagrams above also bring to mind a question about how the CIO and his or her organization is represented at the Board of Directors level within a organization. Typically the CIO does not meet regularly with the Board of Directors. When large-scale IT projects are being proposed the board may ask the CIO to present the project or initiative to them in order to determine whether or not they will approve the funding and resources required for the project, and to get a an idea of what sort of operational or financial return can be expected if the organization chooses to approve the project.

This is one of the elements of IT management that experts in the field believe is a hindrance to the use of technology within organizations. Some believe that the IT organization requires regular representation and further, advocation, at the Board of Directors level. The lack of IT representation at this level of management is likely due to the fact that in most organizations the CIO is not viewed as a peer of the rest of the C level team, but more as an extension of the executive branch of leadership, though there are exceptions such as the example of Tim Stanley of Harrah's Entertainment mentioned earlier. As we saw the CIO role evolve from Director of IS role, we may also see the CIO position elevated in status to be included as part of the core executive team in the future. As IT becomes even more important to businesses, the need for the highest level of representation may be warranted.

In their 2005 Harvard Business Review article entitled "Information Technology and the Board of Directors", Richard Nolan and F. Warren McFarlan explained how the ever increasing dependence of organizations on information technology is making members of organization boards more concerned and thus more proactive in involving themselves in technological initiatives. They suggest that, just at lease one board member is expected to have financial accounting expertise (because or recent financial reporting scandals), at least one board member should have IT expertise as technology becomes more and more important for success in today's world. F (Nolan, McFarlan HBR 2005). This is certainly evidence of a continuation of the trends that contributed to the initial rise of the CIO.

Staying Current

While there are many forums available for learning about the latest advancements in technology for a given industry or sector or just IT in general, very often time and priority become significant factors in how much effort goes into this important but often overlooked aspect of the CIO role. The key categories of the forums available to aid the CIO's continuing education are trade publications and websites, trade shows and conferences, user groups and customer councils, industry associations, and industry standards organizations. We will discuss each in more detail.

Trade Publications and Websites

Trade publications are magazines, Internet sites, or other periodicals published with a very specific focus and target market in mind. In the technology sector there are many such publications and, due to the nature of the content, many are found solely online. Some of the top technology specific trade publications include: Computer World, Information Week, E-Week and many others. There are also trade publications that are specific to certain technologies such as Storage Magazine and Database Trends and Applications Magazine. Another technology focused periodical that is broad enough not to be considered a trade magazine, that is also very popular, is Wired magazine. Even more prevalent than trade magazines are technology focused websites such as www.searchstorage.com and www.searchsolaris.com which are two of a large number of technology specific websites that are sponsored by a firm called Tech Target. It should be noted here that staying current with industry and business trends can be apart from this type of technology specific focus, and because CIO's are business leaders, many are regular readers of Business Week, Fast Company, Harvard Business Review, and the Wall Street Journal. These business based periodicals are considered "must reads" in many business leadership circles.

Trade Shows and Conferences

Many industries have associations or groups that organize trade shows and conferences around a specific topic or set of topics. One of the largest and most well known of these events in the United States is the Consumer Electronics Show which takes place each year in Las Vegas, Nevada. At this show vendors and all affiliates of the consumer electronics industry come to learn about and see for themselves the newest innovations in consumer

electronics. The organizations participating in this show are among the top names in the industry such as Sony, Microsoft, Nintendo, and Apple. Attendees also come to hear keynote speeches from top executives such as Bill Gates (Founder, Chairman and former CEO of Microsoft Corporation) and Steve Jobs (Founder and CEO of Apple).

The IT industry has many such conferences that focus more specifically on technologies that would be applicable in the corporate world. These conferences also typically include keynote addresses from top executives in a particular field and also include educational tracks or curriculum where conference attendees can register for a series of lectures on a topic or series of topics. In order to draw participation, educational sessions are likely to focus on areas of excitement in the industry Some of those you might see today are based on the concepts of Virtualization, Software as a Service, and Cloud Computing which you will learn more about in the coming chapters. A few examples of widely attended conferences related to IT are Interop (www.interop.com) which focuses on infrastructure and software technologies, Storage Networking World (www.snwusa.com), a conference focused on technologies related to data storage, and HITEC (www.hftp.org), which focuses specifically on technology for the hospitality industry. Large technology vendors also put on their own conferences to showcase best practices and capabilities of their products and services, we'll discuss these in more detail in the next section.

User Groups, Customer Councils and Vendor Specific Conferences

Many vendors of IT products have very large and diverse customer bases, and thus they often sponsor user groups, customer councils and conferences to help market their products and to obtain customer feedback on what products and service offerings customers would like to see developed in the future. While these forums are designed primarily to aid sales of certain technologies, they are valuable for IT executives to gain additional insight on new trends and products.

User groups are forums where users of specific technologies can share thoughts about products, get advice from other users and share ideas about what they would like to see the organization develop for their specific needs. While user groups are rarely participated in by CIO's, the personnel that are responsible for specific technologies within the IT organization use them widely for staying on top of trends. A good example is the user group sponsored by server virtualization software provider VMware (www.vmware.com/vmug).

Customer councils sponsored by technology organizations are frequently attended by CIO's and high ranking technology executives. In certain cases councils specifically designed for CIO's are referred to as “CIO Round Tables”. These events allow CIOs to meet with their peers from other organizations to share information or collaborate on issues related to technologies from specific organizations. The organizations sponsoring such councils also use the events to gather valuable customer feedback and to help build executive relationships. IBM, Cisco Systems, Microsoft, EMC and Oracle are just a few of the large organizations that hold these forums for CIOs. Customer councils cater to CIOs from the largest customers of a given technology vendor and are usually by invitation only.

Vendor specific conferences are also key marketing events for technology organizations and offer an opportunity for CIOs and their personnel to stay current with the latest offerings from these organizations. It takes quite a bit of capital to hold these conferences and therefore they are only conducted by the largest organizations in the technology field. A few examples include Oracle World, VMWorld, EMC World and the IBM Technology Conference.

Technology Industry Associations

Technology industry associations are groups that maintain memberships of IT and business personnel and their executives who share interest in a given sector of the technology industry. These associations also hold conferences and regular meetings but differ from the vendor or technology specific conferences mentioned above in that these are typically focused on a topic of technology interest rather than a specific functional technology and thus are much broader in nature. These associations can be global, national or local in scope. Those associations that have a large scale and geographically diverse membership base often have local chapters that conduct regular meetings and events. Some of the most well known associations are the Society for Information Management, also known as SIM (www.simnet.org), the Data Warehousing Institute (www.tdwi.org) and the Technology Leaders Association (www.techleaders.net). Other associations have the objective of promoting the technology industry in a given city or locale. One such example is the Colorado Software and Internet Association, also known as CSIA (www.csiaonline.com), which exists to create a forum for collaboration to promote technology growth in the state of Colorado (USA). CSIA was founded in collaboration with University of Denver professor Don McCubbrey, who is also the editor in chief of this text.

Industry Standards Organizations

Technology industry standards organizations help CIOs and other IT executives implement standard processes and procedures related to IT that in theory help maintain certain levels of control and audit ability in IT environments. These organizations are process centric rather than technology centric and often are composed of a consortium of interested parties from across the IT universe. Other associations for certified personnel in project

management also exist in order to help CIOss implement standards within their organizations, specifically for the reason that standards have long been identified as significant cost savers with respect to process in all aspects of business. Some of these organizations include ITIL (Information Technology Infrastructure Library), ITGI (IT Governance Institute and PMI (Project Management Institute). These organizations provide CIOs with tools that help them manage to efficiency by taking into account the newest and most relevant practices and procedures. We will cover each of these and more standards organizations more completely in chapter 2, as these organizations can play a key role in the overall IS organization.

Prioritizing

All of these outlets provide a means for the CIO to get feedback and to hear new ideas from colleagues, subject matter experts, and even competitors in order to keep current with the latest technologies, industry trends or both. However, we have discussed the numerous key responsibilities of the CIO and you have probably concluded at this point that the CIO is a very busy manager, and therefore may not always have sufficient time for exploring all of the new ideas, products, offerings and trends a particular market has to offer. For this reason much of the technology specific education required to ensure the firm is as far ahead or as close behind the curve as possible is delegated to the leaders of various sectors of technology. You will learn more in Chapter 2 about the IS organization. However, for this topic it's important to point out that underneath the CIO are various technology groups that are highly specific in the technologies they are responsible for on a daily basis. For example there are network specific groups and others related to applications, databases, servers and data storage. As a result, staying current on specific technologies is usually the responsibility of the resources underneath the CIO.

Overall it is important for the CIO to be as current as possible in terms of trends and the capabilities available through technology in his or her industry. This is a difficult task considering the speed at which technology changes, however the firm often looks to the CIO to find the next competitive advantage that can be derived from a new technology. In contrast, some firms and their CIOs do not want to be ahead of the industry or technology curve and are quite content to sit back and let more risk-hungry firms take the chances on new technologies and processes. As we mentioned in the section on CIO challenges, there is a significant amount of risk in any large scale IT project or new implementation that represents changes in a business process. Many firms will purposely allow their competitors to aggressively pursue new technology ideas and after a period of time will evaluate the indicators of validity based on the success and failure of others in order to determine which direction to move. It never hurts to have knowledge of the newest technologies available for a given industry but it is sometimes a smart move to hold off on rushing to the latest craze, and better to let others be the test cases for understanding whether or not a new technology or process is mature enough for wide scale market adoption.

The CIO as a Change Agent

We've left this subject for the last section of the chapter because it provides a good summary of what effective CIOs really encompass and mean to their organizations. In effect, a CIO is an agent of change in both the strategic and tactical sense. On the strategic side are the initiatives invoked by the CIO to increase efficiency and decrease cost, while on the tactical side are the implementations of IT projects and the management of daily operations. According to consultant James Canton, CEO of the Institute for Global Futures, the pace of change in business and the opportunities presented by these changes are accelerating and thus the CIO must be not only the implementer of strategic change but also the predictor and shaper of that change (McCormick, 2008). In our previous sections we discussed the nature and growing importance and responsibility of the CIO within today's organizations. Large scale IT projects and implementations of new processes create opportunities for organizations to gain competitive advantage, and while we identified that a CIO must be agile enough to respond to changes and trends in the business environment, we now also see a need for CIOs to champion these changes, create competitive advantage, and execute projects that result in increased revenue, efficiency and bottom line profits. Part of the reason this responsibility has been relegated to the CIO is that he or she almost always has a greater combined understanding of the the details of technology and its role in business. It has been said by a number of executives in the past that those who know “how”, usually work for those who know “why”. This statement exhibits that senior executives on the business side of a organization understand best the reasons and market forces that make a particular function or offering, be it technological or otherwise, a necessity and further, that the technology or operational personnel who understand how these business visions can be executed tactically are mere implementers in the effort to bring about strategic change or competitive advantage for the organization. This has long been the policy that has kept CIOs in a position of inequality with regard to other senior executives. As we learned from the example of Harrah's CIO Tim Stanley mentioned earlier in this chapter, this concept is rapidly changing as CIOs become more empowered to be the leaders on the forefront of operational advancement. This expectation is likely to become much more broad and generally accepted in the years to come, and as a result we may see the CIO role become synonymous with the role of Chief Change Agent.

Chapter Summary and Review

Now that we have learned about the role of the CIO, let's review how the chapter content maps to our learning objectives for the chapter:

Chapter Learning Objectives and Key Concepts

- **Understand how and why the CIO role came to be prevalent in global organizations**
  - The CIO role evolved from a need to install executive leadership in the IT function of organizations due to the increasing dependence on and complexity of IT environments
- **Learn the key responsibilities the CIO has within the organization**
  - Implement tactical and strategic technology projects within the organization
  - Manage an organization responsible for the daily technological operations of a organization
  - Act as a champion and change agent for competitive advantage and increased efficiency
  - Stay current with industry and technology trends that are relevant to the organization
- **Understand how the role of the CIO differs between organizations and various industries**
  - Since strategic uses of IT differ among industries, the CIO role is in accordance with the importance and criticality of certain aspects of technology to an organization and its industry
- **Identify the key differences and similarities between the CIO and the CTO**
  - The CTO is more important to firms that rely heavily on technology for their product and service business strategy
  - The CTO is often less of a manager and more of a technical visionary in the organization
  - The CTO is also sometimes referred to as the "Head Geek" of the organization
  - In some organizations the lines between the CIO and CTO roles can often be blurred in that typical functions of each role are performed by the same individual
- **Identify the key challenges of the CIO role and how they are handled**
  - Business and Technology Alignment: ensuring IT objectives are designed to promote and enable key business objectives
  - Managing Costs: ensuring that IT functions are managed with financial efficiency
  - Managing Change: enable smooth transitions for users of business systems when new technologies are being implemented and limit or eliminate business interruption during transition
- **Learn to identify risk in an IT project from a management perspective**
  - Conduct risk and financial analysis for all IT projects, objectively reviewing and raising potential issues and concerns for all aspects of the business
- **Obtain the knowledge to determine whether or not you would be interested in being a CIO –** We will address this objective with a series of questions:
  - Are you now comfortable with the role of the CIO as a business and technology leader, or would you prefer to be one or the other?
  - Do you have a new or existing interest in being a key translator of IT to business, and senior executive?
  - Are you interested in the field of technology to the point you would like to pursue a career in IT management?
  - Are you prepared to invest in your career by becoming an expert in technology, capital budgeting and financing, project management, and effective organizational leadership?

Review Questions

Let's review the chapter content with a few questions regarding the key chapter concepts:

1. What were the two critical factors that contributed to the evolution of the CIO role in organizations?
2. What are 3 critical responsibilities of the CIO?
3. Define how the CIO role is aligned with a firm's strategic interest in technology?
4. What is the key meaning and importance of the statement, "There is no such thing as an IT project"?
5. What role does the CIO play with regard to other executive managers?
6. What are three key forums for CIOs to keep pace with technology and innovation?
7. What responsibility of the CIO is growing in importance?

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Chapter 2: The IS Organization

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Learning objectives

- Understand the scope and responsibilities of the three areas that constitute the traditional IS organization: operations, development, and maintenance.
- Become familiar with the respective advantages and disadvantages of a centralized and decentralized IS organization.
- Recognize the differences between traditional and milestone consulting arrangements, and understand the circumstances in which each is most effectively applied.
- Learn methods to successfully utilize consultants.
- Be able to describe a service level agreement (SLA) and the ways in which it varies between the following three outsourcing relationships: conventional outsourcing, collaborative outsourcing, and business transformational outsourcing.
- Identify the three most commonly outsourced areas of IT and know what the associated benefits of each are.
- Understand the importance and need for benchmarking models in the IS organization, and learn about the most common models currently in use.

IT Operations

IT operations refers to the utility services provided by the IS organization (Table 1) and is often used synonymously (but erroneously) with the term IT infrastructure. The definition of IT operations differs across industries, with organizations and vendors often creating their own custom definitions of processes and services for the purpose of marketing their products. Frequently, nonetheless, IT operations includes the management of hardware, network, enterprise security, communications, user administration, and e-mail systems (Information Technology Operations, 2009).

Table 1: IT Operations (Gouge, 2003)

Scope of IT Operations
• LAN/WAN infrastructure management • Systems management and monitoring • Security management • Data center management • Messaging management (e-mail, other electronic communications) • Telecom equipment and administration • Disaster recover (business continuity and contingency planning, backup and restore procedures, test plans) • IT asset management (configuration management, contract and software distribution management, inventory) • Daily systems operations (cost recovery, facilities, job scheduling, output management performance, production control, quality assurance) • Problem and request management (help desk)

Of the three major areas that constitute the traditional IS organization (operations, applications, and maintenance), the IT operations area predominantly receives the lesser share of attention. In reality, however, IT operations has an equal, if not greater, impact on customer satisfaction than application development and maintenance does. For example, if e-mail or the phone system go down for a day, the IT operations area receives considerable attention from users at all levels. And if the electronic data interchange (EDI) or any other type of electronic commerce is suspended for even an hour during a peak business transaction period, the company could be crippled by its inability to process orders (Information Technology Operations, 2009).

The IT operations group also often suffers from what Baschab & Piot (2007) refer to as the "Cinderella" complex. When the services are running normally, no credit is given because satisfactory performance is the expected behavior. There are few events that occur in the operations area (e.g., no disruptions, fast response time) to which a business unit employee would offer praise for the department. Similar to Cinderella's stepsisters, the group is instead asked to "do this, do that," a variety of requests to fix everything from PDAs to large mainframe computer systems. A service might be stable and running well for 355 days a year, but if it goes down for just a single day, especially during a critical business period, the entire image and satisfaction of the operations group (and the IS department) can be damaged, as service failures have the ability to negatively and rapidly impact a large number of customers, suppliers, and internal staff. Additionally, network outages, server failures, e-mail downtime, and inoperative desktop computers can significantly reduce the productivity of an entire company.

Besides system failures, IT operations' next single largest driver of customer satisfaction is frequently the IT help desk, as the help desk interacts with business users on a constant basis (Gouge, 2003). Response time, courtesy of the representative, level of follow-up and follow-through, and speed of resolution are all factors that drive customer satisfaction. It takes only one botched request from a high-level officer in the company to tarnish the reputation of the entire IT department.

"Why the 2008 CIO 100 Winners Are Focused on Operations and Controlling Costs"

Stephanie Overby (2008b) of CIO.com explains the role IT operations played in the 2008 selection of the 100 Top CIOs: "The 2008 CIO 100 honorees are focused on operational innovation – transforming their infrastructure, analytic tools and business processes to control costs and enable the next level of competitive advantage." During an interview between Overyby and Josh Morton, vice president of IT Operations and enterprise testing for Sprint Nextel, Morton explained, "The business reality today is you have to be better, faster and cheaper." Morton says he regularly reminds his team that its goal is to provide the same great quality of service at half the cost and 10 times faster the speed.

"This better, faster, cheaper focus has led to a revolution in how Sprint's IT organization delivers infrastructure support to the business, ultimately enabling the company to be more nimble and improve its own time to market. The effort, a server and storage farm with an integrated infrastructure management layer to automate the provisioning of resources, garnered Morton and Sprint Nextel a 2008 CIO 100 award," writes Overby.

A look at all of 2008's CIO 100 honorees reveals the pervasiveness of Morton's mind-set and where that way of thinking has led CIOs to focus their creativity. "One-third of the year's CIO 100 honorees, who are recognized for delivering business value through IT innovation, categorized their projects as impacting operations."

"These projects aren't aimed directly at disrupting business models or capturing new markets (the innovations that excite academics and analysts), but they have potential, nevertheless, to change companies," writes Overby. The next round of competitive advantage for businesses will be provided by neither capital, labor nor raw materials, but rather efficient and effective business processes. "If IT is to enable the business to compete, CIOs must concentrate on IT architecture, business process agility and resilience, and analytic s that focus on business-critical data in real time. And given today's tight economic situation and increasing global competition, IT must accomplish such transformation in more innovative ways."

IT Development

The application development team is responsible for the creation of new capabilities within existing business applications, upgrading and patching third-party applications, and testing new application functionality before deployment in production (Laube & Zammuto, 2003). Application developers typically specialize in specific technologies and/or software development applications such as object-based, web-oriented, client/server development, enterprise application configuration and customization (e.g., ERP, CRM), and electronic data interchange and application interface development (Malinowski, 2007).

The IT development group is frequently organized around applications in three broad categories, each of which can use a variety of technologies to deliver the required business functions (Baschab & Piot, 2007). These categories are:

- *Customer-Facing Applications:* may include web-based customer access systems, order-entry and order- processing systems, and internal customer service systems
- *Production Support:* the set of supply chain applications, such as procurement, manufacturing, warehousing, inventory, and logistics

- *Business Support:* typically includes those systems that are solely internal (e.g., human resources and accounting)

As the size and complexity of the business systems increase, it is often necessary to dedicate a staff member to a particular application in one of the three aforementioned categories.

The IT development group is also responsible for clearly communicating with the IT department, steering committee, and business users regarding the dates for deployments of new system capabilities. This communication must occur within the IT organization and the business organizations to ensure that everyone is aware of the timing and the functionality that will be provided. Additionally, deployments of new system capabilities must allow for sensitivity to business cycles and should be scheduled to minimize disruption to the busiest business cycles (Harris et al., 2008). For example, if a firm generates 70% of its business during the holiday season in the months of November and December, governance policies should require that IT applications developers have system changes in place by no later than the end of September to provide time to adequately prepare for the holiday rush. Another wise decision would be to allow for no additional system or application enhancements until after the end-of-year busy season.

For development methodologies and application development trends frequently used by application development teams, please refer to Chapters 4 of this text.

IT Maintenance

Software and applications maintenance is a very broad activity often defined as including all work made on a software system after it becomes operational. This covers: the correction of errors; the enhancement, deletion and addition of capabilities; the adaptation to changes in data requirements and operation environments; and the improvement of performance, usability, or any other quality attribute (Canfora & Cimitile, 2000).

The responsibilities of the maintenance area of the IS organization fall into four main categories (Software Maintenance, 2009):

- *Corrective maintenance:* reactive modification of a software product performed after delivery to correct discovered problems
- *Adaptive maintenance:* modification of a software product performed after delivery to keep a software product usable in a changed or changing environment
- *Perfective maintenance:* modification of a software product after delivery to improve performance or maintainability
- *Preventive maintenance:* modification of a software product after delivery to detect and correct latent faults in the software product before they become effective faults

One problem frequently encountered by IS organizations with regards to maintenance efforts is the fact that software maintenance frequently accounts for a huge amount of the overall IS budget. Although figures vary, several surveys indicate that software maintenance consumes 60% to 80% of total life cycle costs (Malinowski, 2007). Additionally, despite studies that indicate the majority of maintenance efforts (over 80%) are non-corrective (i.e., enhancement requests), many IS employees perceive application maintenance as "merely fixing bugs." This perception is perpetuated by users submitting problem reports that in reality are functionality enhancement requests for a system (Software Maintenance, 2009). This negative connotation often results in the assignment of new and inexperienced employees to application maintenance, while the tenured and more experienced IS staff focus on application development.

Robert Glass (Glass 2006) discusses the above-referenced problems with application maintenance and provides four suggestions on how to eliminate them:

1. "Make maintenance a magnet. Find ways to attract people to the maintenance task. Some companies do this by paying a premium to maintainers. Some do this by making maintenance a required stepping stone to upper management. Some do this by pointing out that the best way to a well-rounded grasp of the institution's software world is to understand the existing software inventory.
2. Link maintenance to quality assurance.
3. Plan for improved maintenance technology. There are now many tools and techniques for doing software maintenance better. (This has changed dramatically in the last couple of years.) Training and tools selection and procurement should be high on the concerned maintenance manager's list of tasks.

4. Emphasize "responsible programming." The maintainer typically works alone. The best way to maximize the effectiveness of this kind of worker is to make them feel responsible for the quality of what they do. Note that this is the opposite of the now-popular belief in "egoless programming," where we try to divest the programmer's personal involvement in the final software product in favor of a team involvement. It is vital that the individual maintainer be invested in the quality of the software product if that product is to continue to be of high quality.

There they are...four simple steps to better software maintenance. But note that each of those steps involves changing a traditional software mindset. The transition is technically easy, but it may not be socially or politically quite so easy. Most people are heavily invested in their traditional way of looking at things".

Centralization vs. Decentralization

How to structure IS organizations has been a topic of many pointed debates. And over the years, many different approaches to IT governance have been in vogue. For example, in early years, the expense involved and the expertise required by IT functions made a centralized option the only viable structure. However, as the cost of computing technology decreased during the '80s and trained IT personnel became more available, some individual business units began creating their own IT shops. The development of client/server hardware and software and the widespread deployment of desktop computers also accelerated this trend. Consequently, to accommodate business unit needs and reduce the overall tension around IT costs and capabilities, most companies attempted to decentralize parts of their IT operations (Laube & Zammuto, 2003).

Over the last decade, however, many organizations have begun to swing back towards a centralized model. This tendency of IT organizations to centralize, decentralize, and re-centralize again and again in an attempt to fix inadequacies in their hierarchical governance structures is commonly referred to as the "reorganization yo-yo" (Ulrich, 2009). Many of the original issues remain (e.g., equipment and software are still expensive, expertise is still difficult to find and manage), while many new issues have been added, including the fact that IT is now an essential component of most business processes, and effective use of IT is not just an issue of competitive advantage but also a life-or-death issue for many organizations. And while ultimately there is no single right answer for how a company should structure its IS organization, IT leaders should not feel as though they have to take the binary approach of 'centralized or decentralized.' Rather, IT Leaders and their colleagues in the company can, and should, choose elements of each organizational model that: 1) supports the company's unique priorities, initiatives, and assets; and 2) is structured similarly to other organizational units within the company.

This section will discuss the advantages and disadvantages associated with choosing to utilize centralized or decentralized IT structures. Additionally, a third model will be discussed, the hybrid/federated structure (Cramm, 2008; Laube & Zammuto, 2003; Ulrich, 2009), in which organizations deploy elements of both the centralized and decentralized models.

Centralized IT Organizations

In the centralized model, all IT functions – strategy and planning, application development, maintenance, and operations – report directly to a senior executive such as the CIO, CTO, or sometimes the CFO. All of the assets, including hardware, software, personnel, and the budget, are controlled directly by this organization.

Primary benefits of the centralized IT model include (Meyer, 2006):

- Procurement of hardware and software is possible on the broadest scale within the company, and centralized operations produce substantial economies of scale (for example, centralizing data centers typically results in 10% to 15% savings [Ulrich, 2009])
- Centralized staff eliminates redundant functions, such as multiple help desk support groups
- A unified approach to architecture and standards reduces costs for new applications associated with integration difficulties
- Clarity of purpose and alignment with overall company strategies improve due to the simpler organizational communications required

Potential problems, however, associated with the centralized IT model, include (IT Organization Management: To Centralize or Not to Centralize?, 2001):

- As a cost center, IT's large budgets are a constant point of contention, putting it on the defensive within the company (e.g., when costs of large central IT organizations are allocated back to individual

business units, individual units often do not understand why the costs are so high and don't want to have to pay them)
- A fully centralized structure requires a very effective decision and resource allocation process within the company, since each business unit can have different or conflicting needs for the IT workforce and operations capacity
- If operation of equipment and application support are not excellent, outages in one business unit can cripple an entire company

The key to a centralized organization's success is in its responsiveness: If large, centralized IT operations can be responsive to the needs of business, and then this approach can make sense. Additionally, certain elements of the IT organization, such as data hygiene activities, should always remain centralized. Several companies, such as DaimlerChrysler, Kemper Insurance, and PepsiCo, mainly for the sake of cost savings and ease of management, have migrated back to centralized IT operations after attempts to decentralize them (Laube & Zammuto, 2003).

Decentralized IT Organizations

In the past, as companies adopted client/server architectures, many successfully decentralized IT operations. Other companies decentralized as a result of mergers and acquisitions, as it is frequently the quickest way to solve the problem of integrating disparate hardware and software infrastructures (Cramm, 2008).

Primary benefits associated with adopting a decentralized IT model include (Ulrich, 2009):

- Each business unit has complete knowledge and choice over the allocation of IT resources to support business priorities
- Costs are fully allocated to business unit initiatives and there is the perception of faster, more flexible responses to necessary changes
- IT architects and engineers typically have better access to business information, allowing them to closely tailor their proposed solutions to specific business problems
- The IT organization is typically perceived as a partner in the business unit, and defensive tensions (which can occur in highly centralized models) are reduced

Challenges and problems connected with the decentralized model include (Meyers, 2006):

- A company as a whole will have higher total procurement and operations costs due to duplicate data centers, redundant positions across business units, and multiple independent procurement and vendor partnerships
- New technologies can be difficult and expensive to introduce, as even relatively inexpensive desktop tools (e.g., e-mail, messaging, and calendar applications) can vary widely, producing additional integration expenses and introducing hurdles to the flow of company information
- Providing a unified IT presence to customers and business partners who need products and services from more than one business unit can be problematic
- The decentralized model raises issues of accountability (and can often result in lots of finger pointing): For example, who is responsible for failures in a cross-organizational system? How is accountability for security across business units managed?

Hybrid or Federated IT Organizations

Many companies have developed IT structures that keep selected elements of both the centralized and decentralized models (Cramm, 2008; Laube & Zammuto, 2003; Ulrich, 2009). Functions that require consistency across the entire company are centralized, such as:

- Procurement
- Operations (e.g., data centers, data networks, desktop support, help desks, common infrastructures such as e-mail and intranets)
- Data hygiene
- Architecture
- Standards and processes
- Development and integration of company-wide ERP applications

Most of these aforementioned functions have recurring costs that are easily estimated and budgeted on a central basis, and thus the centralized IT organization retains these budgets.

Functions that are *decentralized* to the business units can include: software application development that is unique to each unit; planning and management of unit-specific service agreements; and specific BU/IT strategy and resource estimates. Nonetheless, even these unique business unit functions must be rolled up into an overall companywide plan so conflicts and/or opportunities are visible and manageable (Ulrich, 2009). Many hybrid organizations provide business unit budget control over the decentralized functions, which helps increase both business unit satisfaction and the ability to optimize expensive resources. In this model, the IT organization manages the resources on behalf of the business units, which pay specifically for the services they use. This also allows for more effective career planning and development of technical staff.

The potential disadvantages to a hybrid/federated model is that it requires strong, collaborative leadership in both headquarters and individual business units (IT Organization Management: To Centralize or Not to Centralize?, 2001). For example, in particular, the CIO must be an executive that can lead a complex technical organization as well as understand the business needs and strategy of each business unit. Additionally, the hybrid/federated model also requires effective strategy, planning, and resource allocation processes in a company so the centralized resources continue to meet the needs of specific business initiatives. Two examples of companies that use the hybrid approach include Citigroup and YMCA (Laube & Zammuto, 2003).

Consulting

IT consulting is a field that focuses on advising businesses on how to best use information technology to meet their business objectives. In addition to providing advice, IT consultancies often implement, deploy, and administer IT systems on businesses' behalves (Information Technology Consulting, 2009). And while many organizations may recognize the need for consultants (approximately 20% of all staff in the 'average' IT department in recent years are externally sourced workers or consultants [Aalders & Hind, 2002]), they nonetheless remain unsure about how to use them. This section will address the two primary consulting arrangements typically chosen by businesses (traditional vs. milestone), and will also provide advice for effectively managing and successfully utilizing consultants.

Traditional Consulting

In a traditional consulting arrangement, a consulting firm deploys a team of individuals to a client site full-time. From the consultant's standpoint, this arrangement is typically preferable, as it maximizes billable time and revenue while also allowing the on-site consultants to better assist businesses throughout projects, directly manage issues, and ensure an overall smoother implementation (Traditional vs. Milestone Consulting, 2009).

As already alluded to, the downside (for the organization) to traditional consulting tends to be the fact that it is normally the more expensive option. Additionally, many organization face end-user availability issues in which a organization's end-users become overworked and too busy to spend time with the consultants (although consultants can largely work independently, they nonetheless frequently need the input and time from end-users to keep the project moving forward). This can be particularly detrimental to organizations with smaller budgets, as on-site consultants are billed regardless of whether their skills are being used efficiently or not (Aalders & Hind, 2002).

Milestone Consulting

In a milestone consulting arrangement, a client employs a consulting firm to check in with them on a periodic, regular basis, ensuring that projects are both meeting their individual goals and, from a broader perspective, remaining on track (Traditional vs. Milestone Consulting, 2009). A primary benefit to the organization of this approach is cost minimization. Furthermore, to the extent that the consultants' arrival is well known in advance, organization end-users can focus on their jobs knowing that time is already allocated to assisting the consultants.

Potential disadvantages associated with the milestone consulting arrangement is the threat of missed goals and deadlines, as there may be no one within the organization keeping a close eye on project implementation on a regular, daily basis. Also, due to the lack of on-site consultants, implementation issues may not be broached in a timely manner (Information Technology Consulting, 2009). Lastly, the overall success of projects' implementations may suffer, as projects that constantly start and stop often lose momentum and thus have greater chances of failures.

Which to Choose?

Before hiring external consultants, senior management should take into consideration issues such as budget, the state of its internal documentation, end-user availability, and the time-frame, scope, and complexity of the issues with which the consultants will be assisting (Aalders & Hind, 2002). These factors will shed light on what the best arrangement is for the organization. For example, a complex but poorly-documented issue that 'needs to be resolved yesterday' will not be successfully accomplished under a milestone approach And at the same time, a simple yet less urgent issue probably won't necessitate a full-time team of consultants to solve it. For most clients, the majority of real-world issues will fall in between these two extremes, ultimately requiring good judgment from those in charge.

Managing and Successfully Utilizing Consultants

Consultants are often poorly managed and under-utilized as a result of: 1) ill-advised and thoughtless consultant selection; and 2) failure on the organization's part to ensure consultants are given appropriate induction to the company and adequate work instructions (Information Technology Consulting, 2009). And while properly managed consultants can provide substantial working leverage, expertise, and objectivity to the IT department, poorly managed consultants, conversely, can unintentionally undermine and inhibit IT department projects and goals. Thus, to ensure the successful utilization and management of its consultants, organizations should (Aalders & Hind, 2002):

- Hire consultants who have the expertise and background to assist with the organization's projects
- Define the timeframe, scope, and specifications of the project which the consultants will be assisting
- Clarify consultant and organization end-user roles and responsibilities
- Properly induct and educate consultants on the organization's goals, culture, key staff members etc.
- Ensure consultants have sufficient resources to effectively work
- Monitor consultant/project progress

Following these guidelines will help guarantee that an organization properly selects, manages, and utilizes its consultants, while also increasing the likelihood of successfully meeting its goals and milestones within projected time-frames and budgets.

Outsourcing

Outsourcing is the transfer of some or all of a company's business processes and/or supporting infrastructure to a third-party service provider with the purpose of achieving certain organizational objectives (Outsourcing, 2009). Once the decision to outsource is made, the organization must address two key questions: 1) what will be outsourced?; and 2) what relationship will exist between the organization and its outsourcing provider?

Service Level Agreements

As already stated, IT outsourcing involves the transfer of responsibilities from an organization to that of an IT services provider. A service level agreement (SLA) is the contract between the IT services provider and the customer that specifies, in measurable terms, what services the vendor will furnish. Developed at the beginning of the outsourcing relationship, the SLA: Records a common understanding about services, priorities, responsibilities, guarantees and warranties; is used to measure and monitor the IT services provider's performance; and is utilized as one of the primary tools for outsourcing governance (Overby, 2008a). It is important to note that an SLA typically relates to only the services the customer receives, and not to how the service provider delivers them (an agreement of this type is referred to as a service-level specification agreement, or an 'input' SLA [Service Level Agreements, 2009].)

What to Outsource?

Depending on organizational objectives, a business may decide to outsource technology infrastructures, business applications, and/or business processes (Laube & Zammuto, 2003):

I. Technology Infrastructure Outsourcing

Commonly used by organizations that want to focus on core business strategies while the service provider focuses on technology and its related components, technology infrastructure outsourcing can involve:

- The operation of an organization's customer's data servers, network devices, and hardware (i.e., everything normally included in a data center)
- Management of an organization's internal infrastructure (e.g., networks, office equipment [LAN, desktop], voice and video communications)
- Taking responsibility for security and disaster recovery for all computing and network functions

For an example of technology infrastructure outsourcing, refer to 'Cloud Computing' in Chapter 5 of this text.

II. Business Application Outsourcing

Business application outsourcing allows an organization to achieve the benefits of leading-edge application solutions while at the same time controlling baseline development costs. There are several types of business application outsourcing, including (Overby, 2008a):

- Software application management: Provides support in the areas of: Programming of software changes/enhancements; management and maintenance services for enterprise-wide software applications (such as SAP, PeopleSoft, Oracle, etc.).
- Design-build-run: This operation has the supplier assume full responsibility for both software development and delivery, as well as ongoing management and maintenance of software platforms. In this model, in addition to application management (described above), the outsourcer continues to operate the system after implementation.
- Offshore solution centers: These are foreign locations where an outsourcing provider has concentrated a large, skilled work group with a strong infrastructure of supervision, processes, and technology (Outsourcing, 2009). This form of outsourcing can provide additional cost savings by leveraging the solution centers' skills and scale and providing proven methods, tools, and technology for delivery.

III. Business Process Outsourcing

Business Process Outsourcing (BPO) involves an organization asking a provider to assume full responsibility for complete business functions. The provider then owns, administers, and manages these functions for the organization. The BPO option delivers management, operation, and continuous improvement of a business' critical processes, such as:

- Customer relationship management (CRM)
- Call centers
- Training and e-learning
- Supply chain and procurement
- Logistics, building management, and maintenance
- Finance and/or accounting activities (billing, taxes, accounts payable, etc.)
- Human resources functions (benefits management, hiring, etc.)

Outsourcing Relationships

The relationship between a company and an outsourcing provider, defined and stated by the SLA, can be a complex one. These relationships tend to fall into the following three main categories (Overby, 2008a):

I. Conventional Outsourcing

A conventional outsourcing agreement typically involves contracting selected business processes to a service provider whose compensation is based on achieving specific and measurable target metrics. For example, a

business may outsource its IT organization in order to improve reliability and quality of service, as well as to decrease operations costs. The outsourcer in turn agrees to provide end-to-end integrated IT services, including support of operations, incident management, change management, and capacity planning (Laube & Zammuto, 2003).

Conventional outsourcing typically involves fixed-fee compensation and motivates the outsourcer through additional payments for reaching targeted performance levels. (It also usually provides for cash penalties for missing targets). One challenge to this type of arrangement is that the stream of incremental savings will eventually reach its limit, as once the operation has been effectively tuned; the ability to generate additional cost savings diminishes substantially.

II. Collaborative Outsourcing

Collaborative outsourcing relationships create value beyond simple cost reductions. For example, an organization's objectives may be to increase customer satisfaction and improve operational efficiency. In a collaborative outsourcing relationship, the outsourcer can be motivated to exceed objectives since it will share in the benefits from implemented improvements (Overby, 2008a). Additionally, in a collaborative outsourcing relationship, the customer and outsourcer work together to define the relationship, jointly setting target objectives, articulating principles of operations, and sharing in the benefits.

Challenges to this type of relationship, however, exist if there are dependencies across the business processes of the organization and the outsourcer. It becomes more difficult to make improvements to complex processes that span multiple organizations. As organizations seek to outsource more complex processes it also becomes more difficult to control and determine accountability. For example, if the business process being outsourced is sales in a call center, the outsourcer may not have any control over sales strategy or new product introductions, yet it is still expected to achieve certain results in performance. In order to manage these issues with collaborative outsourcing and receive greater value from an outsourcing model, an organization should expand its relationship into a transformational arrangement (Laube & Zammuto, 2003). In the previously mentioned example, a transformational arrangement would allow the outsourcer to directly be part of the sales strategy, thereby giving it a better ability to achieve expected results. We discuss transformational arrangements next.

III. Business Transformational Outsourcing (BTO)

Business transformational outsourcing (BTO) is used to fundamentally reshape an organization and its business. It shares many aspects of the collaborative model, but goes further. BTO arrangements are structured to make the company and the outsourcer *both* directly responsible for the desired business outcomes. Also, where collaborative arrangements reward the outsourcer based on hitting specific performance targets, BTO arrangements often allow the outsourcer to share in the revenues and profits of the outsourced part of the business (Overby, 2008a). To be successful, BTO arrangements:

- Require a committed relationship between an organization and the outsourcer
- Outsource the hardest aspects of the program to increase chances of success
- Drive dramatic enterprise-level business improvements
- Have multi-year commitments that may have their rewards several years away
- Require joint leadership with long and short term decision making at the executive level

Additionally, in BTO arrangements, the two parties:

- Jointly develop strategic objectives
- Conduct regular board reviews (including the most senior executives in the organization) to ensure achievement of objectives, review metrics, and drive strategy
- Use incentives that include sharing in the benefits of a new business agreement

Instead of rewarding the meeting of targets such as cost reduction and delivery dates, rewards are typically based on a share of the increased revenue. For example, a company might enter into a BTO arrangement to establish a new sales channel for a new product line. The outsourcing provider and the company will then jointly manage this channel and share in the revenues it generates (Gouge, 2003).

Frequently, despite businesses' attempt to effectively manage their respective IS organizations, many IS organizations still lack discipline, rules, documented metrics, and standardized procedures. And consequently, a large percentage of projects undertaken by IS organizations are failures. To help alleviate this problem, numerous benchmarking models have been developed and are now available to those IS organizations that seek to employ them.

This section provides an overview of some of the most popular benchmarking models in use in IT today, including the Capability Maturity Model® Integration (CMMI), International Organization for Standardization (ISO), Control Objectives for Information and related Technology (COBIT), Information Technology Infrastructure Library (ITIL), and Six Sigma (6σ). Though no model is perfect, with careful evaluation and selection, as well as the commitment from all those involved with its implementation (particularly that of leadership), all of these models can provide huge benefits to an organization, including improved product quality, decreased defects, enhanced processes, and improved organizational efficiencies (Aalders & Hind, 2002).

Capability Maturity Model® Integration

Capability Maturity Model® Integration (CMMI) is maintained by the Software Engineering Institute (SEI) of Carnegie Mellon University in Pittsburgh, Pennsylvania, whose mission is to create advances in "software engineering and related disciplines to ensure the development and operation of systems with predictable and improved cost, schedule, and quality" (Software Engineering Institute, 2009). According to SEI, CMMI is a process improvement approach that provides organizations with the essential elements of effective processes. It is not a process in and of itself, but rather a model that describes the characteristics of effective processes. Based on the Process Management Premise of "the quality of a system is highly influenced by the quality of the process used to acquire, develop, and maintain it," CMMI is used to guide process improvement across a project, a division, or an entire organization, as well as integrate traditionally separate organizational functions, set process improvement goals and priorities, provide guidance for quality processes, and provide a point of reference for appraising current processes.

To determine performance according to the CMMI model, an organization's capability or maturity is assessed in accordance to the Standard CMMI Assessment Method for Process Improvement (SCAMPI). It is an appraisal performed by a trained team of software professionals to determine the state of an organization's current software processes, to determine the high-priority software process-related issues facing an organization, and to obtain the organizational support for software process improvement (Laube & Zammuto, 2003). SCAMPI also provides a consistent method for both internal assessments and external evaluations.

Once obtained, appraisal results (referred to as Maturity Levels, ranging between 1 and 5 – 5 is best) are valid for up to three years after the end date of the appraisal, at which time the results expire and the organization can no longer claim compliance. During this three-year period, an organization can claim the level associated with the results of the assessment and is auditable and assured by SEI of some level of consistency and quality. In addition, some government agencies require a minimum assessed CMMI level as a precondition for awarding software- or systems-related contracts.

The target audience for CMMI is any organization which develops software for either internal or external use. According to SEI's website, Accenture, Boeing, NASA, Lockheed Martin, and Motorola are just a few of the US-based organizations currently using the CMMI. Of all those currently implementing CMMI-based improvement processes, over 68 percent are commercial businesses and in-house technology groups, 28 percent are military contractors, and 3 percent are government agencies (Harris, Herron, & Iwanicki, 2008).

International Organization for Standardization

The International Organization for Standardization (ISO) is the world's largest developer of international standards and its principal activity is the development of technical standards. It comprises a network of the national standards institutes of 161 countries, one member per country, with a Central Secretariat in Geneva, Switzerland that coordinates the system. ISO is a non-governmental organization (meaning its members are not delegations of national governments) that forms a bridge between the public and private sectors (International Organization for Standardization, 2009). ISO has published more than 16,000 international standards, ranging from agriculture to construction, mechanical engineering to medical devices, and finally to IT.

Adherence to ISO specifications is evaluated through a conformity assessment. This entails checking that products, materials, services, systems, or people meet the specifications of a given standard. To facilitate this, ISO develops ISO/IEC guides and standards to be used to carry out conformity assessments. Similar to the CMMI appraisal, achievement of a specific ISO certification by an organization indicates a level of achievement and implied level of quality or compliance according to the standard achieved. In some industries and situations, including IT, compliance with certain ISO standards can be a requirement for doing business.

The two most recognized families of standards that impact IT are the ISO 9000 and ISO 14000 standards. These families of standards are known as generic management system standards: ISO 9000 is concerned with quality management and ISO 14000 is concerned with environmental management. Additionally, ISO/IEC 27002:2005 Information Technology – Security Techniques – Code of Practice for Information Security

Management provides best practice recommendations on information security management for use by those who are responsible for initiating, implementing, or maintaining information management security systems (International Organization for Standardization, 2009).

Other ISO standards provide internationally developed methods to assess conformance. ISO/IEC 15504:2004 describes the assessment model SPICE (Software Process Improvement and Capability Determination). ISO 15504 SPICE is the international standard for process reference models and assessments. It contains the methodology and structure to perform assessments of system development processes, similar in structure to CMMI (Laube& Zammuto, 2003). The difference is that SPICE defines a capability level for each process. This is similar to the continuous representation of CMMI but does not afford the same maturity level rating as the staged representation of CMMI.

SPICE and CMMI have been noted by both ISO and SEI communities as conforming and being complementary to each other. Determining which one to choose does not have to be a definitive choice. If an organization is using one to improve, compliance with the other can be achieved as well. If acknowledgment by a broader international community is sought, ISO's SPICE is the more appropriate credential. If contracts with the US government are sought, CMMI is more applicable (Harris et al., 2008).

Control Objectives for Information and Related Technology

The IT Governance Institute (ITGI) was established in 1998 to advance international thinking and standards in directing and controlling an organization's information technology. ITGI believes that effective IT governance helps ensure that IT supports business goals, optimizes business investment in IT, and appropriately manages IT-related risks and opportunities (IT Governance Institute, 2009). ITGI's affiliate organization, the Information Systems Audit and Control Association (ISACA), publishes the Information Systems Control Journal and offers certification opportunities as a Certified Information Systems Auditor (CISA) or Certified Information Security Manager (CISM). Together, ITGI and ISACA focus on the information technology control community, IT governance, risk, and regulatory requirements.

Control Objectives for Information and Related Technology (COBIT), developed by a worldwide consortium of contributors and reviewers (many with the CISA credential), began as a tool for auditors, but has since grown to include security components and IT governance (Information Systems Audit and Control Association, 2009). Within the context of the IT organization, it is intended to provide a framework and an inclusive language for other IT frameworks, such as:

- IT Infrastructure Library (ITIL) for service delivery
- CMMI for solution delivery
- ISO 27000 series information on security-related standards
- ISO 9001:2000 Quality Management Systems – Requirements
- Project Management Body of Knowledge (PMBOK)
- Projects in Controlled Environments 2 (PRINCE2)

The following text is an excerpt from the executive overview of COBIT 4.1 (Information Systems Audit and Control Association, 2009):

"The business orientation of COBIT consists of linking business goals to IT goals, providing metrics and maturity models to measure their achievement, and identifying the associated responsibilities of business and IT process owners.

COBIT's good practices represent the consensus of experts. They are strongly focused more on control, less on execution. These practices will help optimize IT-enabled investments, ensure service delivery and provide a measure against which to judge when things do go wrong."

For IT to be successful in delivering against business requirements, management should put an internal control system or framework in place. The COBIT control framework contributes to these needs by:

- Making a link to the business requirements
- Organizing IT activities into a generally accepted process model
- Identifying the major IT resources to be leveraged
- Defining the management control objectives to be considered"

Ultimately, COBIT reinforces the need for IT to provide the information that the enterprise needs to achieve its objectives from a perspective of governance and risk, while the COBIT framework promotes managing IT resources from a set of naturally grouped processes in line with the responsibility areas of plan, build, run, and monitor.

IT Infrastructure Library

The IT Infrastructure Library (ITIL) was developed by the United Kingdom's Central Computer and Telecommunications Agency in 1987 as a means to establish process standards for U.K. government agencies. Now maintained by the Office of Government and Commerce, ITIL is a series of documents that comprise the "best practices" of ITIL. IT Service Management Forum USA (itSMF USA), a non-profit organization, acts as the official ITIL user organization, dedicated to promoting and helping to advance best practices in IT Service Management (IT Infrastructure Library, 2009).

ITIL adoption rates have been on the rise. The CIO executive board reported in 2004 that 30 percent of global companies with more than $1 billion in revenues evaluated the potential of implementing ITIL, and approximately 13 percent were moving forward with ITIL implementation. Adoption is expected to increase to 60 percent of global companies with more than $1 billion in revenue by 2008 (Harris et al., 2008).

To produce an ITIL baseline, an organization is audited or measured for performance according to ITIL standards according to a process, BS 15000, introduced by the British Standards Institute in 2000 (IT Infrastructure Library, 2009). BS 15000 is a formal standard allowing organizations to benchmark the delivery of their IT services. It defines a set of requirements covering ITIL service support and service delivery, security management, and relationship management, and specifies a level of quality that can be audited. As an industry standard, it also helps firms qualify and choose suppliers and partner organizations.

Six Sigma (6σ)

Unlike other frameworks and models, Six Sigma is not owned and maintained by any specific community. Rather, Six Sigma began at Motorola in the 1980s with its roots in the quality movement of Total Quality Management (TQM). Six Sigma is frequently called “TQM on steroids” due to its precision techniques of measurement and control introduced by the focus on statistical methods used in the process quality framework (Harris et al., 2008).

In the narrowest definition, Six Sigma is a statistical term that translates to 3.4 defects per million opportunities or parts per million (Six Sigma, 2009). As Table 2 shows, Six Sigma is actually a level of achievement or a metric (although not all organizations pass through all of the sigma levels, it is likely that they will pass through some on their way to the desired state of Six Sigma). A defect is defined as anything that does not meet the customer requirement. At GE, a well-known advocate of the model, Six Sigma was defined as a “disciplined methodology of defining, measuring, analyzing, improving, and controlling the quality in every one of the company's products, processes, and transactions — with the ultimate goal of virtually eliminating all defects” (Harris et al., 2008). Today, Six Sigma is a quality movement intended to improve processes to achieve the highest standards of quality, thereby managing cost and reducing defects to improve customer satisfaction while improving process output.

Table 2: Process Sigmas

Process Sigma	Accuracy (%)	DPMO/PPM*
6	99.9997	3.4
5	99.977	230
4	99.379	6,210
3	93.32	66,800
2	69.2	308,000
1	31	690,000

*Defects per million opportunities or parts per million (Six Sigma, 2009)

The fundamental contributions of Six Sigma are in the culture shift required by the organization and the statistical and project-focused approach to quality improvement. The audience for this quality framework is any organization seeking to improve quality and introduce statistical process control as a method for reducing cost and increasing customer satisfaction. The needs of focused leadership and team structure are addressed through the

defined roles on Six Sigma teams, whose structure serves to prescribe the roles and the responsibilities of those operating on a team. Thus, regardless of the company, product, or industry, the Six Sigma project team construct remains the same.

The process model for Six Sigma is called DMAIC, which is an acronym used for the phases of a Six Sigma project (iSixSigma, 2009):

- Define
- Measure
- Analyze
- Improve
- Control

Utilizing the DMAIC process model, Six Sigma is a very specific type of project management process with a strong management framework that demands leadership involvement. The involvement from the leadership within the organization translates to attention from staff, creating focus on the Six Sigma project and the program. Over time this brings organizational change, a cultural shift away from "that's just how we do things around here" (iSixSigma, 2009). Leadership focus and management behaviors translate for the staff into the level of importance of any initiative. The defined expectations of leadership involvement in reviews called "tollgates" and other stages in the project contribute to the success of Six Sigma by creating a change in the focus of what is important to the organization, namely commitment to process excellence, reduction in defects, and focus on customer requirements.

Chapter Summary and Review

The three fundamental responsibilities of an internal IS (or IT) organization are operations, application development and maintenance of existing applications. The overall objective of IT operations is to keep the organization's software applications running smoothly and to be able to deal with interruptions to service expeditiously. Application development refers to the design and installation of new software applications, while maintenance refers to making change and enhancements to existing applications.

There is a spectrum of options for placement of the IS function in an organization ranging from centralized to decentralized. There is one best fit for an organization at any point in time, but as circumstances change, many organizations tend to move in one direction or another on the centralization/decentralization spectrum.

While utilization of IT consultants is quite common, many organizations do not understand how to select and use them effectively. Outsourcing complete business functions (like computer operations or specific business functions like call centers) to outside specialist firms is becoming common as organizations begin to focus on their core competencies and let firms who focus on IT handle It functions. While efficiency and effectiveness can improve, it is important to have a written understanding (usually expressed as a service level agreement or SLA) to outline each party's obligations and expectations under the outsourcing agreement.

Finally, CIOs would be wise to choose one of the many available frameworks to benchmark the IS organization to give them and other executives comfort that the IS function is well-managed and controlled.

Discussion questions

1. Name the three areas that typically constitute the IT organization and describe their respective scopes and responsibilities.
2. How does the centralized IT model differ from the decentralized IT model, and what are the advantages and disadvantages of both?
3. If your company was facing an urgent and complex IT issue that required the assistance of consultants, which arrangement would you choose: traditional or milestone? Why?
4. Describe three methods for successfully utilizing consultants.
5. What is a service level agreement (SLA)? How is an SLA pertinent to the relationship between an organization and its outsourcer?
6. Define and provide examples of the following three types of outsourcing: technology infrastructure outsourcing; business application outsourcing; and business process outsourcing.
7. What are the advantages and disadvantages of a collaborative outsourcing relationship? How does collaborative outsourcing differ from conventional and business transformational outsourcing?
8. Why are benchmarking models frequently needed by IT organizations, and what are their benefits?
9. Provide a brief description of each of the following: CMMI; ISO; COBIT; ITIL; and Six Sigma.

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Chapter 3: Talent management

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Learning objectives

Understand recruiting practices for IT professionals

- Understand various compensation structures and why each is beneficial
- Understand keys to developing IT professionals
- Discover ways to monitor, measure, and increase productivity
- Learn methods to retain quality IT professionals

Introduction

Each year there are a large percentage of IT projects that run over budget, fail to deliver promised functionality, or that simply never see the light of day despite millions of dollars in investment. The Standish Group, an independent group which tracks IT project successes and failures, in their 2009 report, states that 32% of all IT projects are delivered on time, on budget, and with required features and functions. They also note in their report that 44% of IT projects were delivered late, over budget, and/or with less than the required features and functions. The remaining IT projects, 24%, were cancelled prior to completion or delivered and never used. With one out of four IT projects failing outright, there are billions of dollars being wasted each year on IT. It is critical that organizations improve those odds. One way organizations can do that is by ensuring that they have a smart and motivated IT staff that is capable of understanding the business needs of the organization.

In their 2002 article, "Enduring Practices for Managing IT Professionals" Ritu Agarwal and Thomas Ferratt identify a framework for managing IT professionals. They identify 5 key areas for the successful management of IT professionals including:

- Recruiting,
- Compensation
- Career Development and Security
- Concern for Productivity
- Concern for the Individual (Argawal and Ferratt 2002).

For purposes of this chapter, we will use this framework, as illustrated below, as the basis for the discussion of the successful management of IT professionals.

Recruiting

As mentioned above, the recruitment and selection of a talented and productive IT staff is critical to the success of any firm. Like any other member of their business staff, organizations want to find IT professionals who are smart, eager to learn, and that fit in with the organization culture. More and more, organizations are looking for more than just a person who understands computer programs or systems. Organizations are looking for individuals who understand business processes and who can communicate effectively with others. The problem is that individuals with these skills are in short supply. In 2006, the U.S. Department of Labor did a study to project job growth in the United States. They projected that job growth in the IT industry would increase by more than 800,000 jobs between 2006 and 2016. The network and systems and data communications analyst positions are expected to grow 53% between 2006 and 2016. This growth is more than 5 times the growth rate of any other profession in all industries. Meanwhile, the number of students receiving IT-related degrees from undergraduate institutions in the U.S. is down. Between 2005 and 2006 the number of students earning an IT degree in the U.S. was down 9% and 12 % respectively. These numbers from the U.S. Department of Education are a few years old, but

nonetheless make the point: IT professionals are in short supply. If smart IT professionals are key for project success, and there is a shortage of these professionals, what is an organization to do?

Sourcing

Where does one find talented IT professionals in the 21st century? There are several ways a firm can recruit individuals for their IT functions. For example, firms can recruit at colleges or universities, they can work through professional outside recruiters, they can use Internet recruiting applications such as LinkedIn (a popular networking website similar to Facebook or Myspace), they can gain referrals from existing employees, or they can host a job fair.

Many successful IT firms rely on partnerships with colleges and/or outside recruiting firms to locate potential hires. These firms will often hire IT professionals directly from college, or they utilize a select group of recruiting firms with whom a lower contract fee can be negotiated. In addition, through these partnerships, a firm would have a pre-existing knowledge about the quality of the professionals they are getting.

Internet-based hiring through applications like LinkedIn also seem to be in vogue in the US now for many IT firms. A survey released in May 2008 by Jobvite (an Internet job posting website) suggests that Internet hiring is outpacing employee referrals. Many of the employers surveyed by Jobvite are using social networking sites such as Facebook and Linkedin to find viable candidates. Meanwhile, 8 out of 10 employers, despite offering significant rewards for employee referrals ($1,000 to $1,500 per referral), stated that they actually paid out less than $25,000 a year for referrals. Employers would prefer to hire IT professionals based on employee referrals because they can be sure of the referrals' quality as they are a reflection of the person recommending them. However, a firm can ascertain a lot of information about a potential hire very quickly from Internet applications, and they can make a potential hire very quickly. The downside is that the information on the Internet may not be accurate and bringing these individuals in for interviews or hiring them, and being wrong about their skills, can be costly.

Method	Pro	Con
Partnership	Known and established quality and possible discounted rate	May tie a firm into certain hiring relationships when they want to look elsewhere
Internet Applications	Quick and easy to use	Unknown quality
Employee Referrals	Employees usually recommend quality applicants	Despite incentives, many employees don't refer applicants.
Job Fair	A lot of applicants and potential hires	Unknown quality

Skills sought

One of the key elements to hiring the right person is ensuring that they have the skills necessary to do the job. According to Computer World there are 8 skill sets that are going to be critical to the future success of organizations and which are especially in demand in today's business environment:

- Programming and application development especially as it relates to Web 2.0 applications
- Project Management
- Help Desk/ Technical Support
- Security - demand for government security clearance and demand for expertise in system and wireless security
- Data Center and database management
- Business knowledge
- Networking skills including general network administration and network convergence
- Telecommunications especially when it comes to handling security in a networked environment

In addition to these technical skills, IT firms may also seek experience leading certain projects or detailed experience with certain elements which may be technical or nontechnical.

However, many firms run into problems when IT applicants exaggerate their abilities and cannot do the types of things they state on their resume. David Weldon, an analyst for the Aberdeen Group (an IT research group), suggests that organizations look to experience rather than a particular skill set. He suggests, "Look at what kinds of projects or work the technologist has done. Similarly job applicants should promote the top projects they've worked on to help the organization address its bottom line or business needs."

It is also important to note that in addition to technical skills, an IT professional's "soft" skills can be of equal importance to the hiring firm. Skills such as public speaking, negotiation, and persuasion are among the most valuable in the current economic environment. The success of most IT projects is based on the buy-in of many departments outside of IT. In these cases, communication and negotiation skills are necessary to gain buy-in, to help sustain relationships, and to get the necessary resources to complete the project. Leadership skills are also of immense importance. Having an IT professional who is willing to take the lead and go above and beyond his or her normal duties can be critical in a time of tightening IT budgets and a shortage of IT professionals.

Competitive differentiation

There are literally thousands of firms in need of quality IT professionals and as mentioned above, there is an extreme shortage of supply. Firms have to be smart and make informed decisions about the people they hire. In addition to looking for soft skills from IT professionals, there are other methods for establishing a competitive IT advantage: the ability to hire Millennials and the ability to hire a diverse IT work force.

As the baby boomer generation (the generation born during the middle of the 20th century) begins to retire, it becomes more and more important for firms to fill in those gaps with new employees. The work force of the future, also known as Millennials, consists of nearly 80 million individuals born in the US between 1979 and 1999. Many of these individuals, in the 21 to 28 year old age group, are just starting their careers. Unlike generations before them, this generation grew up with many of today's technologies. The Millenials also possess significant strengths in teamwork and collaborations like social networking and multitasking which are key in most organizations today. Millenials possess the ability to do work in half the time as their predecessors which can create a monumental advantage.

Unfortunately though, the Millenials have some downsides which their predecessors did not possess. According to a survey by careerbuilder.com (a popular job search website), more than 85% of hiring managers and human-resource executives in the U.S. said they feel that Millennials have a stronger sense of entitlement than older workers. One Millenial, Olivia, who blogs for Xanga.com writes,

> *"They are finding that they have to adjust work around our lives instead of us adjusting our lives around work," "What other option do they have? We are hard working and utilize tools to get the job done. But we don't want to work more than 40 hours a week, and we want to wear clothes that are comfortable. We want to be able to spice up the dull workday by listening to our iPods. If corporate America doesn't like that, too bad".*

To create and sustain competitive advantage, many organizations will have to learn how to effectively manage the Millenials group. In some cases that will require more one on one time between managers and employees, more reliance on flexible work schedules, or other creative management techniques.

Another area that may provide a competitive advantage is for firms to hire a diverse IT staff. As with other departments, diversity in IT can foster creativity and a difference in ideas. Diversity may mean hiring employees of a different racial background, different religious background, or different gender. In a time of diminishing supply, organizations should not limit potential hires based on gender, race, or creed. Agatha Gilmore, who writes for Certification Magazine (an IT professional magazine) notes the importance of diversity in the work place: "Luckily, the bottom-line impact of a diverse IT workforce is already being documented. Though women account for only 9 percent of U.S. technology patents, for example, the National Center for Women & Information Technology (NCWIT) points to a study that found those patents created by mixed-gender teams are the most highly cited" (Gilmore 2008). In the US, it is fairly commonplace to hire a diverse workforce. Organizations in other countries might also consider such policies (if they are not already doing so) as a way to obtain a competitive advantage.

One-time inducements

A survey of 32 leading businesses in the US indicated that 5 of 32 (roughly 15%) provided some sort of signing bonus, and 1 of the 32 organizations gave stock options as a one-time inducement rather than cash. Signing bonuses are a great way to attract potential hires quickly with a monetary incentive without upsetting a firm's salary structure. In other words, a firm could give a new employee cash up front and then provide them with a salary that is in line with other employee salaries. As an example, sign-on bonuses became a big part of compensation in the late 1990s during the mad rush to staff up for Y2K. There was a tremendous demand for short- term IT personnel who could address the need. As demand went up, sign-on bonuses went from a relatively nominal amount to up to 100% of a workers annual salary.

It should be noted, though, that while the use of a signing bonus may attract talent quickly, the technique must be used in conjunction with other methods to keep talent long term. There are also consequences to using signing bonuses as a way to attract talent. Signing bonuses could create conflict amongst current employees who may find out about the bonus. They can also create an expectation of future bonuses or large salary increases. This could be why only 15% of the organizations surveyed in the survey above use signing bonuses. Perhaps there are better ways to attract talent.

Compensation

In an industry whose long-term annual turnover has typically been over 20%, a thoughtful retention strategy is essential for every IT organization. Compensation is one key way to obtain and retain talent. Compensation could include salary, bonuses, healthcare benefits, stock options, retirement benefits, and other benefits such as tuition reimbursement. Compensation strategy is key to any firm's hiring or retention decisions. An organization looking for short-term help may offer a high wage or salary to induce IT employees to work for them. An organization looking for a long term commitment may offer a combination of salary, retirement benefits, and stock options. This way, employees are rewarded for their hard work as the organization grows and becomes more profitable. Organizations must inevitably make the decision whether they want a loyal employees or a more fluid work force. An IT firm with a cyclical project schedule may choose to bring on short-term staff to fill a short-term employment need. While an organization with long-term projects, or who might have a core IT function that is essential to their organization, may be looking for loyalty and long term employees.

Standard salary

According to a study undertaken in 2009 by Network World (an IT news website), the average salary for IT professionals in the United States is approximately USD 88,800. This represents an increase of 2.3 % over the year prior (Ioma 2009). Of course this average represents a wide range of salaries for various specialties. Individuals in tech support earn approximately USD 51,900 a year on average while IT senior managers make approximately USD 120,000 a year on average (Ioma 2009).

Job Level	2009 Avg Salary in US dollars	% Change from 2008 Salary
IT Senior Managers (CIO,CTO)	$120,000	2.90%
Middle Managers	$93,700	2.3
Web Application Managers	$105,200	1.4
IT Security Director/Manager	$103,200	2.6
Telecommunications Manager	$99,800	2.1
LAN,WAN or Network Manager	$92,200	2.4
IT/IS Director	$87,900	2.4
Staff	$78,400	2.1
Security Architect/ Admin	$93,900	2.3
Web Application Programmer	$88,200	1.8
Network Architect/Designer	$88,100	2.2
Data Center Manager	$81,100	1.7
LAN, WAN Manager	$70,000	2.3

Network Technician	$64,800	2.1
Trainer, Tech Support	$51,900	2.4
Total	$88,800	(Ioma 2009)

These salary ranges, of course, include both contractors and permanent IT professionals. As mentioned above, salary is simply one part of an employee's total compensation package. For short-term employees, the higher the salary the better. There is no promise of tomorrow for contractors or short-term employees, so a high wage counts for everything. For example, computer programmers sent by temporary help services (THS) agencies earn USD 7.85 more per hour than those hired as permanent employees. While the salary of these employees may be higher, keep in mind that in the US, for example, these employees can be let go after their contract has expired with no repercussion and there is no long term commitment to them.

For long term employees the total compensation package and other organization perks become much more important. A survey was conducted by CIO Insight Magazine asking 234 CIO and IT leaders what benefits their organization provided that were the most important to recruit and retain IT talent. Approximately 49 IT leaders said that they offer higher than average salaries as a way to attract and retain talent. Of the 234 respondents, only 60 thought that salary was an effective tool to hire and retain long term IT professionals.

Benefits

With long term IT professionals, unlike with temporary staff, there are costs associated with recruitment and training. These costs can be significant, and the loss of knowledge from an IT professional who leaves can be costly. Keep in mind that permanent IT professionals in a firm have a better understanding of the business needs of the organization and tend to be more productive. To make a long story short, a great benefits program is another way to make sure that these valued IT professionals stay with an organization. In fact, of the tools listed in the survey referenced above, tuition reimbursement and retirement benefits ranked number one and three in terms of the things that CIOs thought were most effective to retain key IT employees.

Each year *Computerworld*, a popular magazine geared toward IT professionals, puts out a list of the top IT organizations to work for in the United States. These lists are based on employee surveys and testimonials. In 2008, *Computer world* proclaimed The Capital Group Cos. the organization for IT professionals to work for. One of the key reasons that employees love working for the Capital Group is its amazing benefits package. Capital Group invests generously and regularly in its roughly 1,600 IT workers, who, like a majority of Capital Group's 8,000 employees worldwide, rate the organization's Master Retirement Plan (MRP) as one of its best benefits. The organization establishes an account for each employee, or "associate," as they're known, as soon as they're hired. Every year, Capital Group contributes an amount equal to 15% of each associate's total annual cash compensation (including bonuses) to the account, up to the statutory limit of USD 33,750.

Another popular benefit is tuition reimbursement. Tuition reimbursement encourages employees to go back to school for an advanced degree or certification. Tuition reimbursement provides employees with an opportunity to gain knowledge in a new technical area or to expand on their business acumen. Surprisingly, fewer than 40% of organizations pay IT professionals for college credits. According to the table below, the 234 CIO and IT leaders ranked tuition reimbursement as the number one incentive that can be used to retain IT professionals.

Another US organization which is well known for its benefits is SAS, the largest privately-held software organization in the world. SAS has appeared in Fortune magazine's best organizations to work for list for several consecutive years. When it comes to employee benefits, SAS asks, "Will we get enough of a return in terms of employee time saved to merit the investment?" If the answer is yes, SAS provides the benefit. This is why SAS subsidizes two-thirds of the cost of day care. They also provide massages, dry cleaning, haircuts, and auto detailing on-site at reduced costs to employees. The reason SAS offers these benefits to their employees is to keep them focused on work. If an employee becomes preoccupied with activities outside of work, they are less focused and less productive at work. The idea is to remove distractions from IT professionals and let them do their job unimpeded.

Incentive pay

Bonuses are another way to incentivize employees. Typically, bonuses are paid out to reward certain levels of performance in an organization. Bonuses can be used to incentivize a variety of behaviors including individual performances, team performances, or performances on specific projects. Bonuses can also be used to compensate employees for what could be deemed a low salary. Firms should think seriously about behavior that is important to them before they decide on a bonus structure for employees. One thing firms may consider: Rather than paying bonuses to everyone at the end of the year, which can make bonuses meaningless in terms of motivation, instead, pay much larger bonuses to fewer people for specific, publicly recognized, accomplishments. Suddenly, paying a

bonus means something. Everybody on your staff won't hit the jackpot, but everyone will have a chance to earn a bonus based on what he or she accomplishes.

Stock options

Another popular method of compensation used by for-profit corporations is stock options. An employee stock option gives the employee the right to buy ("exercise") a certain number of shares of the firm's stock at a stated price (the "award," "strike," or "exercise" price) over a certain period of time (the "exercise" period). Employee stock options come in two basic flavors: nonqualified stock options and qualified, or "incentive," stock options (ISOs). ISOs qualify for special tax treatment in the US. For example, gains may be taxed at capital gains rates instead of higher ordinary income rates. Incentive options go primarily to upper management, and employees usually get the nonqualified variety.

A organization might provide stock options to employees as a way to give them a discounted stake in their organization. The idea is that if the employee has a stake in his or her organization they will work harder to ensure that the organization succeeds and the stock price goes up. Many organizations may provide lucrative stock options to their employees rather than paying them a high salary. Stock options in these firms may be more attractive to employees because of the perceived potential value of the stock. Employees may believe that the organization they are working for is the next Microsoft or Google where the stock will become enormously high after a certain period of time.

Offering stock options is also important for start-up companies because they may not have the money to offer high salaries or benefits. The only way these organizations can attract talent is through the offering of stock options.

Career development and job security

A large part of an effective retention and talent management strategy is to develop future leaders and make them feel secure with their job and their work environment. Career development is important not just for strategic or contingency leadership planning, but to show employees that a firm has a genuine interest in them and their future. The same thing is true of job security. If employees feel that you are concerned about them and their future employment, they tend to be more loyal and work harder.

Long term career development

In some firms, there is a natural apprehension toward developing employees. There is a fear that spending what could be potentially thousands of dollars on career development could backfire. Many organizations worry that highly trained employees will move on another organization where they could make more money. The simple fact is, though, that paying for and providing employee career training and taking an active stance in an employee's career development demonstrates an organization's interest in an employee and makes an employee more likely to stay with their employer. In addition, employee training and development can make an employee more productive, more knowledgeable, and ultimately a more valuable employee.

In terms of this section, it is important to differentiate standard training from career development. Standard training, which we will discuss further in the section dealing with productivity, has more to do with job competencies and functional skills. You can think of a programmer receiving training in a new programming language or methodology as an example. Career development is more about IT leadership training and is focused on helping and employee develop the necessary skills to make them promotable to a higher management position within the organization. Here are some of the benefits to career development training:

- Improved current and future leadership capabilities and developing internal candidates for promotion (thus preventing and expensive and potentially risky hires from outside the firm)
- Improved innovation and alignment with business strategy
- Improved team-work (both internally and cross-functionally)
- Improved collaboration and knowledge sharing
- Greater clarity of purpose and appropriate decision-making
- A higher performing IT organization (McKeen and Smith 2005)

Leadership training

One of the key areas of career development is leadership training. IT organizations face more challenges today than ever before: Achieving business growth goals, enterprise transformation, coping with technical and relationship complexity, facilitating innovation and managing an increasingly mobile and virtual workforce. Strong IT leaders are needed now more than ever. What can organizations do to develop IT leaders? Smith and McKeen have identified 8 areas of development to train and develop successful IT leaders. A description of each of these

areas excerpted from their 2005 article "Developments in Practice XIX: Building Better IT Leaders - From the Bottom Up," (Smith and McKeen) is covered below:

> **"Personal Mastery:** These qualities embody the collection of behaviors that determine how an individual approaches different work and personal situations. They include a variety of soft skills, such as self-knowledge, awareness of individual approaches to work, and other personality traits".
>
> **"Leadership Skill Mastery:** These qualities include the general leadership skills expected of all leaders in organizations, including: motivation, team-building, collaboration, communication, risk assessment, problem-solving, coaching and mentoring".
>
> **"Business understanding:** It should go without saying that for strategic vision, an IT leader should understand his/her organization's current operations and future direction. This concept is quite well-accepted in IT, although few IT organizations offer formal programs to develop such understanding. Being able to apply strategic vision to a task also involves a much broader understanding of the larger competitive environment, financial management, and marketing. "
>
> **"Organizational understanding:** IT professionals have long understood that technology must work in combination with people and processes to be effective. IT professionals must develop skills which can be used to maneuver within their organizations and work across multiple business areas. Examples include:
>
> - political savvy (to overcome resistance and negative influences)
> - organizational problem-solving (to address conflicting stakeholder interests)
> - effective use of governance structures (to ensure proper support for change)
> - governance design (to work with partners and service providers)".
>
> **"Creating a supportive working environment:** Most IT work is done in teams. Increasingly, these teams are virtual, include business people, staff from vendor organizations, and members from different cultures. Motivating and inspiring one's colleagues to do their best, dealing with relationship problems and conflicts, and making decisions that are consistent with the overall goals of the organization and a particular initiative, are therefore the job of every IT professional".
>
> **"Effective use of resources:** A good IT leader knows how to concentrate scarce resources in places where they provide the biggest payoff for the organization. To do so not only means making use of processes and tools to stretch out limited staff, it also means understanding where resources should *not* be used (i.e., saying 'no')".
>
> **"Flexibility of approach:** A good IT leader knows where and how to exercise leadership. Specifically, a good IT leader must know when to exercise certain skills and understand what situations call for certain behaviors. They must have the ability to adapt".
>
> **"Ability to gain business attention:** A large component of IT leadership is not focused on the internal IT organization, but outward towards all parts of the business. One of the biggest challenges for IT leaders is that the focus of their work is more on business value than on technology. It is important that IT leaders are able to demonstrate this business value to executives who control funding and resources".

In addition to leadership training, it is also important that IT professionals gain an understanding of basic business functions as part of their career development training. This would include things like training in finance, accounting, and project management. The ultimate goal of any IT project is to produce value for the firm which undertakes the project. It is therefore important that IT professionals understand financial calculations such as payback period, capital investment practices, and net present value to determine if the project they are undertaking will generate positive cash flow for their firm. As mentioned above, one of the aspects of career development is the planning and use of scarce resources. Understanding the financial consequences of resource use is critical to the success of IT projects.

Ultimately, training in leadership or business acumen is one way to teach IT professionals to view Information Technology in a more strategic manner. Ray Hoving notes in his article "Information Technology Leadership Challenges – Past, Present, and Future" that the role of leadership in IT is changing and becoming ever more complicated. IT leaders need the ability to see IT projects in larger more strategic context (where strategy means

taking into account the business success of the firm and the firm's overall position in their market) IT leaders must have:

- An innate knowledge of the technologies and natural intuition to know which ones are going to pay off
- Business acumen and the fortitude to demand measurable returns
- The ability to manage a diverse set of internal and external resources within an ever changing set of value propositions
- The IT leader of the past, present, and future has to be an executer with a keen sense of what it takes to get the right things done.

Recall that we introduced and discussed some of these issues in Chapter 1 of this text.

Job security

Job security is critical to obtaining maximum productivity for IT employees. In an era of outsourcing and cutting costs, IT professionals have good reason to be concerned about their jobs. As layoffs begin or jobs are shipped overseas, productivity can decrease. Rumors may begin to run rampant throughout the organization and as employees begin to worry more and more about their job security production will decrease further. When an employee learns that layoffs or outsourcing are being considered, they naturally question the loyalty of the employer which may result in a drop in morale. IT professionals, or any employee for that matter, may view the consideration of layoffs as an underestimation of their abilities or a lack of confidence in them personally. This can be demoralizing to a staff and contribute to a mass exodus of talent before the decision has even been made (Khosrowpour and Subramanian 1996).

Unfortunately, during any period of downsizing, it is the good employees who leave first. After all, it's the good employees who have options outside of the firm where they currently work. These employees often have skills which may be irreplaceable that other organizations may covet. They could have some sort of valuable technology skill or leadership training which makes them valuable. It is important that organizations find a way to retain valuable employees, even during times of turmoil where layoffs may be necessary.

How to handle layoffs

No matter how hard an organization may try, sometimes layoffs are inevitable. So how does an organization break the news to employees that there will be layoffs or that they have decided to ship an IT function overseas? John Tozzi writes, "Management should be transparent about the organization's difficulties, articulate a plan to overcome them, and treat laid-off employees with respect, say experts and entrepreneurs who have stomached the painful process" (Tozzi 2009). It is important for management to keep staff informed of what is going. As noted above, employees can become anxious and nervous about the status of their jobs and good employees who can leave may do so. "In times of uncertainty, what people most crave is some information that helps make decisions," says Sally Klingel, director of labor-management programs at Cornell's School of Industrial Labor Relations (Tozzi 2009). The reason this upfront honesty is critical is to control the rumors that can sometimes run rampant when layoffs begin. These rumors are often worse than the reality.

While it is true that a drop in productivity can occur, this behavior often occurs because of the anxiety caused by not having enough information. Peter Cappelli, director of the Center for Human Resources at the University of Pennsylvania's Wharton School (US), says "in small enterprises, workers often sense when the organization is in trouble anyway, so pretending things are fine will only hurt a business owner's credibility. When employers don't level with staff, employees will speculate about what's going on, and the stories they make up are usually worse than the truth".

It is important, even during a time of layoffs, that an organization maintain its position as a great place to work. At some point in time, these organizations are going to have to begin hiring again and they don't want to tarnish their reputation. Fortunately, there are specific steps that managers can take to help employees during a period of layoffs that will allow the organization to maintain its position as a good place to work:

- Tap your network: Try to contact vendors, or other contacts to see if you can find jobs for laid off workers
- Start an online forum to pool talent: Use web applications like Facebook or LinkedIn to try to connect workers with potential jobs
- Give workers ample notice: This is important to not only relieve anxiety, but to also give workers enough time to find work. These employees will thank you in the long run and may provide great leads once you begin hiring again.
- Direct employees to local resources. Direct employees to career centers at government agencies or local colleges. They provide invaluable resources to find another job.
- Give employees an honest reference. Provide a great reference to employees who worked hard for your firm. Other employers may think that you laid off a worker for poor performance when that may not be the case.

- Keep in touch. Stay in contact with those employees whom you may like to hire back. Activity may pick up at a moment's notice and former employees may still be looking for a job when you are hiring (Tozzi 2009).

Concern for productivity

As mentioned above, productivity is a huge concern for IT managers. Making sure that a manager's IT staff stays on point and productive is critical to making sure that projects get done on time and on budget. Obviously, the way an employer handles hiring and layoffs are a few ways to make sure employees remain productive, but those are simply the beginning. The way a firm manages its employees, a firm's work practices and arrangements, and a firm's culture can all have effects on the productivity of IT employees.

Performance measurement

How does a firm measure productivity? What are the best ways to evaluate employee performance? Providing feedback to and evaluating employees is critical to keeping employees productive and helping them develop their careers. How else are employees supposed to become more productive and improve if they are not provided timely feedback? There seem to be 2 items of importance here: 1) how often to give employees feedback and 2) what type of evaluation system to use.

There are some organizations that strive to give feedback as often as possible. Employee performance may be reviewed monthly, weekly, or even daily. The idea is that the more often that feedback is provided the quicker the employee can take corrective action thereby making them more productive. More timely reviews can also be a good way to provide positive reinforcement on a more frequent basis which can also help with employee morale and productivity. Most of these reoccurring meetings tend to be more informal and serve as a way for the employee to meet with their manager or supervisor on a frequent basis.

In terms of a formal evaluation process, there should be few surprises to employees if you are providing timely feedback to them. Many firms separate the formal process from the informal manager meetings referenced above. Formal reviews may be a time for the organization and employee to achieve other objectives such as career planning, sorting out goals and objectives, and to discuss pay increases. There can be several different timelines for providing formal employee reviews. At Royal Caribbean, for example, one or even two formal reviews a year is not sufficient; CIO Tom Murphy and his managers do quarterly formal reviews, and employees have both a professional and a personal development plan, which complement each other. Harrah's Entertainment takes a three-pronged approach to the review process. First, managers administer biannual performance reviews. Second, workers sit down with supervisors to outline and track their training plans and their career development. At that point, people are given a chance to identify their wants and supervisors also record what projects they have worked on. That allows resource managers to identify which projects would be good for certain employees work on. The third element involves an annual talent review and succession planning exercise in which senior IT executives look at all 500 or so of Harrah's IT employees to identify the strongest performers and plot out succession plans. The succession plans are recorded in a specialized succession planning system used by the organization as a whole.

There is no one method that is best for providing feedback. However, one popular method of employee evaluation is the 360 degree evaluation method. This method gathers feedback on each employee from multiple sources such as managers, team-mates, or even members from other teams that may work with that individual. According to an article in CIO magazine "A third to a half of all IT organizations practice some sort of 360, according to various surveys." These 360 reviews are an excellent way to gain feedback on IT professionals from other business units, especially for IT groups who can on occasion become isolated. "The main reason CIOs should embrace 360s, even if HR says "no," is that they represent a cost-effective way to align communication and expectations within the enterprise."

Intellectual stimulation

Elton Mayo first examined the effect on employee involvement and productivity in 1927. The original study conducted by Mr. Mayo took place in the Hawthorne plant of the Western Electric Organization in Chicago. He wanted to see how workers would perform under different working conditions. Specifically, he wanted to see how workers performed under various lighting conditions. He hypothesized that workers who received more light would be more productive. What he found is that workers under all lighting conditions began to work harder and produce more once the study began. The reason was that the workers knew they were taking part in a study and they felt more engaged and were therefore more productive. It's hard to say whether the workers were genuinely happier and therefore more productive, but there is a case to be made that workers who are more engaged tend to produce more. In terms of IT workers, there is definitely a case to be made that workers who are intellectually challenged and who are engaged with their organization are more productive.

How does an organization go about engaging their IT employees? According to one technology consultant, "IT professionals want to work on an engaging local team that has a lot of energy. People want to be challenged

and work for an organization that innovates; they want mobility, and they want novelty. One organization that is doing this is SAS, which was mentioned earlier in this chapter. We stated then that SAS has been in the top 20 of

Fortune's 100 Best Organizations to Work For list for several years. Their employee turnover rate hovers between 3% and 5%, compared with the industry average of nearly 20%. SAS has three guiding principles: 1) Help employees do their best work by keeping them intellectually engaged and by removing distractions. 2) Make managers responsible for sparking creativity and eliminate arbitrary distinctions between "suits" and "creatives." 3) Engage customers as creative partners so you can deliver superior products.

Two of the three guiding principles are centered around employee creativity and removing distractions in the work place. The low turnover rate at SAS is critical to productivity. New employees require training and are simply not as productive as long term employees. In addition, as Hawthorne suggests, the existing staff at SAS feels empowered and engaged and many of the employees are therefore more productive. Oddly enough, SAS does not rely on economic rewards to keep their employees happy and productive. They rely on the intellectual reward gained from a challenging job. As top executives at SAS see it, the best reward they can give an employee for a job well done is a more challenging job.

Work arrangements

Many IT managers argue that work arrangements such as flex time and telecommuting (such as when to come to work or if they want to work at home) can also make IT employees more productive. The idea is that when employees are allowed to take personal control of their working environment they feel empowered and are ultimately more productive. As you will see below however, these varying work arrangements do have consequences and must be considered heavily before they are instituted.

Flex time

Flex time is the ability for an employee to start and end their work day at a time that is convenient for them. For example, an employer may have a typical work day between 7 am and 6 pm. During those hours, an employee has to work 8 hours, but they get to choose when they start and stop their work day. According to several studies, flex time can increase employee morale, decrease absenteeism, and decrease employee turnover, thereby increasing employee productivity. An experiment conducted in 1981 examined the effects of flex time on employee productivity. The experiment showed that employees were definitely happier with their jobs as job satisfaction (which was measured before and after the flextime experiment) increased 77%. The study also found that these employees were doing work more accurately.

In addition, the study demonstrated that despite a massive increase in workload, productivity did not decrease as much as expected. The productivity of workers who were not allowed flex time decreased substantially more than those who were allowed flex time.

It should be noted that the productivity mentioned in the study was based on independent work done by employees. The study did not measure the effects of flex time on interdependent work where employees rely on collaboration to achieve a common work product. When an organization institutes flextime, there is still a wide variety of hours where employees have the opportunity to interact and collaborate. In other uses of flex time (such as giving employees free reign to decide when they will work rather than a range of hours) there is a chance that employees will not interact, will not collaborate, and that teamwork can suffer. This is especially important for IT because many software development methods and other project work rely on team based approaches. One should weigh their options when deciding whether or not to introduce a flexible work schedule and what type of schedule to implement.

Telecommuting

Telecommuting is similar to flex time in that it allows employees flexibility in their working environment. Simply put, telecommuting is the ability for employees to work from anywhere (their home, for example) using a networked computer rather than commuting to an office using public transportation or their own automobile. There are some definite advantages to allowing employees to work from remote locations. There can be serious cost advantages because employers may no longer have to provide office space for those employees or pay for other costs such as electricity and parking spaces. Like flex time, telecommuting can make employees more productive and can reduce absenteeism while increasing employee retention. Similar to the study conducted above, there was a study conducted regarding the productivity of employees who were able to work from a remote location. This time, several call center agents were selected to work from home. It should be noted that these employees were allowed to work from home directly after the release of a new software product by the organization they worked for, and that the study was conducted over a 5 year span from 1998 to 2003.

The study found the average productivity of telecommuters in the 13 months immediately after the “go live” period increased by 154%, while the average productivity of in-office agents fell by 13.3%. In addition, overall customer service improved considerably for the telecommuters as the percentage of abandoned calls decreased from 12.2% to 3.6%. As mentioned above, there were also cost savings achieved by allowing these workers to telecommute. The table below shows the cost savings associated with the need for reduced space and the increases in employee productivity. Note the positive net benefit of USD 1,361 per employee.

Costs	Amount	Yearly Cost per Telecommuter
Extra Management Supervision	One home visit per week by management at 1.5 hours each based on $50,000 salary for the manager	$1,875
High Speed Line	Monthly Fee of $147 per line	$1,764
Equipment	Onetime costs of $2,000 per telecommuter (assume telecommuter stays for three years and keeps equipment	$667
Total Costs		$4,306
Savings	Amount	Yearly Savings per Telecommuter
Office Space	$4,000 per year per office worker	$4,000
Reduced Complaints	$5,000/year (assume three telecommuters at the start and end of the project)	$1,667
Total Benefits		$5,667
Net Benefit		$1,361
Source: (Butler and Williams 2007)		

As with flex time, there can be other considerations if workers are allowed to telecommute. The employees in the study referenced above were carefully selected. They were employees whom management knew could be trusted and who had a certain level of knowledge about the newly released software product. Agents who were later selected to work from home (agents who did not have the seniority of those selected in the previous study) did not do nearly as well. If fact, their productivity dropped as they handled 3.7 calls per hour compared with individuals who handled 6.0 calls per hour in the office. One must also consider the technology involved in telecommuting. Employees must have the technological capability to work from home (appropriate Internet connections, appropriate Internet service provider, etc.) before they should be considered for such an assignment.

Since employees are working from home, there can also be serious consequences to team projects and collaboration (even more so than with flex time because such employees may not come into the office at all). Both Hewlett-Packard and Intel have rolled back their telecommuting programs for employees. Both organizations noted that telecommuting had a negative impact on employee productivity and collaboration. It is no coincidence that both organizations rely on team processes to accomplish work. Employers have to be cautious about allowing employees to telecommute. There are some employees who need to be in the office. They may be more productive in the office or they could be, as one CIO noted, the gel that holds projects or group work together. The bottom line is that employees who tend to work alone and who perform very task-oriented projects (such as the tech support workers referenced in the studies, programmers, etc.) are the best candidates for telecommuting. Employees who are involved in various team-related projects may not be good candidates for telecommuting. Also, organizations like Hewlett Packard and Intel who rely on employees being creative and collaborative may consider the loss of these elements before beginning a telecommuting program. One has to seriously weigh the pros (cost cutting, potential productivity gains) versus the cons (loss of creativity, team building, and collaboration) before making a decision.

Training

The last item that may increase employee productivity is training. This sort of training is different than the career training mentioned above. The training referenced in this section refers to more job specific training. There

are often advances in technology which can increase employee productivity. These technologies can take the form of a new development methodologies or new software. According to Gartner Research, every hour of technology training provides 5.75 hours of increased capacity. Today's workforce requires continuous training and learning in technical skills, soft skills and IT. A good training program can average 150 hours annually.

IT on the job training can be expensive. Certification programs or training in new development methodologies (discussed in Chapter 4) can be costly. As with other development initiatives, these training programs have to be closely aligned with an organization's business needs. In 2003, the United States government conducted a study on IT training practices for successful private sector organizations. Some of the organizations analyzed in the study were AT&T, IBM, Raytheon, and Cisco. Below is the list of best practices that were surfaced by the study:

Align IT training with business goals	• Enlist executive-level champions (sponsorship) to ensure that training strategies are incorporated into corporate decisionmaking and aligned with business goals • Involve critical stakeholders, such as top management, business unit managers, subject matter experts, human capital staff, and end users, in planning IT training • Address future skill needs and new technologies as part of the planning process
Identify and assess IT training needs	• Identify and document competencies/skills required for each job description • Maintain a current inventory of skills • Address overall career development issues as well as skill-specific training issues • Perform a gap analysis to determine where training is needed • Use self-directed tools, such as individual development plans, to give employees responsibility in assessing their development needs • Use a single portal to give staff and managers access to training and career development information
Allocate IT training resources	• Ensure that an investment process is in place to select and manage training projects • Consider the benefits and costs associated with various training design and delivery methods—e.g., Internet-based as opposed to classroom training • Identify people who have high potential and provide them specialized training opportunities • Ensure that resources are allocated for management training—e.g., leadership and project management
Design and deliver IT training	• Provide IT trainees with the flexibility to choose among different IT training delivery methods • Ensure that on-the-job training is planned and monitored as part of the training process • Consider combining different teaching methods (for example, Web-based and instructor-led) within the same course • Provide just-in-time training • Consider outsourcing training solutions—e.g., university partnerships and external IT training and content providers • Build courses using reusable components
Evaluate/demonstrate the value of IT training	• Collect information on how job performance is affected by training • Validate IT content learning by testing and certification of specific skills—e.g., Java or C++ • Assess evaluation results in terms of business impact

(GAO 2003)

As mentioned above, there are several ways to change your organization's work environment to allow employees to become more productive, although some of these methods seem to be at odds. An organization like SAS, Hewlett Packard, and Intel thrive on employee creativity and collaboration. Programs which stimulate and challenge employees are a great way for them to increase employee productivity. On the other hand, organizations that rely on their employees to be task-oriented such as call centers or certain organizations which rely on stand-alone software programming may see increases in productivity from the use of flex time or telecommuting. A valid training program in line with one or both of these environments can vastly increase employee productivity.

Concern for the individual

This final section is focused on how organizations create a culture where employees want to work and where they thrive. Creating an environment where employees feel wanted increases employee retention and makes a firm more attractive to potential hires. No organization better exemplifies a great place to work culture than Google. In 2009, Google was ranked 4th in Fortune magazine's poll of the best places to work in the United States. In 2007 and 2008, they were ranked number one. Google of course has great benefits, but more than that, they have a culture, similar to SAS, that encourages creativity and encourages employees to come up with new ideas. Google allows their engineers to spend 1/5th of their time (that's one work day a week) to work on projects of their own choosing. There's a dedicated area that's conducive for creative thinking. Walk in some Google offices, and one may see exercise balls in the hallway, washers and dryers, workout facilities, and a snack room.

Similar to SAS, Google has a 5% turnover rate in an industry with a 20% average. In a time of a shortage of IT professionals, Google has no problem attracting or retaining talent. Both Google and SAS have created cultures where employees want to work. They have done this by becoming efficient in providing clear opportunities for advancement, providing valuable recognition for employees, having quality managers, providing a sense of belonging and community, and providing a good work – life balance.

Opportunity for advancement

With most IT specialists there usually exists the possibility of being promoted to a senior specialists (in whatever specialty they are employed), but rarely will those specialists have the chance to move into management or move into other important areas of the organization. Peter Drucker provides an excellent example of such a problem. Imagine a bassoon player in an orchestra. Bassoon players play a very specialized instrument and if they are excellent players, there is a chance they can be promoted to first chair (which in this case could be considered a promotion to a senior level). While they may be able to move to another orchestra, there is a very poor chance that they will someday be able to become the conductor of the orchestra. IT professionals are often viewed in such a light, and while some IT professionals do not want to rise into the management ranks, there are some (often the best employees) that do.

The problem with IT, as opposed to other business units, is that they are often not exposed to upper management and are believed to not have an understanding of general business processes (which is why it is so important to provide training on these items!). It is essential that an organization find ways to provide advancement opportunities for these employees; otherwise they will leave. This is all part of creating an environment where IT professionals want to work. How does an IT organization solve this problem?

The first step is to provide training and upper level recognition for a firm's best IT professionals. General Electric tackled this problem by creating parallel positions in another department for employees where they might become more visible and have more opportunity for advancement. Law firms often promote their specialists to senior partners as a way to provide advancement opportunities. A firm can decide which method may be most appropriate for them based on their culture and work environment.

Recognition

Employee recognition is critical to motivating employees. Recognition makes employees more productive and is another way of retaining great employees. Jean Pierre Brun notes in his study of employee recognition that a lack of employee recognition constitutes the second-largest factor for psychological distress in the workplace (Brun and Dugas 2008). Managers often consider bonuses and salary increases as the most important form of recognition. While bonuses and salary increases are nice in lieu of performance environments (where bonuses are paid based on the ability of the individual to hit certain metrics), there are better methods to motivate employees.

Any sort of recognition program should be authentic. There are many "employee of the month" programs or other recognition programs that have no credibility with employees. Employees can see right through a person who is fake or not genuine about recognition that they are dolling out. The idea of a good recognition program is to make the employee feel good about the work they are doing. Managers should be very clear in telling their employees that they value the work that they do. The following are forms of positive recognition:

- "Manager thanking an employee for his/her involvement in a project (valuing participation).
- Manager recognizing the value of an employee's ideas, even if they cannot be put to use.
- Leading a round of applause in a meeting to highlight the time and effort invested in a team project.
- Supervisor sending a message to thank an employee for his/her courage and perseverance in difficult working conditions.
- Ceremonies to highlight special achievements.
- Peers spontaneously congratulating an employee who has tackled a major work challenge.
- Manager saluting a job well done at a team meeting".

There are no secrets for providing employees with valued recognition. Managers should be genuine, timely, and specific with their comments and their praise. As mentioned above, there is certainly a time to reward employee performance with bonuses, but the types of recognition discussed above are free and employers who use these recognition methods wisely can reap major benefits.

Quality of leadership

How does a firm go about executing the ideas discussed above? It takes a skilled manager and leader to hire the right individuals, provide the right salary, provide the right training, keep employees productive, and to provide high quality and timely feedback capable of motivating employees. These are skills that can be taught to people, and it is important that any firm train its management team in each of the skills mentioned above (a good place to start would be to focus on the leadership skills referenced in the training section).

It is also important that firms have a clear leadership contingency plan in place. The best leaders are often the ones that are promoted from within. These employees understand the organization they work for and the people who work in it (if they have had the proper leadership training). They understand the politics, the culture, and what makes the organization they work for the most productive. If one manager, or even the CIO or CEO, of the organization leaves, it's important that someone can step right in without missing a beat and without dramatically

changing the culture in the IT department. Again, this is why leadership training is critical and why contingency planning for management positions is also of the utmost importance.

Sense of community

One of the things that makes Google, SAS, and some of the other top IT organizations great to work for is the sense of community and belonging felt by employees who work in these organizations. For example, Google has weekly team building activities, such as roller hockey in the parking lot, as part of their weekly routine. Why bother having team members get to know each other and build this sense of community? There are obviously major retention benefits to building a sense of camaraderie at work. Employees would much rather come to work when they know, understand, and enjoy the people they work with. Besides that, there can be major benefits to a collaborative team environment where employees understand each other. Employees who know each other tend to be more honest, willing to share ideas, and share constructive criticism.

Tracy Mauro, a professional trainer at MCI (a telecommunications organization in the US), notes that employees who feel they are a part of a community are more likely to fulfill their obligations to each other. Miss Mauro also notes that having a sense of community in the work place can do wonders for productivity. She writes: "People are the key to building business. Most of the time people are not engaged and working at 100% capacity especially when distracted by crisis. Employees choose every day when and how much effort they will expend after meeting the minimum performance standards. When organizations create an environment where employees want to be fully engaged…they are more likely to increase their discretionary effort".

Lifestyle accommodations

The final piece of this section will focus on work-life balance. Rather than overworking an employee and requiring them to work 70 hours a week or more, the central idea of work-life balance is that if employees have time to do things outside of work, they will be more productive when they are at work. While much of the developed world has cut back the annual number of hours worked per person over the past decade, Americans have headed in the opposite direction, adding 58 hours to their yearly total. The Japanese, by contrast, have cut more than 191 hours in a typical work year. Many US workers don't even take what few holidays they get, giving back an average of 1.8 days, or almost $19.5 billion total, in unused vacation time to employers each year, according to a survey commissioned by online travel agent Expedia.com.

Overworking individuals has proven to be costly. Medical studies show a correlation between a lack of vacation and increased heart attacks or other illnesses. Some studies even suggest that the vacation-loving French and Belgians now out-produce Americans on a per-hour basis largely because employees are given more time off, which allows employees to refresh themselves and focus more while they are at work. A study by Yankelovich Partners Inc. (a consumer research firm) shows that given the choice between two weeks of extra pay and two weeks of vacation, Americans would prefer to take the vacation by a margin of 2 to 1. Many employees, especially in the US as noted above, feel overworked. It is important that, in addition to all of the items discussed in this chapter, employers consider reducing employee stress (usually by reducing the number of hours employees are required to work) to retain employees and make them more productive. At SAS, employees are required to work only 35 hours a week and are discouraged from working anything over 40. The organization's motto is "after 8 hours a day, you are probable just adding bugs".

Chapter Summary and Review

This chapter provides recommendations and best practices for how to manage talent in an IT organization. The recommendations are by no means all encompassing. As a manager or future manager of IT professionals, you should always strive to better understand your work force and strive to help them reach their full potential.

The bottom line is that good IT managers find ways to retain their work force and make them more productive. The best IT organizations all have amazing retention rates. It is no coincidence that prospective IT professionals flock from all over the world to work at these organizations. It is also no coincidence that these organizations have the best, brightest, and most productive employees in the world. In an age of increasing competition and dwindling margins, a smart and productive workforce can create an immense competitive advantage in the market.

It is up to future IT managers to decide on which strategy will work best for them and their organization. Are they going to hire short term employees or long term? What sort of benefits will they offer? How will they make their employees more productive? These are all questions that need answered. Hopefully, this chapter has provided some ways to help make a decision as to what will work best in your organization.

Review Questions

- What are 3 sources for recruiting IT professionals?

- Why should an IT organization consider hiring a diverse workforce?
- Generally speaking, should an employer pay a higher salary to an IT professional or provide additional benefits? Explain your answer.
- Why is leadership training for IT professionals important?
- What do you think is the best way to increase productivity for IT professionals in your organization?
- What ideas do you have to improve the sense of community in an IT organization?
- What are the advantages to providing a better work-life balance for employees?

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Chapter 4: Being a systems innovator

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Editor's Note: The foundation of this chapter was originally published by the Global Text Project in 2007 as Chapter 1 in "Information Systems", Richard T. Watson, Editor. The original material was written by David A. Bray (Emory University), with contributions from Benn Konsynski and Joycelyn Streator (Emory University) and reviewed by John Beachboard (Idaho State University. Revisions and additions made to this chapter were made in 2010 by Jennie Lee Kuchta.

Learning objectives

- Define what broadly constitutes a "system" and an "innovation".
- Describe examples of innovation.
- Describe how one might strive to be a systems innovator.
- Describe the benefits of innovation to society at-large.

Introduction

Let us welcome you the modern age, so full of promise both in terms of human and technological progress! In this chapter, we address the role of innovation and being a systems innovator. Without systems innovators, it is quite possible that our modern age would not be so full of promise and potential. In fact, without systems innovators, humanity might never have reached modernity at all.

Several historians say we humans are "modern" when we do not automatically reject new or foreign elements in society. For human society, modernity begins when communities began to explore, tolerate, and accept the new and diverse. Thus, modernity includes a receptiveness of human societies to new ideas. Living in the modern age allows us to expect that modern enterprises and markets will tolerate and potentially reward to new ideas and new practice. In a modern age, those individuals who design insightful innovations (i.e., innovators) can be highly praised if their innovations are well timed, well designed, and well implemented.

As systems innovators, we welcome the modern age and strive to be open to new and beneficial ideas of change. Human societies value and evaluate new ideas by expected impact and effect. Modern markets and firms represent particular types of human organizations. Markets and firms can incorporate innovations by changing either their design or practices.

Being a systems innovator

Let us briefly consider the meaning of the essential words in the title: "systems" and "innovator" (defining "being" is something we will leave to the philosophers).

Definitions:

- **Systems** are the object of particular designs. Broadly speaking, systems involve the organization of things, logical and physical. Systems include data, processes, policies, protocols, skill sets, hardware, software, responsibilities, and other components that define the capabilities of an organization. Systems include human and non-human aspects. The components, or parts, of a specific system can be either real or abstract. Components comprise an aggregate "whole" where each component of a system interacts with at least one other component of the system. Cumulatively, all the components of a system serve a common system objective. Systems may contain subsystems, which are systems unto themselves

that include a smaller set of interactions among components for a more narrowly defined objective. Systems may also connect with other systems.

- **Innovation** is the process of "making improvements by introducing something new" to a system. To be noteworthy, an innovation must be substantially different, not an insignificant change or adjustment. It is worth noting that innovation is more a verb than a noun in our context. Innovation is similar to the word evolution, which derives from the Latin root for staying "in motion." Systems innovations often include an expectation of forward motion and improvement. To be worthwhile, innovations must be worth the cost of replacement, substitution, or upgrades of the existing order.

The term innovation may refer to both radical and incremental changes to products, processes, or services. The often unspoken goal of innovation is to solve a problem. Innovation is an important topic in the study of economics, business, technology, sociology, and engineering. Since innovations are a major driver of the economy, the factors that lead to innovation are also critical to government policy-makers. In an organizational context, innovations link to performance and growth through improvements in efficiency, productivity, quality, competitive positioning, market share, etc. All organizations can innovate, including for example hospitals, universities, and local governments.

Rather than construct a narrow definition of innovation, it is useful to think of innovation as including, but not limited by, a few key dimensions. Successful innovations include these dimensions. The first dimension is that of innovation form. Innovations manifest in many ways, but generally are either tangible or intangible.

- Tangible innovations result in new goods, services, or systems that you can physically touch. Examples include the introduction of new products or a style of architecture. Intangible innovations include the creation of new services, processes, modes of operating, or thinking.
- Intangible innovations might introduce greater efficiency into an existing process or create an entirely new way of doing something. For example, an innovation could reduce the time required to manufacture a car. This intangible innovation might translate into greater profits for a car manufacturer.

Systems innovators are individuals who design and implement innovations. To design refers to the process of developing a structural plan for an object. Systems innovators are individuals who transform the practice of organizations, markets, or society by making significant forward moving improvements. Systems innovators seek to designs that improve on the old to take advantage of new technologies, new techniques and new practice and processes. We would suggest that systems innovators not only recognize that social and economic structures are all human-made, but also recognize that human structures are always open to changes, enhancements, and redesign.

It is important to recognize that systems operate within systems. Identifying the connections and layers of these systems will make you a successful systems innovator. Often identifying new connections or new layers that no one else has identified yet can provide new opportunities for innovation. In order to better understand the systems approach it is helpful to think of our planet's ecosystem. Similar to our ecosystem, a system is made up of various parts that work together in an orchestrated manner to make a whole. Therefore, when one portion of the system is compromised that entire system suffers.

Systems innovators are designers

Sociologists note that humans are unique in their invention and adoption of tools. Among these human-made tools are the systems and procedures that govern, direct, and enable modern societies to function. These tools also include the systems that enable the actions of commerce and exchange. Systems enable patterns of work and reward and the conduct of participants in enterprise. For our modern age, systems have never been more relevant as the speed of society and the enhancement of information access and opportunity for social interaction increase. Almost all aspects of modern commerce, modern society, and modern life are connected to the designs of humanity. Much of what defines the pace and practices of our modern age are systems and technology-enabled.

Designers matter. To be a designer implies the task of creating something, or of being creative in a particular area of expertise. Part of being a systems innovator includes being a designer. It is worth considering that the fields of "systems design" and "organization design" are similar as both incorporate creatable, changeable, and linkable elements. Designers seek the requirements and expectations, identify the objectives and measurements of success, give structure to the elements, and form to the components of systems. Success or failure hinge on the ability of a designer to attain the proper requirements and expectations of a system. For example, a systems innovator plans to design a new cell phone network for 500,000 subscribers. Unfortunately, the innovator fails to include the requirement of future growth of the cell phone network to 2,000,000 individuals in five years. When the network is

built, per the design of the innovator, new cell phone subscribers must be turned-away from accessing the network because of the omitted designer requirement. Since the designer failed to include the proper requirements, this omission diminishes the success of the system.

In addition to developing a structural plan for a system, designers must manage the process of systems development, to include overseeing systems implementation, adoption, and continuing operation. Design also sometimes involves the augmentation and extension of an existing system. Part of being a systems innovator includes the enhancement of an existing or legacy system with a new idea, method, or technological device. It is important to keep in mind that system's development does not always have to occur from the ground up. Systems can be built around existing systems in order to improve existing systems or allow existing systems to have extended capability. Extending the life of a useful system, or upgrading capabilities to better align with the enterprise objective, may be the best service of the systems innovator. Often, it is easier to enhance an existing system, than it is to decode, decipher, or replace such a system. Social systems are tools designed by humanity. These systems reflect the bias and the values of the designers, or those that task the designers with requirements and expectations. Thus, designers, who create rules, influence systems greatly. Essential elements of the process and product of system development include the unique style and preferences of a designer.

Designers leave their mark, their trail, and their values reflected in the tools they produce. Style and preferences also guide systems implementation. It is also important to note that systems are networks of interacting elements. Thus, the aggregate "whole" of a large system may be more capable, stronger, or beneficial than the sum of its individual components – or it might be less so. Systems amplify the strengths and the weakness of their design. Ideally, well-designed systems amplify the benefits of their individual components. It is important to document a system's strengths, weaknesses, and capabilities in order to better understand where improvements can be made in the future.

Innovations are new answers to problems

The concept of innovation has been widely studied, yet it remains a difficult topic to define. Merriam-Webster's online dictionary describes innovation as "the introduction of something new" or "a new idea, method, or device." While this definition provides a good starting point for our discussion of innovation, there are still a number of dimensions to consider for a more thorough understanding of the concept. Careful observation of our surroundings reveals a multitude of innovations. Everything from electricity to running water, or from personal computers to cell phones, represents some form on innovation from past systems.

Innovations are not limited to tangible products. Innovations also occur when processes are dramatically improved. For example, through advances in cell phones, very little human effort is required to communicate a message across great distances quickly. More than 100 years ago, the similar transactions would have required significant manual work and time for a message to be sent by postal mail.

Many things can trigger innovation. Tools that can be used to trigger innovation include brainstorming sessions, think tanks, stretch assignments, etc. An individual or team of individuals may seek to address an existing problem, respond to a new situation, or explore new ability. While innovations typically add value, innovations may also have a negative or destructive effect as new developments clear away or change old organizational forms and practices. Organizations that do not innovate effectively may die or be destroyed by those organizations that do. Systems innovators are critical to our modern age. Innovators must insure that their envisioned innovations are appropriate to the environment of today and tomorrow. Below is a depiction of how knowledge when combined with an identified problem creates an innovation when paired with analysis and association. In other words, a systems innovator creates solutions to complex problems by pairing their knowledge (individual or group) with a the identified problem.

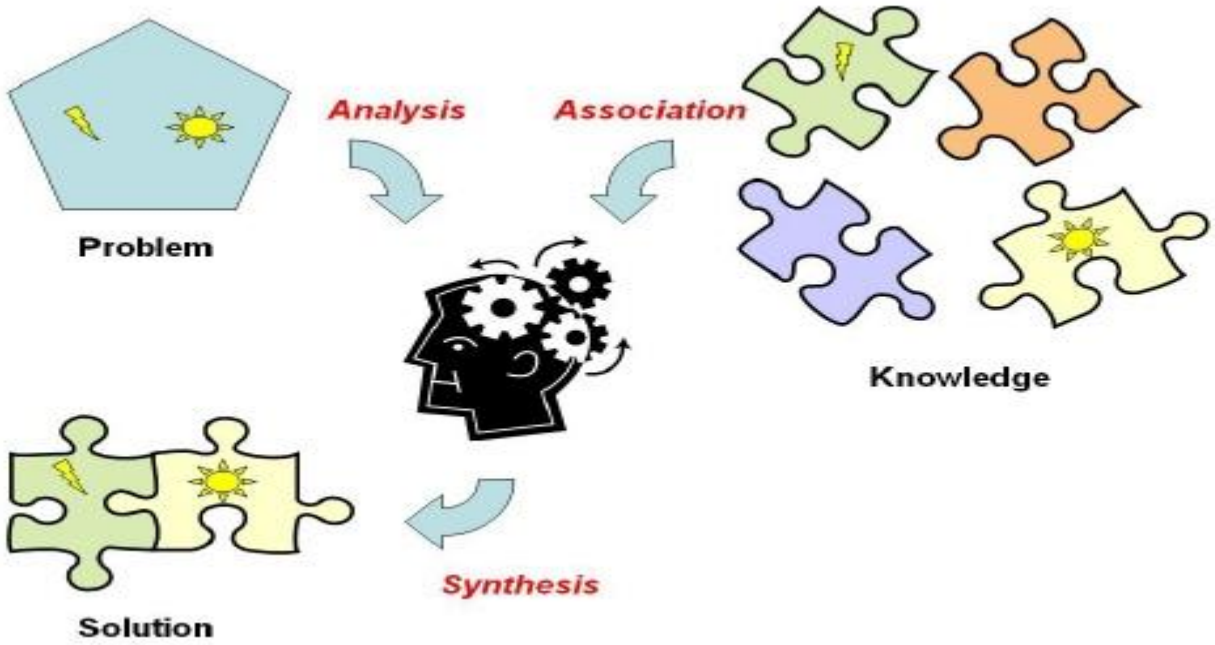

Figure 4.1: Innovating to win (2008)

Innovations are also reactions to change

While innovation can occur as individuals and groups wrestle with new problems, innovation can also be reactionary and occur as a response to unplanned changes. The ancient philosopher Heraclatus once said: "there is nothing permanent except change." The statement is certainly true today in our high tech world. Advances in computing power, communication technologies, and networking of computers around the world has quickened the pace at which dramatic change can occur across large and diverse groups of electronically connected people. Innovation often arises as a way of coping with, attempting to control, or benefit from changes. Changes in the use of information technology often provide the impetus for innovation.

There might be instances where local conditions encourage a particular innovation. For example, if past historical conditions prevented installation of wired telephone networks because they were too expensive, but now cell phone networks are both more affordable and available; the innovation of cell phone networks might open up new capabilities for areas that previously did not have such technology. As cell phone networks become more prevalent, the ways individuals communicate, compute, and exchange information will change and local companies may seek to introduce cell phones with new features that adapt to these changing communications patterns.

Exciting times for systems innovators

We live in exciting times for systems innovators. Advances in electronic communications, airline transportation, and international shipping, increasingly connect the lives of multiple individuals throughout the world. Such connective advances are part of a greater trend known as globalization. For the modern age, globalization includes the opening of commercial markets, increased free trade among nations, and increased education for a larger number of people. With globalization, what you do may influence events on the other side of the world.

With globalization, environments for organizations, both businesses and world governments, are becoming more complex. The reasons for this increased environmental complexity include "the four V's," specifically:

- Increased Volume (from local to global context in terms of transactions)
- Increased Velocity (faster transactions between people)
- Increased Volatility (organizations change and reorganize faster)
- Increased concerns regarding Veracity (the truth is harder to distinguish)

For systems innovators, it is important to recognize this perspective of increased complexity. This perspective is important both because it presents opportunities to innovate – by addressing the complexities and challenges mentioned above – as well as the risks associated with not innovating. Failure to innovate in an increasing complex and interconnected world may mean that your organization, be it a business or government, might become irrelevant and outdated quickly.

Increased complexity also makes the job of a systems innovator a bit trickier: an innovative solution needs to account for increasing complex environment. What may seem to be a straightforward solution may have

unintended effects on a system or other systems connected to a system. This leads to a second important perspective: systems operate within systems. Specifically, our world is a system of multilayered, interconnected systems. Homes connect to gas, water, and electrical systems that link to other homes. Traveling exposes us to systems of highways, public transportation, trains, planes, and ocean-going ships. A business is an organization comprised of multiple workers, interdependent in the tasks they perform. Within the organization, there may be a system of monitoring the funds received into and paid out by the business – and accounting system. This accounting system would include humans (managers and accountants), accounting data, processes for managing accounting data, rules for recording accounting data, as well as technology components.

Within this accounting system may be another system: an information system running a computer program dedicated to tracking electronically the accounts of the organization. A systems innovator looking to improve the organization may focus on the system of the overarching organization itself, the accounting system, or the information system dedicated to tracking electronically the accounts of the organization. Systems can be made up of various systems. In order to have a successful overall system, each system must be able to interact and communicate with one another. We currently live in a time full of business collaboration. Organizations demand that other organizations can interact and communicate with their system. Customized standardization is a term used to describe today's business environment. In order to successfully perform customized standardization various business systems need to communicate with one another. For example, Starbucks, a popular coffee shop chain, as mastered the art and science of customized standardization. A customer can walk in to a Starbucks store and order a drink that is "unique" to their personal preference. This allows the customer to obtain a sense of a "one of a kind" experience. Starbucks has been able to produce mass customized standardization by developing a menu of drinks that can adapt to various modifications as well as additions. Whether a customer is ordering a tall, grande, or venti coffee with non fat, whole, or soy milk, the customer walks away feeling as though their drink was created specifically for them. Customized standardized is a powerful selling tool.

General insights into human (and information) systems

For systems innovators, it is important to note that all human systems are artificial. By "artificial," we mean that human systems would not exist naturally in the world without humans. No natural rules govern the systems humans create – whether the systems are governments, businesses, educational institutions, or information systems. This is not to say that the systems humans create do not have rules; rather, they often do! For systems innovators, you can influence and change the rules. Part of innovating is identifying when the rules of a system, be it an organization or information system, could be modified to provide a better benefit.

So what are rules? Rules are defined ways of interacting with elements in a system, often proscribing an action. One rule might be "do not steal." This rule means that individuals should not take an element that does not belong to them. Another rule might be "if an electronic message is received from Company ABC, route it to our Accounts Payable." With rules, it is important to note that they link elements with actions. Rules can form the policy of a system. By system policy, we mean rules that link actions to elements in a system.

Information systems include data and processes. Data can be logical values (true vs. false), numbers, words, or strung-together sentences. Actions, known as processes, are required to actively exchange, transform, and move data. For a computer to "compute," processes actively manipulate data. Components of an information system detail the rules for what processes can do to data, under what circumstances. A systems innovator seeking to improve an information system might look to modify the data an information system contain or collect. Equally, a systems innovator might improve an information system by modifying what processes manipulate data – or an innovator might modify the policies of a system to reuse existing processes in new ways on data.

Recognizing that all human systems are artificial leads to another equally important perspective for our modern age: organizations are becoming like markets. By markets, we mean places where no one person is commanding everyone else. With marketplaces, you are free to wander to different vendors, try their wares, and are under no obligation to purchase their goods or services. No one is commanding you to buy from Company ABC vs. XYZ – you get to decide.

For organizations, this means that traditional "management" of individuals by command and control is increasingly becoming difficult in our complex, global world. Reasons for this reduced ability to command are partially dependent on globalization. Businesses may be partnered with other businesses where they do not have the ability to directly tell these other companies what to do. The same may be true for world governments. There also may be instances where organizations are competing with one another, perhaps to sell similar goods or services to you as a consumer – or perhaps to discover a new idea or innovation.

Cumulatively, these factors mean that organizations will be less able to command individuals or other organizations what they would like them to do, and instead have to rely on other mechanisms. These other mechanisms include using diplomacy to influence individuals or organizations, being smarter or stronger than other competing organizations, or giving rewards to elicit desired behaviors from individuals.

General implications for a systems innovator

So what does this mean for you as a future systems innovator? It means you should be mindful of the increasingly complex environment of our global world. You should seek out the connections and layers among systems. If you spot new connections or uncover a new layer, you may also identify radical innovations. Sometimes the most important part of being an innovator is having the wisdom to know when to form partnerships and with whom to make friends. It also means you should seek to identify what are the rules of a human system. You should be open to asking "why" a certain rule is in place and allow yourself to consider what would happen if that rule was changed. What would improve the current rules? Are there rules that no longer help as they previously did? You should also recognize that the ability for organizations to command others is decreasing. As an innovator, this trend is helpful, since it increases the chances for you to "market" and spread innovative ideas. This also means you need to consider how to influence and encourage others to adopt your innovations.

Specifically, as a systems innovator, you will need to "market" your innovation. Simply because you have thought of an innovation does not mean it will succeed. If you are not skillful at influencing others to consider and adopt your innovation, your innovation may not succeed. Further, you may need to be smarter or stronger than other innovators – and you may need to consider what rewards would encourage individuals to adopt your innovation. Sometimes an innovation itself can encourage individuals to adopt it, but this often is not immediate. By their nature, humans are not prone to change if they are relatively happy. Even if your innovation provides new benefits, you may need to consider wants to encourage individuals to shift from their old "ways" to your innovation.

Finally, it means you should recognize that innovation is necessary to deal with change. Change is constant in our world, so innovation also needs to be constant. Yes, innovation can be risky as sometimes an idea might not be incomplete, not right for the current environment, or not aligned with the needs of an organization. However, there is a greater, more certain risk that any system will become outdated without innovations. As a systems innovator, you should search, dream, and reach for the future.

How can I innovate?

It would be great if it were possible to describe systems innovation as a simple formula. However, this is not the case. Just as modern societies are open to differing views and ideas, there are many ways routes to innovation. Sometimes, an existing issue or obstacle with a system prevents the achievement of a certain goal. Individuals may brainstorm solutions to this problem and a novel idea will emerge that provides a good fit for removing or minimizing the obstacle. In other cases, an individual who is unfamiliar with the obstacle may bring an entirely new perspective that leads to an innovative solution. For systems innovators, continuous exposure to new ideas on different topics can bring fresh perspectives to familiar issues, thereby triggering new ideas and insights.

Innovation also necessitates a careful balancing-act between risks versus rewards. Many new ideas promise a tremendous payoff and recognition. However, with increasing rewards often comes increasing risk. For example, introducing an entirely new information system to a company's operations department may hold the promise of making inventory management more efficient, producing faster product availability, and increased sales. At the same time, the initial implementation of a new information system probably will cause disruption within an organization, perhaps in the form of requiring new processes or employee training. When undertaking an ambitious effort, it is essential that a systems innovator be aware of the potential downsides and risk factors that will undermine success if not adequately addressed. Complex systems often have unexpected consequences, some of which are likely to be undesirable. Failed innovations are not only time consuming but can be costly and a source of embarrassment for a would-be innovator.

While it may seem wise to take the safe route and focus on smaller, seemingly less risky projects, this may mean addressing small problems or introducing ideas that have a minimal impact on a system's performance. For example, rather than addressing inventory management problems directly, simply upgrading the computers that run the inventory management without actually changing the software that manages the processes, might have a minimal impact on the core problems. In addition, systems projects can often grow in scope as the project progresses. What started as a small effort might uncover additional requirements or system dependencies, prompting a project that started out as a low risk to grow into a longer, larger, more risky endeavor. Systems innovators must balance the reward a potential innovation might provide with the risk that implementation or adoption of such an innovation may go awry.

In addition, systems innovators should appreciate the importance of appropriate timing. Sometimes innovations can be "ahead of its time" or "too late." When designing innovations, it is important to consider environmental factors. An innovation must fit the needs of an organization, market, or society. An innovation introduced out of phase can undermine a system and other innovation efforts. Remember our earlier example of a systems innovator planning to design a new cell phone network for 500,000 subscribers. The systems innovator failed to take into account the requirement of future growth of the cell phone network to 2,000,000 individuals in five years. A skilled systems innovator would have planned for both the present and future of their designed system. As a systems

innovator it is your responsibility to understand the demands and trends of the current and future market. In order to be a successful systems innovator, you must be able to forecast the current and future development of your market. A successful systems innovator will not only ask the question, "How does this affect us now?" but will also ask, "How will this affect us in the future?"

For our modern age, systems innovators can design and create innovation in ways previously unavailable. Innovators must insure that their envisioned innovations are appropriate to the environment of today and tomorrow. Through technology, there are new ways for individuals to combine ideas for entirely new outcomes. This "re-mix" age allows recombination of systems elements to produce results greater than the sum of the parts.

What do innovations achieve?

Ultimately, any systems innovator is important in what their innovations achieve for organizations and individuals. Thus, it is appropriate to conclude discussion of "Being a Systems Innovator" with reflections on what ultimately are the fruits of innovation, and what makes being a systems innovator such an important and essential role for the fast-moving world of the 21st century. For a successful systems innovator, keeping a long-term view on the outcomes achieved from any future innovation is vital.

Innovations marry insights and existing knowledge to produce new knowledge. Without new knowledge, your organization, be it a business or government, might become irrelevant and outdated quickly. By creating new knowledge, innovations are the only sustainable advantage. The present "ways" of systems, with time inevitably become old "ways" and outdated. For our modern age, that some individual or organization will eventually identify an innovative "way" better than the old "ways" is almost certain. Changes happen, and without innovation, organizations might become irrelevant quickly. New knowledge also allows your organization to gain positive benefits from previously unforeseen approaches or opportunities. These new approaches can help your organization grow or profit. Our world's future is made by innovations and new knowledge gained from these achievements.

Imagine individuals at the dawn of the 1900's. If you could go back in time and tell them about the modern world, what would be the "new" knowledge you would share with them? What innovations would be the most important to you? Would you discuss modern jets that travel the global daily? Or would you explain how we have sent rockets into outer space and astronauts to the moon? Or would you tell them about the Internet and personal computers? Or would you talk about our use of antibiotics and modern medicines to treat diseases? What other innovations do you think are most noteworthy?

Now think about those individuals in the year 1900. Would they even believe some of the innovations you told them? How would they react if you tried to tell them about the ability to share electronic messages with people around the world in less than a second? How would you even begin to describe the ability to search for information, music, or videos on the Internet – recognizing that they did not even have television yet in the year 1900? All of these innovations (and many, many more) occurred in less than 100 years, and our world is moving forward ever faster, and with ever more complexity, in our innovations and discoveries. With these innovations comes new knowledge, knowledge we now take for granted in our daily lives. This new knowledge improves our ability to work more productively, live longer and fuller lives, communicate across large distances, and perform tasks in hours that previously took weeks or months to complete.

Innovation also achieves shared knowledge. For innovations to succeed, they often must share (either within your organization or with the world) insights that one or two people previously may have observed or discovered. If you are a systems innovator and you realize a better way for your company to interact with its customers, you will need to share your idea with others to encourage its adoption. Equally, if you discover an improved way for individuals to manage their email messages, you may incorporate this innovation into a software product that you then make available to others (to buy or for free). The knowledge produced by innovators needs to be "shared" for their innovations to be truly realized and recognized. It is important to remember that the innovation process is a continuous loop. Present innovations rely on past innovations and future innovations relay on present innovations. Successful innovations are a product of successful knowledge transfer from person to person and generation to generation.

Innovations achieve new products and profits

Innovations translate new knowledge into new products and profits, particularly for business (but also for organizations where performing efficiently is important). Even for governments, innovations can allow government to save money or do more with the same amount of funds. The radio, the television, the personal computer, the cell phone – all inventions we take for granted today, were innovations that had to be dreamed of, experimented with, tested, and refined before they could be products and produce profits for businesses. Innovations take time and courage to see an idea through to reality. For example, websites like Amazon.com or eBay.com were once innovative start-up companies with untested ideas. Their different innovative visions were believed by some, uncertain by several, and publicly dismissed as not possible by several (at the time). In addition, innovations can increase speed of delivery and response to information. For example, the mobile device has become a 4x2 mechanism for receiving

and responding to information instantaneously. Today's mobile devices allow an individual (as well as an organization) to be constantly connected. Speed of information has proved to be both valuable and necessary to successful sustain an organization.

Systems innovations can produce increased profits for an organization either by producing new products or by producing new ways of doing old activities. Should you accept the challenge of being a systems innovator, you need to be in love with not just the new and exciting, but also with understanding the current context and history upon your area of focus. Past and present events provide a context to find innovations.

It is the mid 1990s and you are a systems innovator. As a systems innovator, you know that historically most people have to go to a bookstore to buy a book. They have either to call or visit the bookstore to see if it has a particular book, and physical bookstores can only carry a limited number of books. For rare or unique books, chances are your local bookstore will not have the product. Equipped with this knowledge of past and present events, you might think about launching a company where people can visit a central website, search through millions of books, and order the book online and have it delivered to their home. Such an innovation became Amazon.com, and produced millions of dollars for its founding innovators.

Again, it is the mid 1990s, you are a systems innovator, and you see a trend where hard drives increasingly are getting physically smaller with more storage space. You also notice a new audio compression technology that allows entire songs to be compressed into small files (called MP3's). Equipped with this knowledge of past and present events, you might think about building a device that would allow individuals to store MP3's on a portable hard drive with a nice, friendly interface for people to search and find the songs they want to play on this portable device. Such an innovation was Apple's iPod – which included not only a hardware device, but also an information system (a website, called iTunes.com) for people to find, purchase, and download the songs they would like to play on their iPods. This innovation also achieved both a new product and large profits for Apple and its Chief Executive Officer, Steve Jobs.

Innovations increase effectiveness

Innovations increase the effectiveness of individuals and organizations. By effectiveness, we mean how well actions of an individual or organization lead to a desired outcome. If an individual has to do a lot of work to produce only a small amount of a desired outcome, the effectiveness of that individual's actions is low. Conversely, if an individual has to do minimal work to produce a large amount of a desired outcome, the effectiveness of that individual's actions is high.

Innovations can make existing ways of doing activities more effective and thus either more profitable or enriching for the participants. Sometimes the art of being a systems innovator is not necessarily about discovering something completely new, but instead is about "refining" some processes exist and making these processes better and more effective. The Internet is full of examples where existing ideas where translated into the digital world and made more effective. Email allows individuals to send electronic messages to each other and receive them in much faster time than it would take to deliver a hand-written message. Computers allow individuals to compose and edit documents electronically using a word processing program in ways that are much more effective than retyping the document numerous times and changing revisions manually.

Individual improvements in effectiveness can also translate into organizational effectiveness. If a team of people discovers an innovative way of rearranging how they work together, this innovation may translate into faster results or better outcomes for the team. For information systems, innovators are often striving to make not only the system work better and more effectively – but also the organizations of people who interact with the technology also work better and more effectively.

No human system is completely effective and all of our systems have the potential to be improved. As systems innovator, your mission is to seek ways of increasing individual and organizational effectiveness. You want to discover innovations that require the minimal amount of work to produce the largest amount of a desired outcome. Challenge the unknown, not feasible, or impossible.

Innovations increase competitive advantage

Innovation increases the competitive advantage of an organization. Using technology in creative ways to solve business problems is an organizations most valuable tool. A wise man once said, "The only constant is change." In order to remain competitive in a constantly changing business environment an organization must be able to adapt and innovate in the face of continuous change. The Chief Innovation Officer's (CIO) role in an organization is to be an agent of and for change. We currently live in a dynamic networked global society and economy. If an organization cannot adapt and cater to the consumer's needs they will not be able to sustain their business model, in other words "If you snooze, you lose." It is important to keep in mind that innovation is a process and not an end result. In order to successfully innovate, an organization must support the execution of small innovation tasks as

well as large "block buster" innovation tasks. In summary, in order to sustain a successful business an organization's CEO and CIO must demand and support innovation no matter its size or form.

There are five items that individuals and organizations need to address in order to remain competitive in today's dynamic environment and successfully innovate (Haag, Cummings, & McCubbrey, 1998). These items include:

- **Understand the CEO's/Management's attitude toward innovation and information technology.**

In order to hold a successful position in an organization your goals need to be aligned with the organization's goals (CEO's/Management's goals). In a successful hierarchy, the priorities of an organization's CEO and upper level management are flowed down through the goals, priorities, and tasks of individuals in the organization. This top down approach is one of the most effect ways to ensure that the goals and vision of the individuals are aligned with the organization.

The CEO's attitude toward innovation and information technology has a direct influence on the amount of innovation and use of technology information in the organization. If the CEO does not believe that innovation and information technology are important, it will not be encouraged in the organization and employees will not innovate. If the CEO believes that innovation and information technology are important, then the organization will have forums and support for such efforts. In a successful organization the CEO will demand and support innovation, no matter how small or large the innovation may be.

- **Bridge the GAP between business people and technical people.**

Across various industries there is a lack of communication between business people and technical people. The communication between these two entities is often broken or nonexistent. As a result, the organization is often stifled and cannot perform to its full potential. In order to solve today's complex business problems, employees need to fully understand the problems at hand as well as the available technologies that could be used to solve these problems. Business and technology departments need to work together in order to achieve a successful solution to today's most complex problems. Management information systems address both business processes and technical solutions. Management information systems are used in conjunction with project teams (a team designed to accomplish specific one-time goals) to solve complex business problems with advanced technological solutions.

- **View the business problems from another perspective.**

In order to achieve successful innovation, employees must challenge themselves to look at the business and technology from a different perspective. It is often difficult to remove yourself from your established role in an organization. However, by removing yourself from that role and looking at your organization from a different perspective (for example the customer), you are better equipped to see and solve complex problems. For example, an innovator at FedEx removed them self from their role within the organization and looked at the business from the perspective of the customer. By performing this exercise, they were able to develop the FedEx mail/package tracking system that allows customers to track their mail. The innovator asked them self the simple question, "If I was the customer what would I want out of the FedEx business?"

- **Demanding creative design.**

Design and construction of innovation is extremely important. A CIO must demand unique and creative design from the organization. Innovation is not using an organization's design to solve your organization's problem. Every organization needs to come up with their own unique tool to solve their unique problem. An organization's design must be extra ordinary not the ordinary in order to be successful. A creative design solves a problem in a different way. For example, think for a moment about the design and architecture of a house. Every individual is unique and demands different needs; therefore if every individual were to design their own home, every house would be as unique as the individual. If the individual had a particular disability or strength the home would reflect this need. An innovation for a organization should follow this same methodology in order to be successful.

10. **Look beyond the 4 walls of a company.**

In order to successfully innovate, an organization must be aware of the innovations that are occurring and developing around them. Integration with other company's IT will make an organization more competitive. For example, Wal-Mart will only do business with suppliers that are able to "communicate" with their systems. If an organization wants to do business with Wal-Mart they would be aware of the requirement and create a system that can "talk to" Wal-Mart's system. Today's business environment is a collection of unique businesses seeking optimal performance in their own self interest. If every business can work together and still achieve the goal of their best self interest, amazing innovations will occur.

Summary

As we have discussed, systems are the object of particular designs. The components, or parts, of a specific system can be either real or abstract. Components comprise an aggregate "whole" where each component of a system interacts with at least one other component of the system. To innovate is to make "improvements by

introducing something new". A noteworthy innovation must be substantially different, not an insignificant change or adjustment. Innovations can be tangible or intangible, radical or incremental.

Systems innovators are individuals who design and implement innovations. To design refers to the process of developing a structural plan for an object. Designers seek the requirements and expectations, identify the objectives and measurements of success, give structure to the elements, and form to the components of systems. Success or failure hinges on the ability of systems innovators, as designers, to attain the proper requirements and expectations of a system.

As a systems innovator, you should be mindful of the increasingly complex environment of our global world. You should seek out the connections and layers among systems. If you spot new connections or uncover a new layer, you may also identify radical innovations. Sometimes the most important part of being an innovator is having the wisdom to know when to form partnerships and with whom to make friends. You should also remember that all human systems are artificial. By "artificial," we mean that human systems would not exist naturally in the world without humans. Part of innovating is identifying when the rules of a system, be it an organization or information system, could be modified. You should seek to identify what are the rules of a human system. As a systems innovator, you should be open to asking "why" a certain rule is in place and allow yourself to consider what would happen if that rule was changed.

As a final important point, systems innovators achieve "magic." By "magic," we mean that innovations designed by systems innovators allow abilities or feats that were previously not possible or realistically feasible. If innovations allow the impossible to be technologically possible, innovations allow "magic." New, innovative technologies often allow such innovation, thereby helping humanity to reshape the natural world. Humans have a long history of using new technologies to overcome the physical limitations of human beings. For example, the use of a plow and the irrigation of crops allowed humans to productively farmland and grow crops. By growing crops, humanity began to build settlements (which themselves began to use new technologies like levels, bricks, hammers, and nails). These technologies helped human civilization to grow. With civilization, humanity began to focus on things beyond immediate, short-term survival – to include education. Education is only possible because we have technologies that allow other human individuals to grow enough food for individuals beyond themselves. We can go to school because others will work while we are studying and provide the necessary resources for our society to function, including running water, electricity, healthcare systems, construction of buildings, transportation systems, and more.

In a sense, all the systems that we discussed at the start of this chapter are a result of innovations and human technologies that have allowed us to reshape our world. Civilization is possible by employing innovative technologies and systems that allow humanity to think beyond short-term survival and pursue education, research, global commerce, foreign relations, and even fun recreational activities like books, movies, and television. Innovations are "magic" – they reshape the natural world. Humans use tools to accomplish tasks that were either not feasible or impossible. Innovative tools also increase the effectiveness of systems and individuals. Historically, human use of tools has allowed us to extend our physical abilities. Now, with information systems, there is the unique opportunity for human beings to extend not only their physical abilities, but also our cognitive abilities. Not only can we work better or faster, but also we might be able to think better or faster as an individual or organization. All of this will be possible through future innovations.

Innovative information systems in the last 40 years have already dramatically changed our world, to include faster, global transactions between people and the ability to collaborate and electronically share commerce, government, or entertainment-related activities with millions of people. Innovative information systems of the future will achieve what we would label "magic" today. As a systems innovator, the fruits of your successful innovations will not only produce new knowledge, new products, profits, and increased organizational effectiveness – your innovations will also achieve that which previously was impossible or infeasible.

Our closing advice: search for beneficial, new ideas. Through your efforts, bold innovations will produce the world of tomorrow.

Exercises (To inspire innovation)

- You are able to go back in time to visit members of your local neighborhood in the 1900's. What would be the "new" knowledge you would share with them? What innovations would be the most important to you and why?
- You are able to go forward in time to your local neighborhood in the year 2075. What do you imagine, as a time-traveler from the present, would be some of the future innovations that you would observe? How would they change human societies? What innovations do would be the most important to you and why?
- You have been hired as a systems innovator to design a new cell phone network for 500,000 subscribers. You are wise enough to include the requirement of future growth of the cell phone network to individual additional subscribers. What other requirements might be worth considering when you design the system? What requirements might influence the success (or failure) of the designed system?

- If you could work on designing any innovation, what would it be and why? Would you create something new or extend an existing system? What requirements and other concerns would you need to consider in designing your innovation? What benefits do you think would occur if you could achieve your innovation as you imagine it?

Innovation quotes (Reference)

"We run the company by questions, not by answers,"

(Eric Schmidt)

"When all think alike, then no one is thinking."

(Walter Lippman)

"Capital isn't so important in business. Experience isn't so important. You can get both these things. What is important is ideas. If you have ideas, you have the main asset you need, and there isn't any limit to what you can do with your business and your life."

(Harvey Firestone)

"Creativity, as has been said, consists largely of rearranging what we know in order to find out what we do not know. Hence, to think creatively, we must be able to look afresh at what we normally take for granted."

(George Kneller)

"It's easy to come up with new ideas; the hard part is letting go of what worked for you two years ago, but will soon be out of date."

(Roger von Oech)

"The best way to have a good idea is to have a lot of ideas."

(Dr. Linus Pauling)

"Discovery consists of seeing what everybody has seen and thinking what nobody has thought."

(Albert von Szent-Gyorgy)

"To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science."

(Albert Einstein)

“Without the playing with fantasy no creative work has ever yet come to birth. The debt we owe to the play of imagination is incalculable."

(Carl Jung)

"When Alexander the Great visited Diogenes and asked whether he could do anything for the famed teacher, Diogenes replied: “Only stand out of my light.” Perhaps someday we shall know how to heighten creativity. Until then, one of the best things we can do for creative men and women is to stand out of their light."

(John W. Gardner)

"The essential part of creativity is not being afraid to fail."

(Edwin H. Land)

"Creative activity could be described as a type of learning process where teacher and pupil are located in the same individual."

(Arthur Koestler)

"Innovation— any new idea—by definition will not be accepted at first. It takes repeated attempts, endless demonstrations, monotonous rehearsals before innovation can be accepted and internalized by an organization. This requires courageous patience."

(Warren Bennis)

“The way to get good ideas is to get lots of ideas and throw the bad ones away."

(Linus Pauling)

"The uncreative mind can spot wrong answers, but it takes a very creative mind to spot wrong questions."

(Anthony Jay)

"Don't worry about people stealing your ideas. If your ideas are any good, you'll have to ram them down people's throats."

(Howard Aiken)

"Some men look at things the way they are and ask why? I dream of things that are not and ask why not?"

(Robert Kennedy)

"Nothing is so embarrassing as watching someone do something that you said could not be done."

(Sam Ewing)

http://www.leadershipnow.com/creativityquotes.html

Innovation processes (Reference)

Innovation is a journey, not a destination. Innovations can occur on many different levels throughout an organization. In order to achieve successful innovation, an organization's leadership must support innovation both small and large at every level. Innovation does not occur in a vacuum, it is stimulated and cultured. In order to cultivate a successful innovation environment, the author of "How to Inspire Innovation" encourages the following steps to be followed:

- **Step 1:** Create a mental and physical environment where innovation is expected and accepted. For example, view mistakes as springboards to progress instead of dead ends. Accept new ideas and physical objects instead of demanding uniformity in the workspace--the idea is to get away from "standard issue."
- **Step 2:** Communicate the need for innovation at all levels. Explain the big picture to all staff members.
- **Step 3:** Watch your language and behavior. Discuss "opportunities" rather than "problems." See your job as encouraging, coaching, inspiring the staff to make breakthroughs and be creative and to trust you to respond to their needs and ideas.
- **Step 4:** Acknowledge new ideas and innovative methods immediately even if you know the idea or method has been tried before. Perhaps now the time is right for an old idea. Keep track of what you've tried.
- **Step 5:** Introduce physical or mental changes to keep employees from returning to habitual ways of thinking. Turn problem "opportunities" and physical objects upside down. Ask employees to mentally walk around questions, to draw issues and to bring their personal skills and expertise into the mix.
- **Step 6:** Cross-train staff whenever possible. Employees need insight into how other departments and teams work so they can see how their position fits in.
- **Step 7:** Set realistic goals and measurements for innovation. For example, "We need to cut customer complaints by 25 percent within the next 30 days." Follow up with rewards and recognition when employees reach their goals.

(http://www.ehow.com/how_2239789_inspire-innovation.html)

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Chapter 5: Achieving efficiency and effectiveness through systems design

Editor: Per Flaatten (Retired Accenture Partner)

Introduction

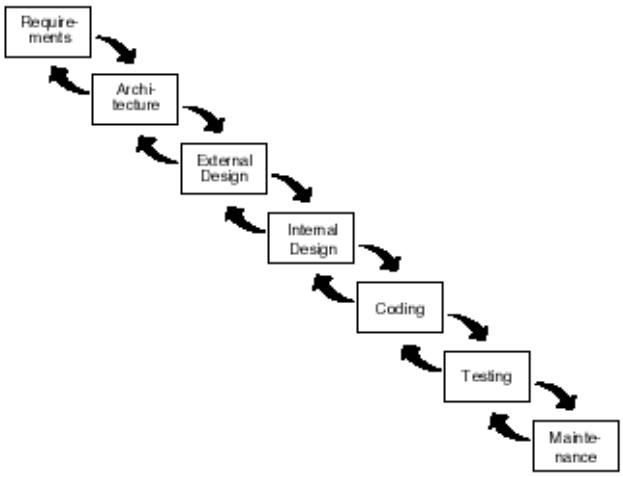
This chapter describes the efficient and effective development of the technology part of an IS. It was originally published by the Global Text Project in 2007 as Chapter 3 in "Information Systems", Richard T. Watson, Editor,

The approach we follow is to first define in general terms the sequence of activities required to go from the decision to create a new IS to its implementation and subsequent maintenance. We then describe the most important issues or difficulties that you may encounter during the process, based on the experience developers have encountered on projects in the past. The rest of the chapter—the bulk of it, in fact—is devoted to describing for each activity possible approaches to resolving the issues and avoiding the difficulties. These approaches are not the only ones that are possible; those that are mentioned here have been selected because they have been successful in the past, are documented in the literature (so you can learn more about them by consulting various reference works), and enjoy widespread acceptance in real-life IS departments.

Unless otherwise indicated, we assume that the IS being developed is a web-based system that processes business transactions of some kind, and that the project is of medium size—say 5 to 25 people on the team. This means that we do not consider the development of websites that are purely informational, nor for personal productivity, nor that result in a software product for sale to individuals or organizations.

Development process: From idea to detailed instructions

What the development process essentially does is to transform the expression of an idea for an IS—a problem to be solved, an opportunity to be taken advantage of—into a set of detailed, unambiguous instructions to a computer to implement that idea. The biggest problem is that computers are excessively stupid and will only do what they have been told to do. For example, suppose you create a billing program for an electric utility and specify that bills must be paid within a certain time or the customer's electricity will be cut off. Suppose further that a customer receives a bill stating that he owes USD 0.00 (he might have a previous credit). Contrary to a manual system where all the work is done by humans, a computerized system may well treat this bill as any other bill and insist on payment; it may even send a signal to the customer relations department to cut off power for non-payment. To avoid this, explicit instructions must be included in the billing program to avoid dunning for amounts of less than a certain limit.



Systems developers must therefore pay attention to an excruciating amount of detail—not only when business goes on as normal, but anticipating all the exceptions that may arise. The exceptions may in fact amount to several times the work required for normal cases. The system then becomes, through sheer accumulation of details, more and more complex. This complexity is in itself a source of difficulty—it becomes hard to "see the forest for all the trees," to keep your eye on the big picture of the business benefits to be achieved, while at the same time making sure that every technical and business detail is right and finding out what went wrong whenever something does go wrong—as it invariably will.

From the earliest days of computer technology, the method for developing information systems has addressed the need to proceed from the general to the ever more detailed. The first well-known effort at formalizing the process came in 1970, in an enormously influential paper by W. W. Royce describing the waterfall model of the systems development life cycle.[2] Every author on systems development bases his or her work on some variation of this model, and we, too, have our favorite, depicted in Exhibit 1.

The work products or "deliverables" to be created during systems development start with the business case, the formal description of the rationale for developing a system in the first place, the results to be achieved and a cost-benefit analysis detailing planned development costs (often treated as an investment) as well as operational costs and savings. The business case is often considered part of project management rather than the development process per se; we include it here because it is the developers' best tool for not losing sight of the essential—the end result they are trying to achieve. As development work proceeds, developers make choices: one of the main factors in deciding which alternative to pick is the impact of the choice on the business case. For example, a choice that increases benefits may also increase costs: is the trade-off worth it? As a result, the business case must be maintained all along the life of the project as decisions are made.

The next deliverable in the waterfall approach is the information system's requirements. Requirements come in two flavors: functional requirements—what the system should do: processing, data and media content—and quality requirements—how well the system should do it: performance, usability, reliability, availability, modifiability and security.

The business objectives documented in the business case and the requirements, especially the quality requirements, dictate the architecture or overall shape of the information system being developed. The architecture describes the major components of the system and how they interact. It also documents design decisions that apply to the entire system, so as to standardize the solutions to similar design problems occurring at different places. Architectures or elements of architecture can be common to many applications, thus saving the project team time and money and reducing the amount of risk inherent in innovating. For example, many sales applications on the web use the concept of a "shopping cart", a temporary storage area accumulating product codes and quantities ordered until the customer decides that she has all she wants, at which point the application gathers all the products, computes the price, and arranges for payment and delivery. Shopping cart routines are available commercially from several sources.

The design of the information system is at the heart of the development process. The design is in two parts:

- A description of how the system will appear to its users. This is called the external design or functional design.
- A description of how the system will be operate internally, largely hidden from users. This is called the internal design (or technical design), and it lays the foundation for programmers to create the code which the hardware will execute.

1. [2]Royce, Winston W. "Managing the Development of Large Software Systems," *Proceedings of IEEE WESCON*. August 1970.

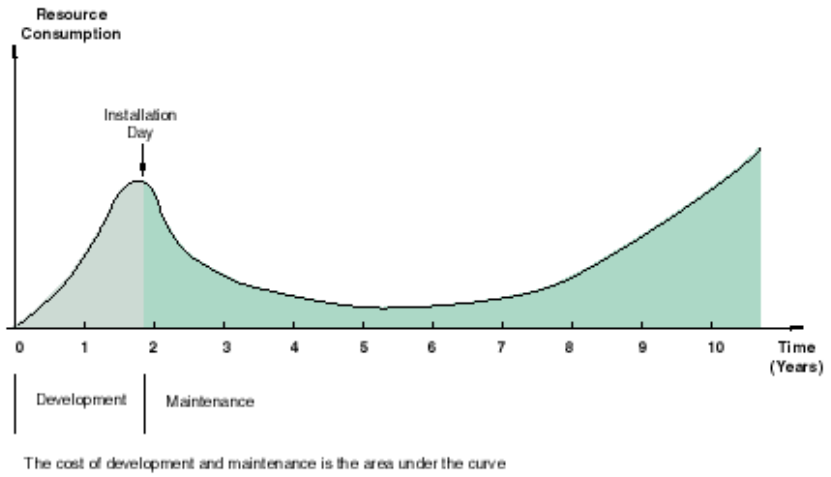


Exhibit 2: Total costs of a system

The functional design specifies the interaction between the users and the system—what actions the user can take and how the system will react; it describes the inputs and outputs (screens, reports, messages exchanged with other systems); it establishes the different databases and their structure; and it shows at least a storyboard of the media content (text, graphics, photos, audio/video clips, etc.).

The technical design inventories the programs and modules to be developed, and how processing flows from one to the other. It also takes the architecture one step further in the implementation of some of the quality attributes, such as data integrity, fallback operation in case the system is unavailable, and recovery and restart from serious incidents. Finally, here is where any routines to create the initial data and media content required on day one of the new system's operation.

Code is the technical name for the programming statements and database specifications that are written in a language that can be understood by the technology. Creating code is a highly self-contained activity; the details depend on the environment and the subject will not be treated further in this chapter.

Throughout these steps, the initial idea for the system has been transformed into a set of computer instructions. Each step is performed by human beings (even if assisted by technology in the form of development tools) and is therefore subject to error. It is therefore necessary to conduct tests to make sure that the system will work as intended. These tests are organized in reverse order from the development activities: first, the code is tested, module by module or program by program, in what is called unit tests. Next come string tests, where several modules or programs that normally would be executed together are tested. Then follow integration tests, covering all of the software and system tests, covering both the software and the people using the system. When the system test has been completely successful, the information system is ready to for use. (Some organizations add an additional test, called acceptance test, to signify a formal hand-over of the system and the responsibility for it from developers to management. This is especially used when the software is developed by a third party.)

To put the importance of testing into perspective, note that it statistically consumes just about 50 per cent of the resources of a typical IS department.

With the system test complete and the initial data and media content loaded, the information system is put into production, and the development team is done. Right? Wrong! In fact, the most expensive part of the development process, called maintenance, is yet to come.

No sooner has a new system started to operate than it requires changes. First, users quickly discover bugs—errors in how the system operates—and needed improvements. Second, the environment changes: competitors take new initiatives; new laws and regulations are passed; new and improved technology becomes available. Third, the very fact that a new system solves an old problem introduces new problems, that you didn't know about beforehand. To illustrate this, take the standard sign at railway level crossings in France: Un train peut en cacher un autre ("One train may hide another one".). This caution alludes to the fact that you don't know what lies beyond your current problem until you have solved it—but then the next problem may take you completely unawares.

In theory, every change you make must go through a mini-life cycle of its own: business case, requirements, architecture, design, code and test. In reality, only the most critical fixes are done individually and immediately. Other changes are stacked up and implemented in periodic releases, typically a release of minor fixes every month and a major release every three to six months. Most often, the maintenance phase is performed by a subset (often around 25 per cent) of the initial development team. But since the maintenance phase is likely to last for years—certainly more than ten and not infrequently 20 years, the total cost of maintenance over the life of a system can eclipse the cost of initial development, as shown in Exhibit 2.

(The increasing maintenance cost towards the end of the system life is due to the fact that the more a system has been modified, the harder it is to understand and therefore to make additional modifications to.

Issues

In this section, we will describe the difficulties that designers have historically had (and to some extent continue to have) in performing their tasks. These difficulties will help explain the widely accepted approaches, and some of the more innovative ones, that are the subject of the bulk of the chapter.

Cost

The first and most apparent issue with systems development is one of cost. From the earliest days, systems development has been seen as a high-cost investment with uncertain returns. It has always been difficult to isolate the impact of a new business information system on the bottom line—too many other factors change at the same time.

There are two components to total cost: unit cost and volume. Unit cost can be addressed by productivity increases. Volume can only be reduced by doing less unnecessary work.

System developer productivity was the earliest point of emphasis, as evidenced by counting lines of code as a measurement of output. (Lines of code is still a useful measure, but not the most critical one.) Both better computer languages and better development tools were developed, to a point where productivity is no longer the central issue of systems development. It is generally assumed that a development team is well trained and has an adequate set of tools.

Reducing the amount of unnecessary work is a more recent trend. Unnecessary work arises from two main sources: "gold plating" and rework.

Gold plating refers to the tendency of users to demand extras—features that they would like to have but that do not add value to the system. What is worse, developers have tended to accept these demands, mostly because each one seems small and easy to implement. The truth is that every time you add a feature, you add to the complexity of the system and beyond a certain point the cost grows exponentially.

Rework becomes necessary when you make an error and have to correct it. If you catch the error and correct it right away, no great damage is done. But if the error is left in and you don't discover it until later, other work will have been done that depends on the erroneous decision: this work then has to be scrapped and redone. Barry Boehm has estimated that a requirements or architecture error caught in system testing can cost 1000 times more to fix than if it had been caught right away. Another way of estimating the cost of rework is to view that testing takes up an average of 50 per cent of the total initial development cost on most projects, and most of that time is spent, not in finding errors, but correcting them. Add the extra cost of errors caught during production, and the cost of rework is certainly over one-third and may approach one-half of total development and maintenance costs.

And this is for systems that actually get off the ground. A notorious study in the 1970s concluded that 29 per cent of systems projects failed before implementation and had to be scrapped (although the sample was small—less than 200 projects). These failures wind up with a total rework cost of 100 per cent! More recently, Bob Glass has authored an instructive series of books on large systems project failures.

Speed

In more recent years, concerns with the speed of the development process have overshadowed the search for increased productivity. If you follow the waterfall process literally, a medium-to-large system would take anywhere from 18 months to three years to develop. During this time, you are spending money without any true guarantee of success (see the statistics on number of failed projects above), with none of the benefits of the new system accruing. It is a little bit like building a railroad from Chicago to Detroit, laying one rail only, and then laying the second rail. If instead you lay both rails at once, you can start running reduced service from Chicago to Gary, then to South Bend, and so one, starting to make some money a lot earlier.

Another factor that increases the need for speed is that the requirements of the business changes more quickly than in the past, as the result of external pressure—mainly from competitors but also from regulatory agencies, which mandate new business processes and practices. Eighteen months after your idea for a new system, that idea may already be obsolete. And if you try to keep up with changes during the development process, you are creating a moving target, which is much more difficult to reach.

Complexity

One of the main characteristics of information systems is that they are large, made up as they are of hundreds or thousands of individual components. In an invoicing subsystem, you might have a module to look up prices, a module to extend price by quantity, a module to add up the total of the invoice, a module to look up weight, a module to add up weights and compute freight costs, a description of the layout of the invoice, a module for breaking down a multi-page invoice, a module for printing... Each module is quite simple, but still needs to be

tracked, so that when you assemble the final system, nothing is forgotten and all the parts work together. Compounding this is the fact that each module is so simple that when somebody requests a change or a refinement, you are tempted to respond, "Sure, that's easy to do".

And even though the components may be simple, they interact with each other, sometimes in unanticipated ways. Let us illustrate with an example—not taken from the world of IS, but relevant nonetheless. A large company installed a modern internal telephone system with many features. One of the features was "call back when available." If you got a busy signal, you could press a key and hang up; as soon as the person you were calling finished his call, the system would redial his number and connect you. Another feature was "automatic extended backup". This feature would switch all the calls that you could not or would not take to your secretary, including the case where your line was busy. If your secretary did not respond, the call would be sent to the floor receptionist, and so on, all the way to the switchboard, which was always manned. (This was in the era before voicemail.) The problem was of course that the backup feature canceled out the call-back feature—since you could never actually get a busy tone.

The effect of interaction between components in a business information system are often in the area of and quality requirements described earlier, such as performance, usability, reliability, availability, modifiability and security. None of these requirements are implemented in any one component. Rather, they are what are called emergent properties in complexity theory. For example, an important aspect of usability is consistency. If one part of the system prompts you for a billing address and then a shipping address, other parts of the system which need both should prompt for them in the same sequence. If you use a red asterisk to mark mandatory fields to be filled in on one screen, then you shouldn't use a green asterisk or a red # sign on another screen. Neither choice is wrong—it is making different choices for the same function that reduces usability.

Finally, a critical aspect of complexity is the difficulty of reliably predicting system behavior. This means that you cannot be content with designing and coding the software and then start using it directly. You first have to test it to see whether it actually does behave as predicted (and specified). This test must be extremely thorough, because errors may be caused by a combination of conditions that occur only once in a while.

Unpredictability also applies to making changes to the system. This means that once you have made a change (as will inevitably happen), not only must you test that the change works, but you must also test that all those things that you didn't want to change continue to work as before. This is called regression testing; how to do it at reasonable cost will be discussed later.

Technology and innovation

One of the main drivers of information systems development is to take advantage of technological innovation to change the way business is done. As an example, take how the emergence of the Internet changed business practices in the late 1990s allowed new businesses to flourish (Amazon.com, Google, and eBay spring immediately to mind) and, to a lesser extent, existing businesses to benefit.

However, for every success, there were many failures. Every innovative venture carries risk, and while many dot-com failures were due to a lack of solid business planning, others failed because they could not master the new technology or tried to use it inappropriately. (Bob Glass's books referred to previously are filled with horror stories illustrating these dangers.) The problem is that if the technology is new, there are no successful examples to follow—and by the time these examples show the way, it may be too late, since others, the successful adventurers, may have occupied the space you would like to carve out for yourself. The difficulty, then, is to know how close to the leading edge you want to be: not too close, or you might be bloodied; and not too far behind, or you'll be left in the dust.

A related problem is that of change saturation. A mantra dear to business authors is "reinventing the organization". This may be good advice, but an organization cannot keep reinventing itself every day. Your most important stakeholders—customers, employees, even shareholders—may get disoriented and no longer know what to expect, and the organization itself may lose its sense of purpose.

Alignment on objectives

Any system development project is undertaken for a reason, usually to solve some operational difficulty (high costs, long processing delays, frequent errors) or to take advantage of a new opportunity (new technology, novel use of existing technology). However, many stakeholders have an interest in the outcome. Workers may resist innovation, regulators may fear social consequences, management may be divided between believers and skeptics, development team members may be competing for promotions or raises etc. If the objectives are not clearly understood and supported, the new system is not likely to succeed—not the least because the various stakeholders have different perceptions of what constitutes success.

Adoption

Once a new system has been created, the next challenge is to make people—employees, customers—use it. In the past, back-office systems such as billing, accounting and payroll were easy to implement. The users were clerks who could be put through a few hours or days of training and told to use the system; they had no choice. Today's system users may be less pliable and may refuse to go along or protest in such a way that you have to change the system, or even abandon it. As an example, Internet customers may "vote with their feet,, i.e. go to another website that provides the same service or goods at a better price or more easily.

Another example of how things can go wrong was recently provided by a large hospital organization that had created at great expense a system for physicians and surgeons. It was based on portable devices that the physician would carry around and on expensive stationary equipment at the patients' bedsides and in nursing stations. Three months after the launch, it became apparent that practically all the physicians refused to use the system, and it had to be uninstalled, at the cost of tens of millions of dollars.

Useful life

The final issue we will consider is how to plan for a system's useful life. This is important for two reasons. First, as with any investment, this information is used to determine whether a new system is worthwhile or not. If you have a system that is expected to cost USD 5 million and bring in USD 1 million per annum, you know that the system must have a useful life of at least five years.

Second, planning the useful life of a system gives you at least a chance to decide how and when to withdraw or replace the system. Most development projects do not address the issue of decommissioning at all. As a result, systems live for much longer than anyone would have imagined. This is how so many systems were in danger of crashing on the first day of the year 2000—none of the developers had imagined that their systems would last so long. A perhaps more extreme example is that of the United States Department of Defense, which is reputed to have had more than 2,200 overlapping financial systems at one time. Efforts to reduce this number have not been very successful, proving that it is much harder to kill a system than to create one.

Overall development strategy

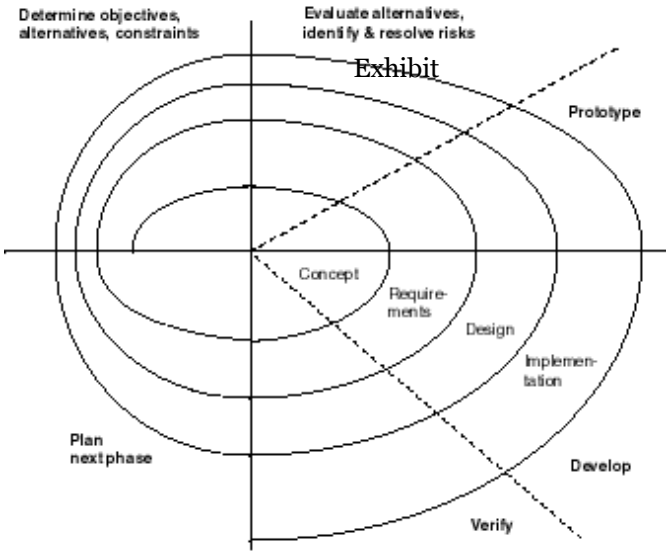
Before we go into the various techniques and tools that are specific to each of the steps in the systems development life cycle, let us first look at the overall approach. The issues that you must address when you choose one approach over another have already been outlined above: development projects take too long to pay back; by the time they are implemented, the needs have changed, and the time elapsed before errors and shortcomings are experienced in operation make corrections costly. On the other hand, the system may require a critical mass of functionality before it can be truly useful, and a rapid implementation of a part of the system may do no good. Finally, If the system you are building is truly innovative, especially in its use of technology, the risks of failure are high and special precautions must be taken.

Iterative development

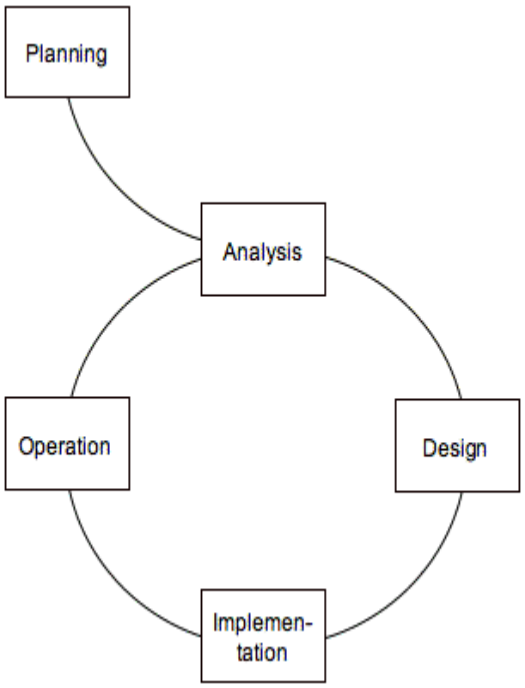
Iterative development is the standard approach today. It is characterized by the following:

a series of short (3-6 month) development cycles, allowing for quick feedback from experience gained with the working system

- Each cycle delivers some significant, useful functionality.
- The early cycles focus on "low-hanging fruit"—functionality which is cheap to develop and has a high payback. Early successes give credibility to the project and enables you to do more difficult things later.
- The experience with the functionality in one cycle allows you to adjust the system in the next cycle.
- The project management style is called "time-boxing": each iteration has a deadline for implementation which cannot be exceeded. If some planned functionality takes too long to develop, you postpone it to the next cycle instead of delaying the cycle itself.
- Maintenance follows initial development in a smooth transition (see the section on Maintenance later in this chapter). In fact it is difficult to tell when development ends and maintenance starts.



Exhibit



The first version of iterative development was called Rapid Application Development, created by James Martin in the 1980s in response to the emergence of CASE (Computer-Aided Software Engineering) tools, and the approach has remained tool-intensive. Iterative Development also goes under the name Incremental Development, emphasizing that functionality is added gradually.

Alternative approaches: "Big Bang"

Occasionally, the circumstances of a given project may dictate that you use a "big bang" approach, where all the functionality of the planned system has to be delivered at the same time. The London Stock Exchange underwent two major transformations, one in 1986, when computerized and phone technology displaced face-to-face trading; and another one thirteen years later, when the phone technology was phased out, at least for the top 100 stocks. These two "big bangs" were successful, but both carried a built-in transition period where old and new systems coexisted.

In other cases, you may be building a brand new facility and want to use new technology, such as the computerized baggage handling at Denver International Airport in 1995. This system resulted in an unmitigated catastrophe and had to be scrapped at least temporarily.

The last temptation to adopt a "big bang" approach may be when you want to create an integrated enterprise-wide system, managing all the transactions and management data of an entire enterprise. Hardly anyone attempts this anymore after the consistently unsuccessful attempts in the early days of database management systems (around 1970) and Information Engineering (1985-1900).

In summary, rather than cede to the temptation of delivering everything at once, do your utmost to find a gradual approach, where you can learn as you go and change direction as dictated by reality.

Alternative approaches: Prototyping

Prototyping is a variation on iterative development, used mostly for very innovative projects, those where the risk of failure is the greatest. Mostly, it is used with new technologies that requires new architectures. The basic principles of this approach were documented in an article by Barry Boehm, and illustrated by the following schematic which gave the apt name "Spiral Methodology" to the approach.

The principle behind prototyping is similar to iterative development, with the following two exceptions:

Instead of starting with low-hanging fruit, start with the highest risk area. This enables you both to avoid spending large amounts on unfeasible systems and to learn the most from your errors, by making them early.

- Be prepared to throw away version 1 and even possibly version 2 of your system. The purpose of the prototype isn't to provide business functionality so much as it is to learn what not to do.

Requirements

Once you have decided on the approach to the development project, the next step is to find out in detail what the system should do—and, assuming you have opted for iterative development, what should take the highest priority. Then you need to formulate these requirements so that they can be used to drive the project, in particular when the requirements change in midstream.

Requirements elicitation

When you are eliciting system requirements, focus on what functions the system should perform, what data is required to support those functions, and how important the quality requirements—performance, reliability, usability and flexibility—are likely to be.

If the system you are planning is primarily intended to solve operational problems (high cost, high error rates, unresponsiveness, customer complaints...), you should spend some time getting familiar with the current operation, focusing on those people who actually experience the problem (as opposed to those to whom the problem or its symptoms are reported). This approach was systematic in the early days of information processing and was called "Analyzing the Current System." (One of the additional advantages of analyzing the current system was that it allowed the project team to learn about the business while doing something productive. Project teams today usually have to meet the expectation that they already know the basics of the business.)

There is less emphasis on the current system today, especially if the motivation for the system you want to build is to take advantage of technology to exploit a new opportunity. In that case, you want to focus on finding people who have a vision of what could be done, preferably in a group setting, where creative ideas are likely to flow.

Interviewing is by far the most common technique used in reviewing a present system. It relies heavily on such active listening skills as open-ended questions, appropriate words and phrases, acceptance cues, and restatement at both the direct and emotional level. Used properly, silence can also be effective.

The most widespread group technique is probably Joint Application Design. JAD was developed in the early 1980s to overcome some of the difficulties caused by the more classic approaches to requirements analysis.

The technique itself consists of gathering highly competent users (about ten) for a two-four day workshop to discuss, conceptualize, and analyze. IS personnel are present, mainly to listen, to record what is being said, and to document the users' contributions. The workshop is led by an independent person to whom neither the users nor the IS personnel report. The role of the leader is twofold: to elicit decisions by consensus and compromise rather than by fiat or majority vote and to keep the meeting on track so that the system to be built is the one that is discussed.

A particularly effective way of documenting what is being said is to create a prototype of the application on the fly. When you hear a user express an idea, it is particularly effective to be able to say, "Is this what you mean"? as you illustrate a screen layout, mouse clicks or navigation paths on a computer (projected on a large screen for everybody to see). The group can then react, critique, and build on what is shown.

There are a couple of traps you need to avoid with group techniques. The first is called "groupthink" and consists in the group losing its critical sense and going along with absurd or unworkable ides—partly because it is difficult for a group member to appear to be the only one who is against some idea. The other danger is related: a group may become overenthusiastic and push for "gold-plating," features and functions that look nice but serve no useful function—or not useful enough to be worth the cost. Don Gause and Gerald Weinberg have written an excellent and thought-provoking book on the subject.

Finally, if the system you are planning is going to be used by outsiders (consumers, customers, suppliers, the general public) you need to devise a way to make their voices heard, for example by surveys or focus groups.

Requirements prioritization

It is impossible to satisfy all the requirements that a group of users and other stakeholders may come up with, especially if you are doing iterative development. The decision to include one set of requirements and not another is difficult. First, different stakeholders are interested in different results. Second, two requirements may be mutually contradictory; for example, higher performance may require more powerful hardware at greater cost. Third, some requirements may need to be satisfied before others can be implemented. The process needs to be seen as both fair and responsive to stakeholders' wishes.

In some cases, a straightforward economic analysis such as return on investment may be the right approach. This usually works best for requirements in the aggregate and less well for each detailed requirements. The difficulty is tying each individual requirement to a specific benefit and a specific cost. It is also a tedious job when the number of requirements is large. Thus, a prioritization scheme based on pure economics is best suited for the big-bang approach to systems development.

A similar approach, but based on risk (highest risk first) is appropriate for the prototyping approach to very innovative projects.

An alternative approach is Quality Function Deployment. This approach (introduced by Toyota in the 1970s to improve their process for designing automobiles) sets up a series of matrices describing how well each requirement contributes to fulfill each business objective, then how each design feature (developed at a later stage) implements each requirement, and so on, thus illustrating qualitatively where the most benefit will be had. The unique part of this approach is that a group of stakeholder is asked to rank features pairwise—"I prefer B to A, C to B, C to E...." The end result is a series of ranked requirements where all the participants feel that their voice has been heard, thus helping to build consensus.

Functional requirements formulation

The requirements need to be documented unambiguously, to minimize later differences in interpretation. There is no standard format: text, schematics, and even prototypes can be used.

The most useful guideline is to document the requirements in plain language as testable statements. For functional requirements, this is pretty straightforward, for example: "After the customer has tried unsuccessfully to enter a Personal Identification Number (PIN) three times, the system will terminate the transaction, send an alert to the Security Department and retain the customer's card." This statement can now be cross-referenced to the design (in what module is this function implemented?) and to the test data (where are the instructions to the tester to try three wrong PINs and how is the result of this test documented?).

Plain language is useful for rigor and completeness; however, for any but the smallest systems, plain text becomes cumbersome and confusing. It is hard to communicate to users what the system will do and how it will accomplish its overall objective, and asking them to take a position on whether everything is covered is unfair. In particular, you are likely to hear, later on, comments of the type, "I assumed that this or that function was covered..." or, "It goes without saying that..." If these comments come as responses to processing errors once the system has been implemented, it is too late.

To address this problem, information systems professionals have developed a range of graphical representation tools, the three most widely used of which are decomposition diagrams (also known as Warnier charts after their advocate, a French analyst named Jean-Dominique Warnier), data flow diagrams (DFDs), and entity-relationship diagrams (ERDs).

Warnier charts, an example of which is shown in Exhibit 5, show how a function can be decomposed into subfunctions. In turn, each subfunction can be further subdivided, all the way down to an elementary level. (The same hierarchical decomposition technique can be used in many other contexts, for example in outlining an essay.) The technique has the advantage of being easy to grasp and easy to use. However, it is not suitable for all purposes. It essentially can depict only a static structure, which must, in addition, be composed of mutually exclusive and completely exhaustive elements—MECE in analyst jargon. In other words, the decomposition must not leave anything out and no element can be used in more than one place.

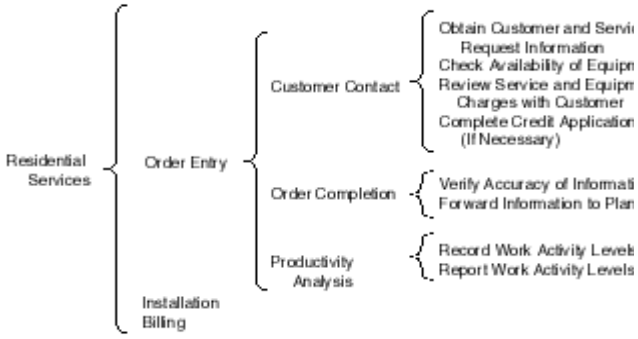


Exhibit 5: A Warnier chart

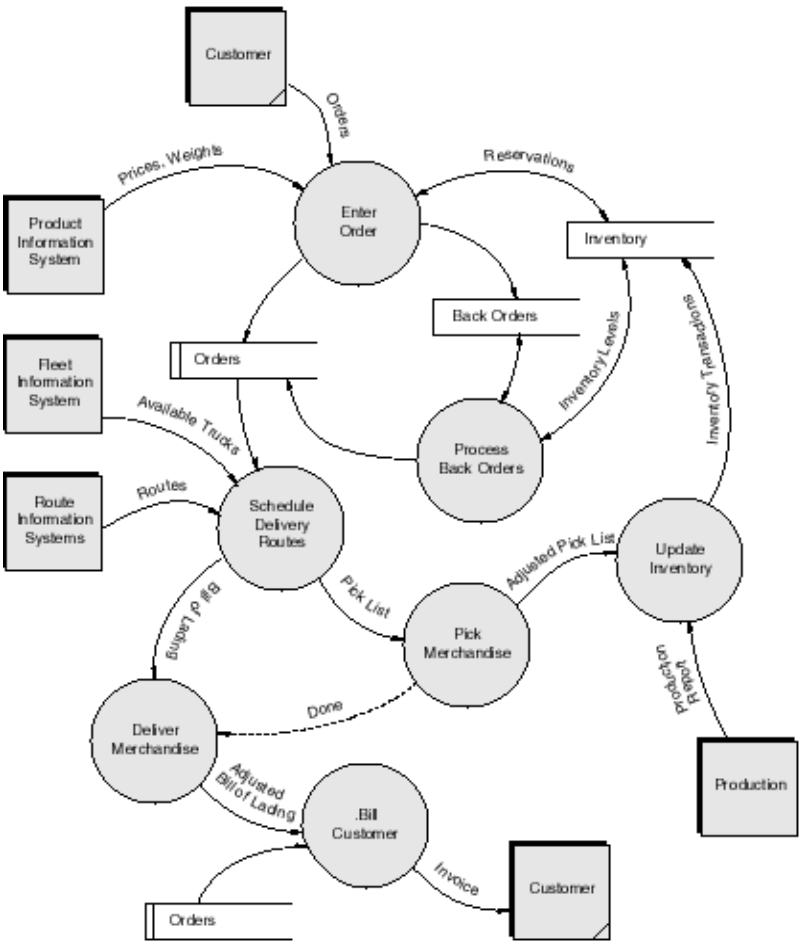


Exhibit 6: A data flow diagram (DFD)

DFDs depict a flow of activities whereas the Warnier chart technique depicts static structures. An example is shown in Exhibit 6. Data flow diagrams are more powerful than Warnier diagrams but are a little more difficult to grasp and to draw correctly. They are best adapted to repetitive administrative work: processing a pile of customer orders that have come in through the mail, picking the orders from inventory, delivering them, mailing invoices and collecting payments. (This was how most information systems were organized before the days of computers and in the early period of information technology; it is still used by utilities such as phone and electric companies for billing and payments; it goes under the name of batch processing.) As a result, DFDs are no longer as widely used as before. A variation that remains in widespread use is a diagram that shows the flow of activity down the page which is divided in columns, one for each organizational entity or system that intervenes in the processing of a single function. (This type of chart has been called “swimlane diagrams.”)

ERDs have a different purpose from Warnier charts and DFDs. They depict data structures: entities that correspond to things about which the system maintains data, such as customers, products, and orders; and relationships between them, such as the fact that each order belongs to one customer, but each customer may place several orders, and that each order consists of several products. In addition to identifying the entities and relationships, the model identifies the main attributes, or pieces of data, to be stored for each entity. An example is shown in Exhibit 7. The ERD is an invaluable tool not only to point out dependencies and relationships among pieces of data, but also for the actual design of relational databases.

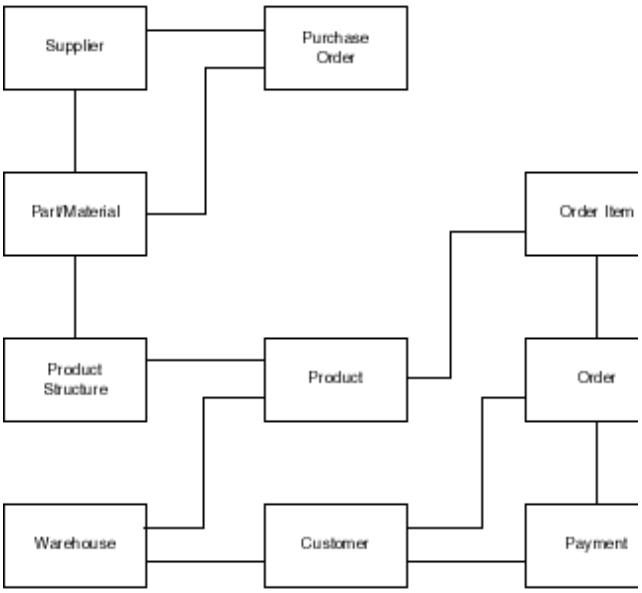


Exhibit 7: ERD diagram

Other techniques are available for more specialized purposes, and you can also, if you have a specific need, develop your own. Bear in mind that you may then have to invest in training other people to use your homegrown technique.

Graphical techniques are indispensable tools for communicating and explaining requirements. But that is all they are. If a given technique falls short of this objective, do not use it. Above all, do not get caught up in the formalism and the stringent rules that some authors prescribe if these rules interfere with the main purpose. (But do remember that you are communicating not only with users and management, but also with your colleagues, who may have very specific expectations about the techniques you have selected.)

Quality requirements formulation

The formulation of quality requirements (performance, reliability, usability, flexibility...) should also be testable. This implies most often that you set a measurable, numeric goal, for example: "The system must be available to end users at least 98 per cent of the time in any given week". This cannot necessarily be tested directly before the system goes live. However, your design must include a way to keep track of whether the performance objective is being met.

The Software Engineering Institute has developed an entire design methodology driven by quality requirements that explains this process in detail (reference required).

Architecture

An architecture of any kind of complex man-made system, such as a cathedral or an office park, describes the overall structure of the system: its major components and how those components interrelate.

The architecture of a business information system can be defined as the infrastructure and interfaces that enable system components (such as hardware, software and network communications) to work together to accomplish the system's purpose. The architecture is defined for the system as a whole, rather than for each of its components. In fact, the infrastructure and interface standards are usually shared among multiple systems. For example, all the web-based systems in an organization, whether Internet or intranet, might share the same architecture.

Generally, the system architecture is imposed on a project team by the organization's Information Systems (IS) department. Depending on the needs of the business system, the project team may request changes to the architecture, which are then typically implemented by a separate architecture team led by the organization's systems architect.

Sometimes, a new architecture is needed. This typically happens when an organization decides to use technology in a novel way to take advantage of a business opportunity. In such cases, a new architecture may be developed at the same time, or slightly ahead of, the business information system. A brand-new architecture can carry tremendous risks and should only be undertaken after careful consideration by the systems architect.

Importance of architecture

Could you build an information system without an architecture?

Yes, it is possible to build small, isolated information systems without a formal architecture, just as it is possible to build a log cabin without one. But as soon as you want to build a building which is larger or has multiple components—an energy efficient home, an apartment complex, an office high-rise—you need an architecture to show where the electric wiring, the plumbing, heating and air conditioning, the stairs and the elevators should go and how they should work together.

The main role of a system architecture is to help manage the complexity and size of modern business information systems. The architecture embodies important design decisions that have already been made. This is a constraint on the team, which is not free to make decisions that run counter to the architecture, but it also means that there is some kind of support within the organization—including knowledgeable people, development guidelines, reusable code, and implementation experience with the architecture—making the team's job easier.

The fact that many design decisions have already been taken has the following advantages:

- *Risk reduction*: first, the use of proven components and interfaces reduces the number of unforeseen problems arising during system development and operation; second, technological innovation is easier to control, because the architecture pinpoints the main risk areas, isolating them from what remains routine.
- *Integration*: well-architected systems are easier to integrate with each other and with legacy systems, because the architecture defines and describes in some detail the points at which two systems are allowed to interact.
- *Productivity*: an architecture is an investment—the stronger the architecture, the higher the productivity of the development team after an initial learning curve. Developers can in a certain sense "reuse" the technical decisions made by the system architect and less time is spent analyzing and testing alternative solutions.
- *Reliability*: the use of proven components and approaches that have already been successful in the specific environment in which you are working reduces the total number of errors and makes it easier to find those errors that do occur.
- *Maintainability*: standardized design and construction makes it easier for maintenance teams to correct, enhance and extend them to a changing business and technical environment.
- *Predictability*: an established architecture has well-known technical characteristics, making it relatively easy to analyze and predict performance, reliability, usability and other quality measures.

Selecting, extending or creating an architecture

On projects where both the business functionality and the technology are well understood, the project team will be best served by adopting an existing architecture, with minor modifications where needed. If the system is small enough, the architecture may not need to be specified in much detail. For example, a system may be simply defined as being web-based: this implies a host of technical decisions, as will be illustrated in later chapters.

Of course, if some element is absent from the architecture needed for a project, the team may be free to add it. This increases the risk and the cost, since no support will be available from the system architect and her team.

Where a new development project is driven by business innovation, it is best to adopt an existing, robust architecture. This reduces the development risks by not adding technical risks to the business risks.

On projects driven by technology—when someone has had a novel idea for applying technology in a way that has not been done before—you may well need a new architecture altogether. This architecture must at least be designed before the requirements process goes too far. In most cases, it will need to be developed and tested on a pilot project, to verify that the technology is workable and will help solve the business problem.

Finally, note that most of the systems "development" activity of existing IS departments is in fact maintenance. Maintenance requests very rarely have an impact on the system architecture.

In summary, in most cases, the system architecture will be given at the outset of a development project, or at least in its very early stages—certainly before requirements gathering is complete and before design has gone very far.

Design

To design a system is to decide how the requirements formulated as described in the previous section and approved by all the stakeholders are going to be implemented. The design process has two main focal points: the future users of the system (external, functional, or user design) and the IS professionals who will code and test it (internal or technical design).

External design

The first question of a design is, how will the users interact with the system?

Physical interaction

Physically, the interaction takes place via some device. In the generic case assumed in this chapter, this will be a personal computer hooked up to a network (often the Internet, but sometimes to the organization's internal network). The devices that are available are then a keyboard with a mouse, a screen with a given resolution, and a printer, most often based on inkjet technology. When the user population is the general public, you must be prepared to accommodate a variety of technical solutions: some users may have a lower screen resolution, some may have slow printers or no printers at all. The operating system and the browser—the software that enables the PC to communicate with the Internet—may also vary from user to user. You must therefore be careful to use the "lowest common denominator", the minimum capability likely to be available to all users.

Alternative means of interaction are available. Historically, users communicated with computers via forms that were filled in and transcribed to paper tape or cards in the form of patterns of holes. Early on, machine-readable data formats were developed such as optical character recognition (OCR) and magnetic ink character recognition (MICR). These had severe technical constraints but are still widely used in specialized applications such as check processing and invoice payments (where the account number and invoice amount are printed in OCR font on a slip that the customer detaches from the invoice and sends in by mail with the payment). The retail industry developed an industry-wide standard Universal Product Code (UPC) in the 1970s, embodied in bar codes on grocery packages, in books and on most other products. Similar in principle (but technologically quite different) are the magnetic stripes on the back of credit cards (often extended to membership cards that enable checking in and out as well as dispensing membership services). These forms of interaction require some specialized equipment, ranging from a hand-held scanning wand to an automated teller machine (ATM).

More recent developments include using touch-tone telephones for data entry. Automated response systems take phone callers through a series of menus to direct their calls either to a person with whom they can interact or to voice messages (either generic information useful to any customer or customer-specific messages, such as a credit card balance, generated on the fly). It is also possible for the caller to be asked to enter a series of digits—a customer number, a password or Personal Identification Number—or even alphanumeric text. Internet applications are emerging that are specifically designed to interact with mobile phones that use video and audio as well.

Another recent development is the use of Radio Frequency Identification (RFID), miniature transponders located in products, library books, electronic toll collection devices in cars and trucks, and cattle, to mention but a few uses.

For some very large systems, the development of a new input/output device may even be justified, as with the hand-held, wireless package tracking devices used by Federal Express.

In all cases, you must address two issues. First, how can the users get access to the interaction device? Are they likely to have a PC or a cell phone? Are they likely to adapt to using them as interfaces? (Cell phone texting may not be optimal for a system catering to retirees, nor may PCs with landlines connected to the Internet be the most appropriate solution in remote, non-electrified regions.) Alternatively, if the users are the organization's own workforce, what is the cost of equipping them? Second, whenever a user interacts directly with an information system, there is always room for doubts about the identity of that user, so you must decide what level of user authentication is necessary and how you can achieve it. There exists technology that is solely devoted to this authentication, such as fingerprint and retina scanner; other, frequently used solutions rely on password or PINs.

Interaction flow

The interaction flow follows directly from the functional requirements, and in particular the process descriptions or schematics (DFDs or "swimlane" diagrams) described in section 5 above. To revert to our default example of a web-based application using a PC with a mouse, a keyboard, a VDU and a printer, you need to develop detailed layouts of screens and printouts (you can use presentation software such as Powerpoint to mock up these) and descriptions of what the system does in response to each possible user action—entering text, clicking on radio buttons, check boxes and navigation arrows, or pressing the Tab or Enter keys, for example. For each item that the user can act on, also called a control, you describe all the possible user actions and for each of those, the system's processing and possible responses. (This is called by some a Control-Action-Response, or CAR, diagram, an example of which is shown in Exhibit 8.)

CAR Diagram			
Control	**Control Type**	**Action**	**Response**
About Us	button	click	hyperlink to About Us
Contact Us	button	click	hyperlink to Contact Us
Locations	button	click	hyperlink to Locations
Careers	button	click	hyperlink to Careers
Site Map	button	click	hyperlink to Site Map
Personal Finance	folder tab	click	display Personal Finance pane
Wealth Management	folder tab	click	display Wealth Management pane
Small Business	folder tab	click	display Small Business pane
Open Account	drop-down list	select	launch Open Account script for selected account type
User ID	text box	type	display text
Password	protected text box	type	display asterisks
Login Button	button	click	launch Check Password script with User ID and Password as parameters
Forgotten Password?	button	click	launch Password Reminder script with User ID as parameter
Select a Service	drop-down list	select	
Login Button 2	button	click	(see Login Button)
Learn More	button	click	hyperlink to selected service
Enroll	button	click	launch Enroll script for selected service
		Enter key	(see Login Button)

Exhibit 8: CAR diagram

For each process, you have a choice between two basic interaction styles, system-driven and user-driven. System-driven systems take usually either a question-and-answer approach or a menu-and-forms approach. Take as an example an income tax filing application. One approach is to have the system ask a series of questions in a sequence that is determined by the designer, prompting successively for the taxpayer's name, ID number, marital status, income from salary, taxes withheld, and so on. This is a very appropriate method for an individual taxpayer, who does this only once a year and whose knowledge of the intricacies of what you have to report and on which form is limited.

For a tax preparer with multiple clients, a menu-and-forms approach may be better. The user can choose which form to fill in from a menu; in response, the system displays a screen image of the form and the user can fill it in, using the Tab key to move back and forth between fields and character, arrow, backspace and delete keys to fill in each field on the form.

A third form of system-driven interaction, often neglected because the interaction itself is minimal, is batch processing. The best example comes from periodic applications such as utility billing or bank statement printing. In these examples, the processing is initiated by a timer (every night at 1:30, or every Monday, etc...). An entire file or database is processed without human intervention and the result is distributed by electronic (email) or physical ("snail" mail) when the processing is complete. A useful trick for weekly or monthly applications that print out large volumes of data is to organize the process by slicing the input file into segments—as many segments as there are days in the period. For instance, for a monthly application, you could print out all the customers whose name begin with A one night, B the second night, and so on. This is called cycle billing and is in general use.

Other types of applications may be best served by a user-driven approach. One example is Internet navigation, where the user can look up information (for instance in an on-line product catalog) by navigating freely from web page to web page, following links or invoking embedded search functions. As he or she finds products that are of interest, they are put in a shopping cart; at the end, when the user wants to confirm the order, the application takes on a system-driven character again, to enter delivery, invoicing and payment data.

Another example of a user-driven application is the spreadsheet. The user is given a variety of tools and functions: putting them together step by step enables him or her to complete the task at hand, whether it is to compute loan amortization calendars or organize the music collection of a church choir. Spreadsheet software is in fact so flexible that it is questionable whether to call it an application at all; it is more like a tool. In fact, many organizations create applications from spreadsheet software by distributing pre-formatted templates: budgeting and expense tracking are often treated this way. In this case, you could argue that the spreadsheet software is like a programming language and the template is the true application.

A final consideration is that of user identification and authentication. Most networked applications deal with resources that must not be tampered with—whether it is selling products or giving access to confidential information. In these cases, any user should be identified—who is it?—and authenticated—is the user really who he or she says? The usual procedure is to assign the user an identifier the first time he or she uses the application. This identifier is then stored by the system and permits subsequent activities. In addition, associated with the identifier is a password that only the legitimate user is to know. When logging in, the user supplies both the identifier and password. The combination of the two, if correct, authenticates the user who is then authorized to use the application.

The choice of style and flow thus depends on the application, but also on the user population. An inappropriate interaction style can cause a system to fail, especially if the users of the system are outside your control (e.g. the general population) and have a choice whether or not to use the system. This is a little less critical if the system is aimed at the employees of your organization, but a poorly designed interface can only have detrimental consequences: loss of productivity and lack of cooperation to cite only two.

The following are some guidelines for good interface design. The list is not exhaustive, but it contains some hints that you may not otherwise have though of; user interface design is a vast subject and you should reference the ample literature before starting.

- Do not consider yourself a surrogate user, thinking, "This is how I would do it if I were to use the system". You are not. You have a different educational and professional background. Get help from actual users to evaluate your design.
- Be consistent. Use the same controls and actions to accomplish similar functions. If you use feedback cues such as icons, color, fonts, sounds, etc..., make sure they are associated systematically with the same actions throughout. For instance, if you want to use a garbage can icon to discard unneeded data, then make sure you always use the same garbage can icon, in the same place on the screen, and with the same "Oops" function.
- Provide "Oops" functions at all points where it seems useful. Users are often afraid to use system functions, especially those they do not use very often, because they are afraid that the consequence of an error may be to break the system. Consistently having "Oops" or Undo functions available makes the system much more usable.
- Pay attention to users who have some physical impairment, such as color blindness, vision or hearing impairment, only one arm...Do not rely exclusively on color or sound to convey information.
- Make it very clear when a transaction, a data base update, or other irrevocable action has been performed, at what is called a commitment point.
- Do not overcrowd screens and reports, but don't commit the opposite error either: you do not want to devote a whole screen to a single item of data.
- Avoid distracting graphics and decorative elements, especially for high-usage systems. "Pizzazz" may be fun the first time, but users quickly get tired of it.
- Pay special attention to error processing. Make sure the user understands what is wrong and which steps to take to correct it. Anticipate that the user will try to perform unexpected actions and design the interface to react accordingly.
- Let the user choose the identifier and the password with as few constraints as you can. This is especially valid for external customers and occasional users. You can be more demanding with frequent users, especially within your own organization—assigning an ID rather than letting the user choose, forcing a mix of alphabetic and numeric characters for the password, making the user change the password periodically. (To force this discipline on occasional users—who may not use the system for months at a time—is counterproductive, because he or she is likely to compromise password security by writing it down.)

Data

In the typical case, data design consists of deciding how to organize the permanent data maintained by the application into a relational data base, made up of a series of tables—usually one for each entity identified in the entity-relationship model during the requirements analysis. Each line (record, tuple) of a table describes one particular occurrence of the entity type. For instance, in a customer table, there will be one record per customer; and each of these records will contain attributes or data items describing that customer: name, address, telephone number...

Each attribute is described with respect to its functional definition, its value domain, its physical representation on various media, and any restrictions on the operations that can be performed. This documentation decreases the number of programming errors and data base integrity problems during implementation and operation of the system.

For each entity, a key is chosen to identify it uniquely. A good key has no meaning outside of identifying the entity uniquely. In addition, a good key never changes its value for any given entity over the entire life of that entity.

For each relationship, an implementation is chosen. In most cases, relationships are implemented via foreign keys: an attribute of the entity is the key of another entity, serving as a pointer. For example, an order entity contains the customer number of the customer who placed the order. Then, when the order is processed, the application can access the customer data (for instance, to ascertain the delivery address).

One of the most important criteria for a good data design is that the data items (attributes) are assigned to the right table (entity). The objective is to avoid storing data redundantly. For example, in the order process outlined above, you want to store the customer's delivery address in the customer table rather than in each of the customer's orders in the order table. This isn't so much to save space as to insure consistency. If the same piece of data is

stored in several places, there is a risk that the values at some point will come to differ. Then, you are faced with the dilemma of choosing one, but which one?

The process of assigning attributes to the correct tables is called normalization. There is a set of precisely defined steps and criteria that you can follow to make this process almost foolproof. (Need reference here). The acid test is to run down all the functions of the system and ask yourself whether any of them would require updating the same piece of data twice.

Even though the occasion of all this work is the implementation of a single system, one of the main purposes of data base design is to ensure coherence of definitions and consistency of data values across all the systems of an organization. Thus, much of this work is ideally performed by a data administration section, which covers the activities of the entire IS department, not only the current project. If there is no data administration section, then one of the analysts on the project plays the same role, covering only the project.

Media content

The last aspect of external design that we'll cover is media content design. This refers to the design of applications whose main purpose is to convey information to the application users, whether it be products for sale, press releases, academic articles or similar content.

Media content can be in several different forms: text, still images, animations, video or audio, or any combination of the three. Designing the content and the presentation of the information is the affair of communications specialists. Your responsibility as a system designer is primarily to provide for the storage and retrieval of each component as needed. You must also decide how the media content will be maintained (say, by changing the photographs when a product is modified) and how to ensure that all the navigation links available to the user work correctly. It is easy to radically modify the content of a page; it may not be so easy to locate all the other pages that point to the one you've modified, to see whether those links still make sense. It is even worse when you suppress a page without suppressing the links to it, leaving the user high and dry in the middle of navigating the web.

Internal design

The internal, or technical, design of an information system is the description of how the system will be implemented. Most of the work done here is intimately dependent on the architecture adopted, but we can identify a few general principles that apply across the board. This will be the simplest and the most useful if we look at the end result of the design rather than the process to get there,

The internal design identifies and describes all of the components of the system: hardware, software, communications protocols. For each component, it describes which functions are fulfilled by, or allocated to, that component. The decomposition/allocation should meet the following criteria:

- *Completeness*: Each functional requirement (see section 5 above) is allocated to a component.
- *High cohesion*: Each component performs functions that belong logically together. For example, extending and totaling the lines of an invoice and the computation of sales tax arguably belong together; checking a user's password does not.
- *Low coupling*: Each component interfaces as simply as possible with other modules. For instance, an on-line ordering application might have a module to process credit card payments. The invoicing program should just communicate the invoice amount to the credit card payment module, which, after processing the credit card data entered by the user should simply indicate to the calling module whether the payment was accepted or not.

One particular strategy of allocation is worth bringing out: object orientation. Whereas traditional systems allocate functions to modules based on the processing flow, object orientation uses the data structure as the criterion. Each object (corresponding to an entity in the entity-relationship diagram or a table in a relational database) is packaged with its code. The functions that such an object can perform are typically to modify the value of an attribute (say, the customer address) or to send the value of an attribute back to the requesting program. The application still needs to implement a flow of processing (for example, log in, followed by browsing of the catalog, depositing items in a virtual shopping cart, checking out and paying). The object-oriented paradigm can be made systematic by considering each such process as an object in itself, even though it is not an entity in the entity-relationship diagram.

Object orientation has the advantage of making it easy to meet all three of the criteria enumerated above. The structure of the system is simpler and more reliable than traditional systems design. The disadvantages are that performance may be a problem and that the approach is less familiar, especially for IS professionals of a certain age.

Code

Completing the design process results in a series of detailed specifications. The translation of these specifications into a form that can be understood by the technological components of the system—PCs servers, mainframes, communications gear... This is called coding. (It used to be called programming, but it entails in fact more than writing programs—for example, database specifications).

How this is done is specific to each environment and will therefore not be further described here. Each programming language has its own peculiarities, and each IS department has its own habits; the best organized departments have in fact established coding standards to be followed by all team members. This has the advantage of making work more interchangeable: if everybody uses the same style, work on one component can be taken over by anyone. Maintenance is also greatly facilitated by standards.

Test

Why we test

We test a software program, an application, an entire business information system to detect errors—things that don't work the way they are supposed to. If the system doesn't work properly, we find out why and fix it (or abandon it, if we judge it too expensive to fix).

We test other things, too. New airplanes are tested before they are declared airworthy. Before buying a new car, you probably want to test-drive it. In the United States, the Food and Drug Administration mandates extensive tests, lasting several years, of any new medication before it can be prescribed or sold over the counter. Sometimes, the tests are insufficient, as with the case of the X-ray equipment that would, under certain circumstances, irradiate patients with 1,000 times the normal dose; as a result, patients died. In other cases, it isn't possible to test a product under realistic conditions: the Lunar Excursion Module could not be tested on the moon before the real moonshot.

Software—beyond a few hundred instructions—becomes so complex that its behavior cannot be accurately predicted just by inspecting it. Errors creep in through inattention, misunderstanding, or other human weaknesses. Just as no one would want to fly an untested plane, no one would want to use untested software.

Testing is a part—a critical one—of a more general process called software defect removal. (Other techniques include inspection, prototyping, and automated syntax checking.) Even used in conjunction, these defect removal techniques cannot guarantee defect-free software. The most thorough of tests cannot address all the possible values of input data against all the possible states of the database. A defect may remain latent for several years until some highly unlikely combination of circumstances reveals it. Worse, the test itself may be defective: after all, the test, too, is designed and executed by fallible human beings.

In traditional systems development methodology, testing is seen as a discrete activity, which occurs once development is substantially complete. This view causes problems, because the cost of correcting errors becomes exponentially larger the more time passes during which the error remains undetected. An error that is discovered by its author as it is committed can be corrected immediately, at no cost. A requirements error discovered during operation may invalidate the entire system—and carry business interruption costs in addition. Experts estimate that correction costs can be a hundred times higher when the error is discovered after the system has been delivered. The reason for these high costs are that the longer the time between committing an error and discovering it, the more work will have been done and therefore have to be corrected or scrapped and recreated.

The V model of verification, validation, testing

Before explaining how testing is done, let us place it in a wider context. At about the time that the IS community discovered the high cost of error correction, the United States Department of Defense devised a set of processes to control the work of contractors on large, complex weapons systems procurement projects. Because of the increasing software content of modern weapons systems, these processes were naturally adapted to the world of software development. They also put testing in proper perspective as one means among many to ensure software quality.

Because of the shape of the graphical representation of these processes, the name V model was coined. An example of a V model that applies to business information systems development is depicted in Exhibit 9.

The left-hand side of a V depicts activities of decomposition: going from a general objective to more and more detailed descriptions of simpler and simpler artifacts (such as program code in a business system). The right-hand side depicts integration: the assemblage into larger and larger components of the individual pieces of code created at the bottom angle. As each assembly or subassembly is completed, it is tested, not only to ensure that it was put together correctly, but that it was also designed correctly (at the corresponding level on the left-hand side of the V).

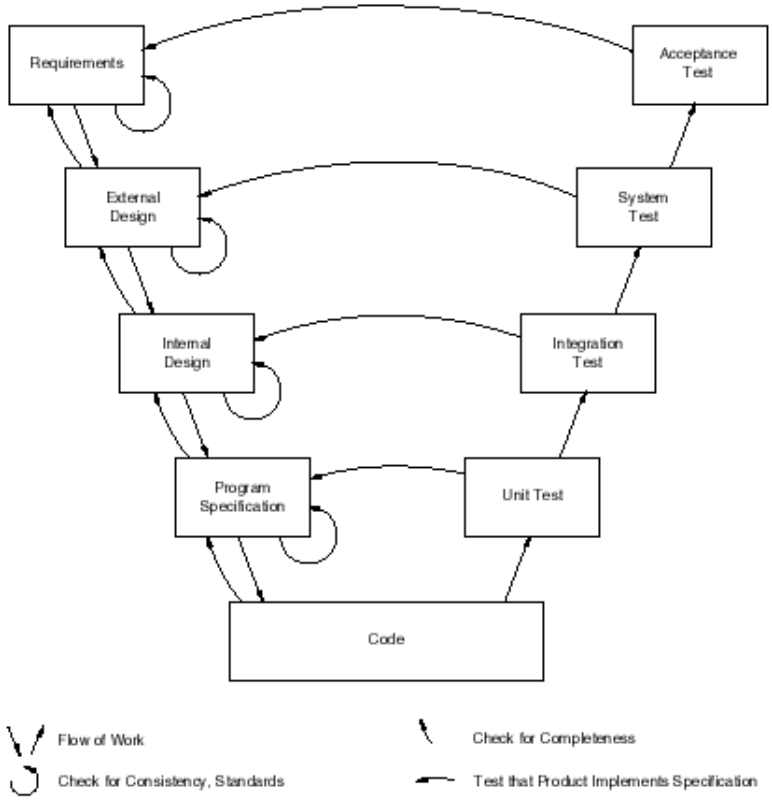


Exhibit 9: A V model

The final characteristic to be noted is that each phase corresponds to a hand-off from one team to another (or from a contractor to a subcontractor, in the original Department of Defense version of the V model). In the case of systems development, what is handed off is a set of deliverables: a requirements or design document, a piece of code, or a test model. The hand-off is only allowed to take place after an inspection (verification and validation)of the deliverables proves that they meet a set of predefined exit criteria. If the inspection is not satisfactory, the corresponding deliverables are scrapped and reworked.

Let us define verification and validation. **Verification** checks that a deliverable is correctly derived from the inputs of the corresponding activity and is internally consistent. In addition, it checks that both the output and the process conform to standards. Verification is most commonly accomplished through an inspection. Inspections involve a number of reviewers, each with specific responsibilities for verifying aspects of the deliverable, such as functional completeness, adherence to standards, and correct use of the technology infrastructure.

Validation checks that the deliverables satisfy the requirements specified at the beginning, and that the business case continues to be met; in other words, validation ensures that the work product is within scope, contributes to the intended benefits, and does not have undesired side effects. Validation is most commonly accomplished through inspections, simulation, and prototyping. An effective technique of validation is the use of traceability matrices, where each component of the system is cross-referenced to the requirements that it fulfills. The traceability matrix allows you to pinpoint any requirement that has not been fulfilled and also those requirement that need several components to be implemented (which is likely to cause problems in maintenance.)

Detailed descriptions of various do's and don'ts of inspections are available from most systems analysis and design textbooks, as well as from the original work by Ed Yourdon. (reference here)

Testing, the third component of the V model, applies to the right-hand side of the V. The most elementary test of software is the unit test, performed by a programmer on a single unit of code such as a module or a program (a method or a class if you are using object-oriented programming). Later on, multiple units of software are combined and tested together in what is called an integration test. When the entire application has been integrated, you conduct a system test to make sure that the application works in the business setting of people and business processes using the software itself.

The purpose of a unit test is to check that the program has been coded in accordance with its design, i.e., that it meets its specifications. It is not the purpose of the unit test to check that the design is correct, only that the code implements it. When the unit test has been completed, the program is ready for verification and validation against the programming exit criteria (one of which is the successful completion of a unit test). Once it passes the exit criteria, the program is handed off to the next phase of integration.

The purpose of integration testing, the next level, is to check that a set of programs work together as intended by the application design. Again, we are testing an artifact (an application, a subsystem, a string of programs) against its specification; the purpose is not to test that the system meets its requirements. Nor is the purpose to repeat the unit tests: the programs that enter into the integration test have been successfully unit-tested and therefore are deemed to be a correct implementation of the program design. As for unit tests, the software is handed off to the next level of testing once the integration test is complete and the exit criteria for integration testing are met.

The purpose of system testing, the next level, is to check that the entire business information system fulfills the requirements resulting from the analysis phase. When system testing is complete and the exit criteria for system testing are met, the system is handed off to IS operations and to the system users.

How to test:
Prepare the test

Let us start with unit testing. To unit-test a program, you: first create test cases. A test case is the description of a unique combination of inputs and data base states. The secret to good, efficient testing is to plan the test cases so that each is unique and together they are exhaustive. In practice, you develop unit test cases from the program specification to make sure that all the processing rules and conditions are reflected in at least one test case. You create a separate test case for each state of the data base that could have an impact on how the program works. Pay special attention to boundary conditions, those that are abnormal or at the edge of normality. For instance, when processing a multi-line order, pay special attention to the first and the last lines of the order. Include orders that have one line, or none at all, or a very large number. Consider also abnormal cases, such as that of trying to create an order for a customer who is not recorded on the data base. Create different orders for different types of customers. Consider what happens for the first order of the day, when the order file is empty, or after a heavy day, when the order file becomes very large. Create order lines with very small and very large amounts. Are negative amounts accepted? It is as important for a program to raise the proper exceptions for erroneous inputs as it is to check that valid data is processed correctly.

Once you believe the test cases are complete, cross-reference them against the program specification to ensure that each specification is addressed.

Once the test cases have been created, prepare the test scaffolding, the environment in which the test will be run. If the program is a user interface program, most of the test data needs to be laid out in a script for the user to follow. If not, input or transaction files must be loaded. This can be done with a test data load utility or it may require a specially written program. Next, the test data base (including web site content, if applicable) must be created. The best way to do this is to have the project team maintain a master database of shared test data from which each programmer can extract relevant tables, rows and files , modifying them where necessary for the purpose of the test. (You cannot use the database directly, since your program is likely to update it, thus creating unexpected conditions for everybody else.) If the project team doesn't have a common test data base, create your own, as you did for input and transaction data.

Next, consider what stubs and drivers you need to test your program. In many cases, a program needs to communicate with other programs, some of which may not have been created yet. A stub is a small program that can be called by the program being tested and can simulate the services rendered by the called program. A driver works the other way around: if your program is designed to be called by a program that doesn't exist yet, and you must write a simple program that activates yours.

Another useful tool is one that does screen capture. This tool records keystrokes and screen display changes; it enables you to repeat exactly the same test and to compare its output before and after you make modifications.

Before running the tests, you should prepare the expected results for each test case in each test cycle. Most developers do not do this. They believe that it is sufficient to run the test and review the output to see if it is correct. This is insufficient, for two reasons. First, people have a propensity to see positive results. Subconsciously, the brain will often rationalize an error and tend to think that the result is actually correct when it isn't. Second, preparing expected results is an excellent way to review the completeness and relevance of the test data.

Ideally, you would load the expected results on to a file in the same format as that produced by the test. Then, the comparison between expected and actual results can be done electronically—a much more reliable approach than trusting human faculties. A keystroke/screen capture facility comes in handy here, especially for programs that are part of the user interface. But even if you don't have such a tool, comparing a predetermined expected result against an actual one is a lot more reliable than just viewing the actual result to decide whether it is correct.

Preparing expected results is time-consuming and not much fun. Ultimately, however, by avoiding false positive results and by making it easier to repeat the same tests after correction, you save time and increase quality.

However, since the cost is incurred earlier than the benefits materialize, project management has a tendency, when put under time pressure, to shortcut this indispensable investment.

Execute the test and record the results

With all the preparation that has gone on in advance of the unit test, executing it and recording results is as simple: just do it.

Well, not quite. If you do not have a scripting tool and you are testing at the user interface, you must observe an iron discipline of recording what you do and how the system responds, by taking notes and printing screens—or even photographing screens using digital photography or Polaroids. This is easier said than done.

Find and correct errors

When you have executed a test, review the output, either by examining the results of a program to compare the expected v. the actual results, or by scanning the results yourself. A discrepancy between the two may have one of the three following causes:

The discrepancy is only apparent: the results are just in a slightly different format (such as a zero being unsigned in one and signed in the other). Correct the expected results so that the discrepancy does not repeat, wasting time every time the test is rerun.

- The discrepancy may stem form an error in the test data. This occurs quite frequently. The expected result itself may be wrong; there may be a clerical error in the test data; or the test data may not correspond to the intent of the test case. In the first two instances, the error is easily corrected. In the third case, it may be a little more complex, because the problem is a sign that the program specification may have been misunderstood.
- The discrepancy is due to an error in the program. In that case, correct the program and rerun the test. You must also make sure that the correction has not disturbed a part of the program that has already been tested, if necessary by rerunning all previously run test cycles. This process is called regression testing. In practice, you do not run a complete regression test every time you find a small error in your program—you can postpone it until the end. However, before you can hand off the program to the next phase, you need to rerun all the test cycles once after all your corrections have been completed.

Executing the other tests

The V model introduced describes the flow of development and integration, specifying that for each development phase, there is a corresponding test. The V model is only a schematic representation, however; in real life, more tests are required than those shown, and some things are difficult to test for—in particular the quality requirements, performance, usability, reliability and maintainability, and may require extensive work.

How much testing is enough?

A central question is, when are you done testing? We have already said that it is impossible to guarantee that a system is free of defects, no matter how long you test it. So when do you stop?

This is essentially an economic question. It can be formulated in two ways:

- The benefits of delivering the system, including its residual errors, outweighs the risks, or
- The cost of discovering additional defects is greater than the savings gained from finding and removing them.

Either case boils down to a judgment call. This is most apparent in the first formulation, which refers explicitly to risk. In the second view, we need to add the word “probable” in front of both the cost and the savings, to emphasize that it is hard to predict how much effort you will need to find the next bug and indeed how grave that defect is going to be.

The decision is illustrated by the defect removal curve in Exhibit 10.

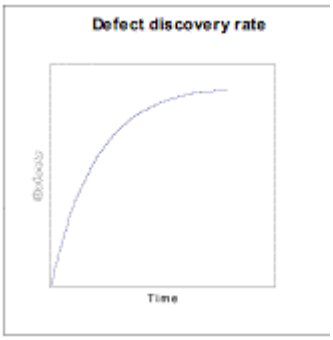


Exhibit 10: Defect removal curve

Prototyping

According to the V model, each test is assumed to be executed on the actual code after it has been developed. In many cases, preliminary tests can be devised that do not require a fully developed system. Rather, they work on a "synthetic" application, one which has the same technical characteristics as the application under development, but which doesn't really do anything of functional value. In the V model, such tests are identified as prototypes; setting them up and running them is called prototyping. The benefit of prototyping over testing on a full system is that you can do it earlier; any correction you need to make to the specification you are prototyping will cost much less to make than if you wait until actual testing is possible.

If you create a prototype to test out some specification, it doesn't mean that you can omit the corresponding test later on. In fact, the test is still needed, because the implementation of the specification may be incorrect. But you should be able to run the test, and especially post corrections, in much less time than if you don't prototype.

A corollary of the view of testing that we have just described is that any deliverable created by an activity on the left side of the V model is liable to be tested. It should therefore be couched in testable—concrete, operational—terms. A requirement that states, "The system must be extremely reliable," is not useful. Rather, use descriptions such as, "The system must be available to users during 99 per cent of its scheduled uptime" and "The system will produce no more than one Type 0 System Change Request per week." The deliverable is not complete unless it also is accompanied by a test model, containing at least a description of the testing approach and ideally a set of test cases.

Another corollary is that test data have to be designed. You cannot use live data—data extracted at random from an existing application, at least not exclusively. (An exception may be made for volume testing.)

Maintain

Problems with the waterfall life cycle

When the waterfall life cycle was first published, development project planners used it as a generic systems development plan, translating each activity as a separate bar on a GANTT chart which couldn't be started until the previous activity was completed. This approach caused a number of difficulties and has largely been abandoned. The waterfall life cycle is now used almost exclusively as a training framework, because it distinguishes between the different kinds of activities that take place during systems design—although it does not represent an actual chronological sequence of events.

The main reasons for the inadequacy of the waterfall concept are related to the need to manage changes to the system. We have already mentioned that as soon as a system has been launched, requests for changes start accumulating. In fact, these requests start almost as soon as the first systems requirements have been agreed to, whether it is because the business and technological environments keep changing or because verification, validation and testing (including prototyping) uncover defects that need to be corrected.

Specifically, the problems that arise are the following:

Projects take too long. By placing each activity on the critical path rather than doing some of them simultaneously, the elapsed time of a project cannot be shortened beyond a minimum of a year or more in the typical case. During the long development phase, costs are incurred; benefits do not start accruing for several years. This interferes with the realization of the economic benefits supposed to be brought by the system.

1. Requirements have to be finalized—"frozen" is the term most used—too early in the project. During a year or more of development, the world does not stand still, and what may have been useful at the start of a project may be irrelevant a year or two later. This became especially true when information technology started to be used as a competitive weapon in the early 1980s.

2. Users frequently do not get a full understanding of the system until it is almost done. Accepting a requirement or a design on paper is not at all the same as seeing and using a real system, and users who see a system in operation for the first time may quickly discover major problems. As a result, either the system has to be delayed by major corrections or it will be released on time, but with known defects.
3. Once the developers have handed the system over to operations, they quickly find, contrary to their (somewhat unrealistic) hopes and expectations, that they can't just forget about it. As people start using the system, they find undesirable system behaviors such as bugs, poor performance, etc. They also develop ideas for additional functions to add to the system, whether these ideas for modifications come from their own experience in using the new technology or are due to changes in the environment—imposed by the competition, regulators, and society at large. In other words, maintenance hits.
4. In fact, maintenance is already needed during development. As programmers test, they find bugs that have to be fixed. Some bugs are just errors they have made themselves, but sometimes errors are due to poor design or to a misunderstanding of the real requirements. Errors may in fact be found at any point during the development process. To correct these errors, you may have to go back one or several phases in the life cycle to scrap some work previously done and rework it. (Royce knew this: he provided the back arrows on his diagram to address this need. But project planners did not truly understand the problem. As a result, the maintenance activity—or bug fixing—that goes on in a waterfall project is usually conflated with the testing activity.)
5. On innovative projects, another difficulty arises. The team members may not know how to perform their designated activities in the best way, because they have never done it before. When this happens, designers experiment by quickly implementing and testing a possible solution, thus anticipating the later stages of the waterfall life cycle.

Development vs. maintenance

All of the points enumerated above have been extensively analyzed and solutions have been proposed. Most of the solutions result in a shorter initial period of systems development—say, three to six months—after which periodic new releases of the system provides additional functionality every three months or so. While many authors had started promoting Rapid Application Development (RAD) in the early 1990s, this did not become generally accepted until the race to create web-based applications towards the end of the decade. However, by the time the e-bubble burst in March, 2001, RAD and incremental releases had become the norm for all but the most ambitious systems development projects. Even though the pace of creation of web applications has leveled off, we have not seen a return to large, big-bang projects.

A consequence of this trend is that maintenance has now become the normal mode of application creation. In the past, you might have a large team working for three years on the initial development of an application, followed by a team reduced to one-half or one-third the initial team, working for ten to twenty years to do maintenance. This would imply a ratio of initial development to maintenance of 1 to 2 or 1 to 3. With the new model, the initial development would take place with a smallish team over three months and maintenance would still last for ten or twenty years with a team of the same size or slightly smaller, giving us a ration of development to maintenance of 1 to 50 or 1 to 100 in extreme cases.

This tremendous shift has not attracted the interest of researchers and authors. IS departments have realized it, however, and the best-run organizations articulate their work around maintenance as the default activity, initial development being almost an afterthought.

In the new model, you do not have a unidirectional flow from requirements (supposed complete) through design to construction. Rather, you have system change requests flowing from any part of the process (wherever an issue has arisen) to any other part of the process (wherever the request has an impact).

Most IS departments use the following classification for their system change requests:

Type 0: Emergency fix. The system has a critical error and is not operational; no bypass is available.

Type 1: Error correction. The system does not work according to specifications. A temporary bypass is available.

Type 2: Enhancement. The system does not work satisfactorily: there are reliability, usability or performance issues.

Type 3: Extension. The system needs new or modified functionality to respond to external changes or to increase its business value.

Type 4: No system change required. The request is one that can be satisfied by more information or by routine action (such as a password reset). This category is included here only for the sake of completeness.

In the standard case, Type 0 requests are addressed immediately. Type 1 and simple Type 2 requests are bundled together in what is often called a "dot" release, typically monthly (or in some cases weekly). More complex Type 2 and all Type 3 requests are bundled in major releases, typically every three months (or in some cases every month).

The resulting life cycle might look somewhat like Exhibit 11.

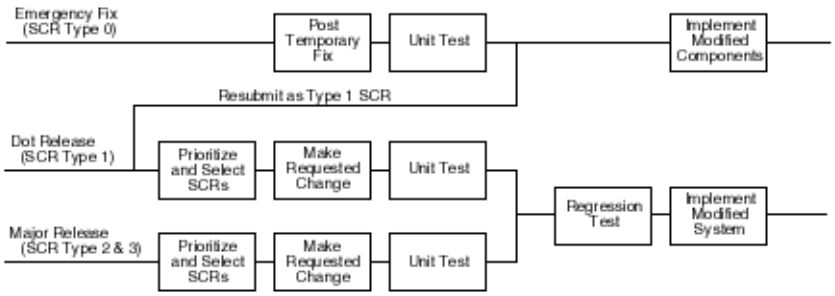


Exhibit 11:A systems life cycle

Testing during maintenance

One of the major problems with maintenance is that modifying a system, whether by correcting a component or extending its functionality, there is a high risk of disturbing, unintentionally but unavoidably, functions that do not need to be (and in fact should not be) changed. This accentuates the need for regression testing: testing that not only does the modification work, but everything that was not modified continues to work as before. Any but the most trivial change may require you to rerun an entire system test.

During maintenance, you will create new programs or even subsystems (to address Type 3 SCRs—functional extensions) and you will modify existing programs (typically to address other types of SCRs, but sometimes also Type 3s). Unit testing new programs during maintenance is no different from doing it during development. Testing program modifications, however, can be a little less rigorous. In general, you will test only that the modification works, but perform no regression testing (at the unit level) to check that the unmodified parts still work as specified. This is possible because the risk of errors is relatively low and because the correction-induced errors you may have caused will most likely be caught by the system-test level regression test, which is not optional, whether your maintenance release contains major new functionality or not.

For emergency fixes (Type 0), the same rule holds. Regression testing of emergency fixes just is not cost-effective. However, in the next scheduled release, the type 0 fix must be backed out and resubmitted as a type 1 fix. This way, it will be re-implemented, unit tested at the program level and regression tested at the release level, just like other SCRs.

Correspondingly, the regression test at the system test level becomes more important. This has several consequences:

The regression test is time-consuming and costly. However, it does not cost much more to test many modifications than just a few. This is a powerful argument for organizing maintenance in releases, as described in the previous paragraph.

- The system test from the first release becomes the regression test for the following releases. This is, in fact, part of the “product” as delivered to operations; no system is complete without it.
- When planning a new release, one of the first deliverables is the revised regression test model. For releases that have a lot of new functionality, you may also want to schedule other tests, depending on how you judge the risk of an unsatisfactory result. These tests are likely to be fairly infrequent and also fairly release-specific, and the maintenance of a regression test for these purposes is usually not economical.

Chapter 6: Project Management

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Introduction

Project management is the discipline of planning, executing, monitoring tasks while also managing resources, time and budget to complete those tasks in a common goal to bring about the successful completion of specific project goals and objectives. Typically used in the design and implementation of information systems. It is sometimes lumped in with program management, however technically a program is actually a higher level construct where a group of related and somehow interdependent projects come together to complete a larger initiative.

A project is a temporary endeavor, having a defined beginning and end (usually constrained by date, funding or deliverables), undertaken to meet unique goals and objectives, usually to bring about beneficial change or added value. The temporary nature of projects stands in contrast to the usual business operations, which are repetitive, permanent or semi-permanent functions to produce products or services. In practice, the management of these two systems is often found to be quite different, and as such requires the development of distinct technical skills and the adoption of separate management.

The primary challenge of project management is to achieve all of the project goals and objectives while honoring the preconceived project constraints. Typical constraints are scope, time, and budget.

Learning Objectives:

- Understand what a project is.
- Learn the Project management methodology.
- Understand the importance of Planning, Execution, Monitoring and closing a project.
- Identify project roles and stakeholders
- Understand the runaway project

Key Chapter Concepts:

- History of Project Management
- Project Management approaches
- Project Management Process
- Institute of Project management, setting a global standard
- Who are Project managers? What is the Project Triangle?
- Creating a work breakdown structure
- Avoiding the runaway project

The History of Project Management

The Ideals of Project Management have been around a long time, it's only the formulation of the tools and techniques that have been done in the past 50 years. For example could the Great Wall of China have been built with ingenious natural materials and a team of millions over a span of a thousand years without project management? It is possible to say that the concept of project management has been around since the beginning of history. It has enabled leaders to plan bold and massive projects and manage funding, materials and labor within a designated time frame. What leaders from the distant past managed to accomplish is amazing and without the project management tools available today.

As a discipline, Project Management developed from several fields of application including construction,

engineering, and defense activity (Cleland and Gareis, 2006). Two forefathers of project management are Henry Gantt, called the father of planning and control techniques (Stevens, 2002), who is famous for his use of the Gantt chart as a project management tool; and Henri Fayol for his creation of the 5 management functions which form the foundation of the body of knowledge (PMBOK) associated with project and program management (Witzel 2003). Both Gantt and Fayol were students of Frederick Winslow Taylor's theories of scientific management. His work is the forerunner to modern project management tools including work breakdown structure (WBS) and resource allocation.

Project management has been practiced since early civilization. Until 1900 civil engineering projects were generally managed by creative architects and engineers themselves, among those for example Vitruvius (1st century BC), Christopher Wren (1632–1723) , Thomas Telford (1757-1834) and Isambard Kingdom Brunel (1806–1859), (Lock, 2007). It was in the 1950s that organizations started to systematically apply project management tools and techniques to complex projects. (Kwak, 2005).

1. The 1950s marked the beginning of the modern Project Management era. Project management became recognized as a distinct discipline arising from the management discipline (Cleland and Gareis, 2006). In the United States, prior to the 1950s, projects were managed on an *ad hoc* basis using mostly Gantt Charts, and informal techniques and tools. At that time, two mathematical project-scheduling models were developed. The "Crirtical Path Method" (CPM) was developed as a joint venture between DuPont Corporation and Remington Rand Corporation for managing plant maintenance projects. And the "Program Evaluation and Review Technique" or PERT, was developed by Booz-Allen & Hamilton as part of the United States Navy's (in conjunction with the Lockheed Corporation) Polaris missile submarine program (Gareis, 2006). These mathematical techniques quickly spread into many private enterprises.

At the same time as project-scheduling models were being developed, technology for project cost estimating, cost management, and engineering economics was evolving, with pioneering work by Hans Lang and others. In 1956, the American Association of Cost Engineers (now AACE International; the Association for the Advancement of Cost Engineering) was formed by early practitioners of project management and the associated specialties of planning and scheduling, cost estimating, and cost/schedule control (project control). AACE continued its pioneering work and in 2006 released the first integrated process for portfolio, program and project management (Total Cost Management Framework).

1. The International Project Management Association (IPMA) was founded in Europe in 1967, (Booz Allen Hamilton - History of Booz Allen 1950s) as a federation of several national project management associations. IPMA maintains its federal structure today and now includes member associations on every continent except Antarctica. IPMA offers a Four Level Certification program based on the IPMA Competence Baseline (ICB) to APA (Kousholt, 2007). The ICB covers technical competences, contextual competences, and behavioral competences.

In 1969, the Project Management Institute (PMI) was formed in the USA (Lock, 2004). PMI publishes A Guide to the Project Management Body of Knowledge (PMBOK Guide), which describes project management practices that are common to "most projects, most of the time." PMI also offers multiple certifications.

Project Managers

A project manager is a professional in the field of project management. Project managers have the responsibility of the planning, execution, and closing of any project, typically relating to construction industry, engineering, architecture, computing, or telecommunications. Many other fields in the production, design and service industries also have project managers. Selecting members of the project team is critical to the success of any project, ensuring the right skill set is available in each role.

A project manager is the person accountable for accomplishing the stated project objectives. Key project management responsibilities include creating clear and attainable project objectives, building the project requirements, and managing the triple constraint for projects, which is cost, time, and scope.

A project manager is often a client representative and has to determine and implement the exact needs of the client, based on knowledge of the firm they are representing. The ability to adapt to the various internal procedures of the contracting party, and to form close links with the nominated representatives, is essential in ensuring that the key issues of cost, time, quality and above all, client satisfaction, can be realized.

Project Management Triangle

Project management is often summarized in a triangle. The three most important factors are time, cost and

scope, commonly called the triple constraint. These form the vertices with quality as a central theme.

- Projects must be delivered on time.
- Projects must be within scope.
- Projects must be within cost.
- Projects must meet customer quality requirements.

The triangle illustrates the relationship between three primary forces in a project. Time is the available time to deliver the project, cost represents the amount of money or resources available and quality represents meeting the client requirements that the project must achieve to be a considered a success.

The normal situation is that one of these factors is fixed and the other two will vary in converse proportion to each other. For example, time is often fixed and the quality of the end product will depend on the cost or resources available. Similarly if you are working to a fixed level of quality then the cost of the project will largely be dependent upon the time available (if you have longer you can do it with fewer people).

Time

The time required to produce a deliverable is estimated using several techniques. One method is to identify tasks needed to produce the deliverables documented in a work breakdown structure (WBS). The work effort for each task is estimated and those estimates are rolled up into the final deliverable estimate.

The tasks are also prioritized, dependencies between tasks are identified, and this information is documented in a project plan or schedule. The dependencies between the tasks can affect the length of the overall project, as can the availability of resources. Time is different from all other resources and cost categories.

The PMBOK defines the Project Time Management processes as:

1. Activity Definition
2. Activity Sequencing
3. Activity Resource Estimating
4. Activity Duration Estimating
5. Schedule Development
6. Schedule Control

Cost

To develop an estimate of a project cost depends on several variables including: resources, work packages such as labor rates and controlling influencing factors that can create a variance in cost. Beyond this basic accounting approach to fixed and variable costs, the economic cost that must be considered includes worker skill and productivity which is calculated using various project cost estimate tools. This is important when companies hire temporary or contract employees or outsource work.

Cost Process Areas

- Cost Estimating is an approximation of the cost of all resources needed to complete activities.
- Cost budgeting the estimated costs of resources, work packages and activities to establish a cost baseline.
- Cost Control - factors that create cost variance can be influenced and controlled using various cost management tools.

Scope

Requirements specified to meet the established goal of the project. The overall definition of what the project is supposed to accomplish, and a specific description of what the end result should be. A major component of scope is the quality of the final product. The amount of time put into individual tasks determines the overall quality of the project. Some tasks may require a given amount of time to complete adequately, but given more time could be completed exceptionally. Over the course of a large project, quality can have a significant impact on time and cost (or vice versa).

A phenomenon known as "scope creep" can be linked to the triangle too. Scope creep is the almost unstoppable tendency a project has to accumulate new functionality. Some scope creep is inevitable since, early on, your project will be poorly defined and will need to evolve. A large amount of scope creep however can be disastrous.

When the scope starts to creep, new functionality must be added to cover the increased scope. This is represented by the quality arm of the triangle, representing the ability of the product to fulfill users' requirements. More requirements fulfilled equals a better quality product.

In this situation you have three options:

1. Add time - delay the project to give you more time to add the functionality
2. Add cost - recruit, hire or acquire more people to do the extra work
3. Cut quality - trade off some non-essential requirements for the new requirements

If the art of management lies in making decisions, then the art of project management lies in making decisions quickly. When faced with scope creep you cannot ignore it. You need to tackle it in one of the ways described above and the sooner the better. Delaying raises the risk of your project failing.

Work Breakdown Structure

The Work Breakdown Structure (WBS) is a tree structure, which shows a subdivision of effort required to achieve an objective; for example a program, project, and contract (NASA, 2001). In a project or contract, the WBS is developed by starting with the end objective and successively subdividing it into manageable components in terms of size, duration, and responsibility (e.g., systems, subsystems, components, tasks, subtasks, and work packages) which include all steps necessary to achieve the objective.

The Work Breakdown Structure provides a common framework for the natural development of the overall planning and control of a project and is the basis for dividing work into definable increments from which the statement of work can be developed and technical, schedule, cost, and labor hour reporting can be established (NASA, 2001).

A work breakdown structure allows the summing of subordinate costs for tasks, materials, etc., into their successively higher level "parent" tasks, materials, etc. For each element of the work breakdown structure, a description of the task to be performed is generated (EIA-731.1). This technique (sometimes called a System Breakdown Structure) is used to define and organize the total scope of a project.

The WBS is organized around the primary products of the project (or planned outcomes) instead of the work needed to produce the products (planned actions). Since the planned outcomes are the desired goals of the project, they form a relatively stable set of categories in which the costs of the planned actions needed to achieve them can be collected. A well-designed WBS makes it easy to assign each project activity to one and only one element of the WBS. In addition to its function in cost accounting, the WBS also helps map requirements from one level of system specification to another, for example a requirements cross reference matrix mapping functional requirements to high level or low level design document.

Project Management Institute (PMI)

According to the Project Management Institute, as the number of projects swell, the pool of credentialed talent is not keeping pace. In the Persian Gulf and China Sea regions alone — where entire cities are being built, seemingly overnight — a shortage of 6 million skilled project professionals is expected by 2013. Add to that the fact that, of the 20 million people participating in projects worldwide, just one million have professionally recognized formal training on how to best execute those projects. One thing becomes clear: The demand for skilled project managers is at a critically urgent level.

For nearly 40 years, PMI advocated on behalf of project professionals around the world. Project Management allows an individual to speak with one common language, no matter their industry, geography, or whether they manage projects, programs or portfolios. This common language steers organizations toward achieving repeatable, predictable results

With more than one million members, credential holders, volunteers and trained project professionals worldwide, PMI advocates project, program and portfolio management that can enhance and accelerate organizational change - driving innovation, improving bottom line performance, and strengthening competitive advantage. (PMI, 2010)

PMI offers certifications in the following areas. www.PMI.org

- Project Management Professional (PMP)
- Certified Associate of Project Management (CAPM)
- Program Management Professional (PgMP)
- PMI Scheduling Professional (PMI-SP)
- PMI Risk Management Professional (PMI-RMP)

PMI Standards

Global standards are crucial to the project management profession because they ensure a basic project management framework is applied consistently worldwide. For 25 years, PMI's global standards have helped establish the Institute as the premier authority in project management, helping it mature into the global organization it is today. In fact, the American National Standards Institute has recognized PMI as a Standards Development Organization.

It is the mission of the PMI Global Standards Program to improve the understanding and practice of project management by identifying, defining, documenting and championing generally accepted project management practices and a common project management lexicon.

PMI's standard development efforts started with the groundbreaking PMBOK® Guide – now with over 2 million copies in distribution – and extend to almost a dozen global standards in its library. PMI standards are grouped according to the following themes:

- Projects
- Programs
- People
- Organizations
- Profession

Project Management Approaches

Because Project management has been around for such a long time there are many different approaches to running a project. Some include agile, interactive, incremental, and phased approaches are commonly used in Information Technology. We will focus on the most commonly used approach called the traditional, this is also the approach taught by the Project Management Institute.

Regardless of the methodology employed, careful consideration must be given to the overall project objectives, timeline, and cost, as well as the roles and responsibilities of all participants and stakeholders.

The PMI Standard

The Project management institute teaches the traditional approach that identifies a sequence of steps to be completed. In the "traditional approach", we can distinguish 5 components of a project in the life of a project:

Traditional phases of a project:

- Project initiation stage
- Project planning or design stage
- Project execution or production stage
- Project monitoring and controlling systems
- Project completion stage

Not all the projects will visit every stage as projects can be terminated before they reach completion. Some projects do not follow a structured planning and/or monitoring stages. Some projects will go through steps 2, 3 and 4 multiple times as shown in the above diagram.

Initiation Stage

The initiation stage is responsible for laying down the scope of the project. This is a very important stage that should not be taken lightly. If the initiation is not done correctly, the chances of the project being successful are very low.

To conduct the initiation stage correctly, members of the project need to have a good understanding of the environment they are working in. It is also important to make sure the proper controls are set in place. If any problems are found, they should be reported as quickly as possible, and they will need to be fixed before the project can proceed. The initiation stage is about accurate planning. The team responsible for the project should take the time to review the needs of the client the project is geared towards. They should look at goals that can be achieved within a realistic period of time. They should also take the time to review any current operations that may be in progress.

Once this is done, the team will come up with a concept for the design of the end product or service. The team will also look at the financial aspect of the project. A budget must be set up, and the costs involved must be well understood. After this, the stakeholders will be selected. These will include the users, and the individuals who will be working on the project. Once all of this information has been gathered, the team will next want to create a Project Charter. The charter will have information that deals with the cost, schedule, and procedures that need to be carried out.

The initiation stage should include a plan that encompasses the following areas:

- Analyzing the business needs/requirements in measurable goals
- Reviewing of the current operations
- Financial analysis of the costs and benefits including a budget
- Stakeholder analysis, including users, and support personnel for the project
- Project charter including costs, tasks, deliverables, and schedule

Planning or Design Stage

The planning stage defines and refines objectives, and plans the course of action required to attain the objectives and scope that the project was undertaken to address. The major pieces of this are scope management and the Work Breakdown structure.

Scope management is the set of processes that ensures that the requirements of the customer are captured in a specification of work that ensures its delivery, that all the project work is done, and that only the work required to complete the project is done. In other words, scope management makes sure that the project is completed without expending any unnecessary effort.

Scope planning defines the document that states how the scope will be specified, controlled, and verified. The project team develops the scope management plan for each project. More complex projects require a more detailed scope planning process.

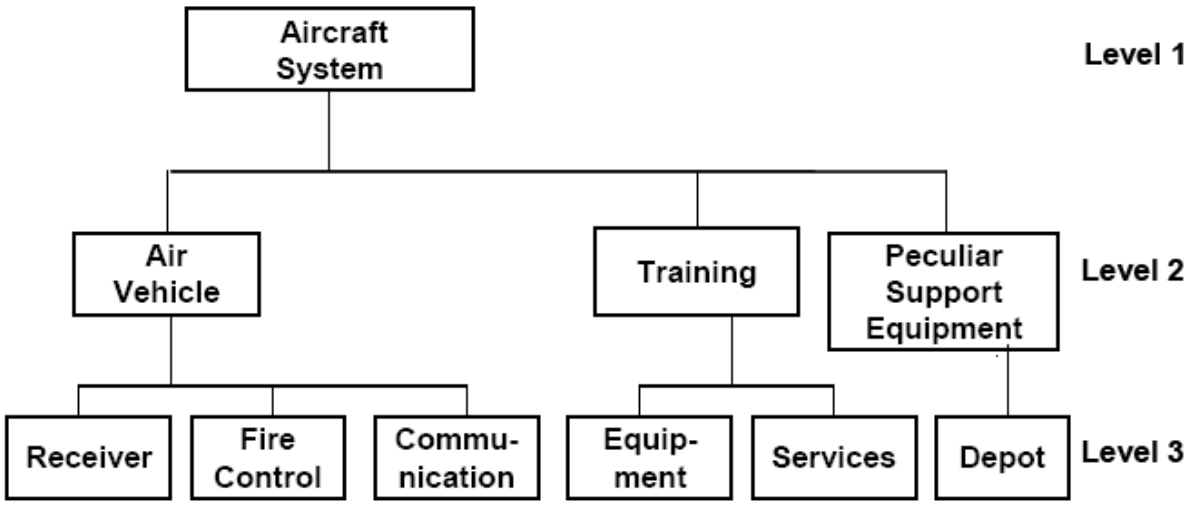
The next process, scope definition, is the process that refines the preliminary scope statement and clearly states what the project will and will not accomplish. The supporting documents are reviewed to ensure the project will satisfy the stated goals and the resulting scope should state the stakeholders' needs and clearly communicate the expectations for the performance of the project.

Many inexperienced project managers move too quickly from the scope statement to the activity sequencing processes. This practice is a mistake and often leads to activity omissions and inaccurate plans. PMI stresses the importance of first creating a work breakdown structure (WBS), and then moving to activity management processes.

The WBS provides the project manager and project team with the opportunity to decompose the high-level scope statement into much smaller, more manageable units of work, called work packages. The resulting WBS should provide a complete list of all work packages required to complete the project (and nothing more).

In creating the WBS, the project team repeatedly decomposes the work of the project into smaller and smaller units of work, resulting in a collection of small work packages. The process continues until the resulting work packages are simple enough to reliably estimate duration and required resources. When you have work packages that are manageable and represent a single work effort, stop the process. Each project is different, so this process results in different levels of detail for each project.

The last main feature of the WBS is that it is organized in a hierarchical fashion. The highest level is the project. Under the project, the milestones that represent project phases, divisions, or main deliverables are listed. Each milestone process or task is then divided into further levels of detail until the lowest level, the work package, is reached.



Example of a product oriented work breakdown structure of an aircraft system.

Project Execution or Production Stage

The most important component in this phase is to ensure project activities are properly executed and controlled. During the execution phase, the planned solution is implemented to solve the problem specified in the project's requirements. In product and system development, a design resulting in a specific set of product requirements is created. This convergence is measured by prototypes, testing, and reviews. As the execution phase progresses, groups across the organization become more deeply involved in planning for the final testing, production, and support. The most common tools or methodologies used in the execution phase are an update of Risk Analysis (discussed in more detail below), in addition to Business Plan and Milestones Reviews.

Once a project moves into the Execution Phase, the project team and the necessary resources to carry out the project should be in place and ready to perform project activities. The Project Plan should have been completed and base lined by this time as well. The project team and specifically the Project Manager's focus now shifts from planning the project efforts to participating in, observing, and analyzing the work being done. A Project Manager's responsibilities do not stop once the planning of the project is done. Because a Project Manager is responsible to internal and external stakeholders, the project team, vendors, executive management, etc. the visibility of the position is intensified. Many of these people will now expect to see and discuss the resulting deliverables that were so meticulously detailed in the Planning Phase. As a Project Manager, keeping yourself from getting "down in the weeds," especially on large projects, will be important during project execution. This will allow the Project Manager to focus their attention on enabling the project plans, processes and managing the expectations of customers and stakeholders.

Particular attention during Project Execution will need to be paid to keeping interested parties up to date with project status, dealing with procurement and contract administration issues, helping manage quality control, and monitoring project risks. While the processes to control many of these elements are discussed within the Project Control Phase it is still important that the Project Manager be mindful of the issues as the project is being performed. Daily interaction and feedback from team members will be vital to project success.

Quality Assurance

Quality Assurance incorporates a process of evaluating overall project performance on a regular basis to provide confidence that the project will satisfy the relevant quality standards. Accordingly, while it is important that each team member be responsible for the quality execution of tasks, a team or individual from Quality Management may be included in the project team and provides an integral role in the execution of quality throughout the project. This team or individual assures that the quality plan is executed as planned. The quality team or individual is a member of the project team, but must also have a reporting chain outside the project to facilitate problem escalation. Problem escalation is the process of moving a problem to a higher management level if sufficient attention is not given by the Project Manager. The independent reporting chain provides a check and balance on the project.

Performance Monitoring

A project manager should implement an execution plan to measure actual performance as compared to planned performance. For example, actual project schedules will need to be reviewed periodically and compared to baseline schedules in order to discern if the project is performing according to plan. If the project is not performing according to baseline, steps will be taken to get the project back on track. The same monitoring and analyzing should take place on budgets, quality, risks, scope, etc.

Provide Project Status

While the Project Manager is responsible for relaying project status to parties outside the project team, the project team is expected to report status to the Project Manager. This includes communicating information on both a formal and informal basis.

The Project Plan Execution Process ensures that planned project activities are carried out in an effective and efficient way while ensuring that measurements against project plans, specifications, and the original project feasibility continue to be collected, analyzed and acted on throughout the project lifecycle. Without a defined project execution process each project team would execute projects using their own best practices, experience, and methods; allowing certain control, tracking and corrective action activities to be missed.

Project plan

It is important to note that project execution relies heavily on the plans developed in the Planning Phase. There is already enough work to do within the Execution Phase of the project, therefore having to reinvent ways of dealing with risk, change requests, training and resource issues, and other such obstacles to progress are impractical and undesirable.

It is also critical during the Execution Phase that the Project Manager supports and monitors the execution of other important project plans such as the Communications Plan, the Risk Mitigation Plan and Procurement Plan via daily interaction with the project team and stakeholders.

Project Manager Responsibilities

The Project Manager's responsibility in the Execution Phase is to provide input into new system requirements for the functions and features that were not planned for in the Planning Phase. In addition, the Project Manager will be responsible for insuring that any external vendors, once contracted to do the work, meet the contractual agreements specified within their contracts. Project Managers will also be responsible for tracking, reviewing, and analyzing the performance of contractors on a project.

This performance reporting will be the basis for any contractual changes that need to be made during the life of the contract. Finally, Project Managers will play an important role in oversight and review of any contract changes that will affect the project.

Risk Mitigation

Risk identification, monitoring and resolution are key tools to successful completion of a project. Quality Assurance is critical to the identification of risks. Part of controlling a project during the Execution Phase is to have an established risk management process. This process is begun as part of Project Planning and is kept current until Project Closeout. The key elements to this process are:

- Creating a central repository for risk information and associated documentation of risk items and resolution strategies
- Summarizing information on a risk form
- Including a risk summary in the regular status meetings
- Providing a consistent and ongoing evaluation of risk items and development of risk strategies:
- Identify the risk
- Evaluate the risk
- Define a resolution

Reporting Status

Status reporting is an integral part of the project management processes. It is the means by which the project team, the stakeholders, and executive management stay informed about the progress and key activities required to successfully complete the project. The purpose of the Status Report, like the status meetings, is to develop a

standard format for the formal exchange of information on the progress of the project. The Status Report should be tailored to the project, but should be the same form for the full team.
Status Reports should be prepared by the project team detailing activities, accomplishments, milestones, identified issues, and problems. Status Reports should follow a standard template so all reports are in the same format.

The Status Report Template should be used to report key information including:

- Current status
- Significant accomplishments for the period
- Scheduled activities
- Issues

Along with the Status Report form, the following may be attached:

- Updated Gantt charts
- Recovery plans for activities not on schedule
- Corrective action plans for expected problems
- Resolution to assigned action items

Project monitoring and controlling systems

The Monitoring and controlling process deals with unplanned events that can occur at any point during the project, this phase includes controlling changes, monitoring the project: anticipating, identifying and controlling risks, and monitoring changes to the organization.
In order to provide stability to the project, project agreements must be recorded, and any changes to agreements must be evaluated for their effects upon other agreements. These agreements should thus be recorded in controlled documentation (Whitten, 1995), and when an agreement is changed, then all other agreements that are based upon that agreement must be reevaluated.

In order to control controlled documents in the project, it is proposed that there be a change control committee (Whitten, 1995), to review changes. The change control committee would include the overall project manager, phase project managers, representatives of workers, users, the data processing group and business policy management, and perhaps a change control administration manager to update schedules and provide unbiased advice on business, technical and administrative decisions. Problems of interest to upper management, such as budget issues, would be escalated up to them for resolution.

When a phase is completed, resulting automated systems should go into maintenance mode. Changes to an automated system agreed upon by the change control committee would be sent to a business group for design and to a maintenance group for implementation in the automated system. The maintenance group is often part or the entire group that did the development of the automated system.

Once a phase is implemented, a help desk should take telephone calls from users of an automated system. The help desk would give advice on the use of the system and report on errors and suggested enhancements to the maintenance group who would go through the change board for review.

For very large projects the project manager monitors the overall project. A phase project manager monitors his or her phase. The phase project manager reports any risks to the overall project manager. Jointly, phase project managers and overall project manager should:

- Identify risks, potential project problems, as early as possible
- Identify when goals may not be met
- Identify when constraints may be violated
- Ensure that contingency plans occur before unrecoverable problems occur
- Provide and receive project status for the phases and total project.

When there is a significant chance that the goals of the project will not be met, this risk should be reported to upper management. Also, when the constraints of the project may be violated, specifically, costs being overrun and schedules significantly slipped, these risks should also be reported.

When there are disagreements between the phase project manager and overall project manager, then resolution will be escalated to the change control committee. Lack of resolution there could escalate to upper management.

Project completion stage

The Project Closeout Phase is the last phase in the project lifecycle. Closeout begins when the user accepts the project deliverables and the project oversight authority concludes that the project has met the goals established. The major focus of project closeout is administrative closure and logistics.

Project closeout includes the following key elements:

- Turn over of project deliverables to operations
- Redistributing resources—staff, facilities, equipment, and automated systems
- Closing out financial accounts
- Completing, collecting, and archiving project records
- Documenting the successes of the project
- Documenting lessons learned

The major activities in the Closeout Phase consist of tasks that are typically administrative and logistical in nature. Initially, the focus is on performing the tasks associated with dispensing and reconciling personnel, property, and funding. When these tasks are finished, the attention of the project manager is focused on documentation of lessons learned and project closure. At some predetermined point, a post Implementation review of the project deliverables is conducted. The primary documents prepared during this phase include the Project Transition Checklist, Project Closeout Report, and Post Implementation Report.

Avoiding the Runaway Project

Runaway projects have been a problem in information systems (IS) for quite some time. In 1988, KPMG found that 35% of their largest clients currently had a runaway project, and in 1991 the percentage of firms increased to 60%. Plus, over 50% of the respondents considered this to be normal (Cringely, 1994) The traditional definition of a runaway is any project that grossly exceeds budget and time targets but yet has failed to produce an acceptable deliverable. Given that each runaway project is a dysfunctional use of organizational resources, it is important for practitioners to be able to identify them early and react appropriately (Rothfeder,1988).

Identifying Runaway Projects

Projects do not suddenly get out of control, there are always early warning signs that indicate a project is in jeopardy. Identifying a runaway project (or one that can potentially become a runaway project) consist of recognizing the early warning signs that precede project failure.

The two most obvious signs of a runaway project are missed deadlines and team members constantly coming back for more money. If these have occurred, the project is probably already out of control.

There are some legitimate reasons (such as a change in the scope of the project) for spending more time and money on a project than what was originally allocated. If rigorous project change control is practiced the schedule or budget "overage" should not be a surprise because they would have already been approved.

The key to knowing to what degree the project is out of control is whether the missed deadlines and requests for more money are anomalies or trends. The Project Manager should have assigned a dollar value to each of the project's deliverables. If the actual dollars spent on a deliverable start to exceed the budget, it should be noted whether this occurrence is an anomaly or a trend.

The project charter and project plan are crucial to the success of an IT project. They should have been in place before the project began. Without them, no one is accountable for the runaway project.

The project charter (also called the Statement of Work or SOW) is the defining document of an IT project. It indicates things such as how the deliverables are defined and who has acceptance authority. The lack of a project charter is a definite sign that a project is (or will become) out of control.

If there is a project plan, people should be doing work according to it. Having team members who are not working on tasks in the project plan is a sign that the project is not being managed properly (The Casey Group, 2003).

Rescuing Runaway Projects

Excessive cost overruns or failure do not have to be the fate of most runaway IT projects, they can be rescued by containing and controlling them. There are a few steps to successfully rescuing a runaway project. By following these steps, an organization will be able to get a runaway IT project back on course.

1. Admit a Problem May Exist

Rescuing a runaway project first requires admitting that there is a problem. Someone must say that the project is in jeopardy, especially if the project is mission critical or if the budget is substantial. The urge to "fix" the problems by spending more money and time must be resisted; an organization cannot spend its way out of a runaway project.

The urge to stay with a runaway project that appears to be near completion must also be resisted because the last

month of work never comes. The project will get "last mile syndrome," which means it takes 95 percent of the project time to finish the last 5 percent.

Admitting there is a problem is a challenge. Some Project Managers and team members do not want to give bad news because they fear repercussions from management. To get people to talk, a penalty-free environment must be created. People must know that the objective is to ascertain the true status of the project, not to punish them. However, people must also know that there will be repercussion if they do not talk during the amnesty period and it is later discovered that they had useful information (The Casey Group, 2003).

2. Pause the Project

Pausing the project is the most difficult step because some people may feel that the project is on the path to failure and want to disassociate from it. If a vendor is involved with the project, it may want to pull its team out. However, by not pausing the project, more hours and costs will be burned without knowing the project's status or if it can even be completed. Pausing the project gives the team an opportunity to regroup and create a new plan.

3. Conduct a Project Audit

The project audit's purpose is to find the root cause for the project getting out of control. The primary reason most projects get out of control is that the project manager is relatively inexperienced and the runaway project was beyond the person's capabilities. In addition, there may not have been a support system in place to help the project manager overcome this lack of relative experience. A deficient project charter is another common reason projects get out of control. Some teams do not have a project charter. This contributes to the project getting out of control because without a project charter, the project is not truly defined.

The Project Audit consists of two audits:

- The Process and Procedure Audit consists of a compliance checklist that is a series of questions in addition to items that should be in place in any project, such as a statement of work (project charter) and project plan.
- The Personnel Capability Audit consists of evaluating two factors. First is the interpersonal dynamics of the team members. The objective is to understand how well the team members are suited to each other. An effective team must have temperaments that complement each other. Second, the team members' technical skills must be evaluated. Team members must have the skills necessary to effectively perform their jobs.

Failure does not have to be the fate of a runaway project. With early recognition and by following governance steps, most runaway projects can be contained and controlled before a company experiences more serious financial consequences of an IT project that has gotten out of control.

Chapter Summary and Review

Now that we have a better understanding of Project Management , let's review how the chapter content maps to our learning objectives for the chapter:

Understand what a project is.

- A project is a temporary endeavor, having a defined beginning and end (usually constrained by date, funding or deliverables), undertaken to meet unique goals and objectives, usually to bring about beneficial change or added value.

Learn the Project management methodology.

- Some methodologies include agile, interactive, incremental and phased approaches, the most common is the traditional which is taught by the Project Management Institute.
- The project triangle, Cost, Time, Scope in surrounding quality.
- Understand the importance of Planning, Execution, Monitoring and closing a project.

Each stage of the traditional approach to project management provides the foundation of a successful project, following this approach gives the project manager the most likelihood to succeed.

- Project initiation stage- The initiation stage is responsible for laying down the scope of the project. This is a very important stage that should not be taken lightly. If the initiation is not done correctly, the chances of the project being successful are very low.
- Project planning or design stage, planning stage defines and refines objectives, and plans the course of action required to attain the objectives and scope that the project was undertaken to address. The major pieces of this are scope management and the Work Breakdown structure.
- Project execution or production stage, most important component in this phase is to ensure project activities are properly executed and controlled. During the execution phase, the planned solution is implemented to solve the problem specified in the project's requirements
- Project monitoring and controlling systems, Monitoring and controlling process deals with unplanned events that can occur at any point during the project, this phase includes controlling changes, monitoring the project: anticipating, identifying and controlling risks, and monitoring changes to the organization
- Project completion stage, Project Closeout Phase is the last phase in the project lifecycle. Closeout begins when the user accepts the project deliverables and the project oversight authority concludes that the project has met the goals established. The major focus of project closeout is administrative closure and logistics
- Identify project roles and stakeholders

- Project manager and supporting team, the phase manager, and the implementation of the change control board are key contributors in a projects success, we also discussed the role of upper management in governing a project.

Understand the runaway project

- Overrun in time, and budget
- Knowing the process of rescuing a runaway project (Admit there's a problem, pausing a project and conducting an audit.

Review Questions

Let's review the chapter content with a few questions regarding the key chapter concepts:

1. Who is a Project Manager and what are their responsibilities?
2. What is the most common approach to Project Management?
3. Who were the founders of Project Management and how long has Project Management been around?
4. What constitutes a runaway project and how can it be rescued?
5. What is the project triangle and its components?
6. Who are the key stakeholders to a project?
7. What is a Work Breakdown Structure?

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Chapter 7: IT Security- Internal Threats

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Introduction

For many years, the ghosts of viruses, Trojan horses, phishing, spam and worms have been the greatest concerns for the IT department and the chief security officers of organizations. However, recent statistics show that the true enemy of the security of an organization comes from within the organization's security walls. According to CompTIA's 7th Annual Trends in Information Security: an Analysis of IT Security and the Workforce study(2009), "the primary cause of many security breaches is unintentional end-user error—often by non-IT staff." The most significant costs of security breaches remain the overall impact on employee productivity according to the study. About one-third of U.S. respondents cite loss productivity as the top consequence of a breach, followed by a disruption of revenue-generating activities.

"The exact amount of money lost to IT security breaches is tough to calculate because of the difficulty in estimating lost productivity," said Tim Herbert, CompTIA VP of Research and author of the study. "But the data suggests security breaches cost US companies in excess of USD$17 billion annually, and most likely significantly more." (CompTIA, 2009).

Studies from other countries show that internal threats are a world-wide problem. According to MacAfee, a survey by the software security software firm, in Europe:

- One in five workers (21%) let family and friends use company laptops and PCs to access the Internet.
- More than half (51%) connect their own devices or gadgets to their work PC.
- A quarter of these do so every day.
- Around 60% admit to storing personal content on their work PC.
- One in ten confessed to downloading content at work they shouldn't.
- Two thirds (62%) admitted they have a very limited knowledge of IT Security.
- More than half (51%) had no idea how to update the anti-virus protection on their company PC.
- Five percent say they have accessed areas of their IT system they shouldn't have (Schneier 2005)
- The McAfee survey also identified four types of employees who put their workplace at risk:
- The Security Softie – This group comprises the vast majority of employees. They have a very limited knowledge of security and put their business at risk through using their work computer at home or letting family members surf the Internet on their work PC.
- The Gadget Geek – Those that come to work armed with a variety of devices/gadgets, all of which get plugged into their PC.
- The Squatter – Those who use the company IT resources in ways they shouldn't (e.g. by storing content or playing games).
- The Saboteur – A very small minority of employees. This group will maliciously hack into areas of the IT system to which they shouldn't have access or infect the network purposely from within. We will talk more about this type of internal threat later in the section. (Schneier 2005)
- There are various forms of internal threats to an organization. However, some of the security attacks that organizations need to pay particular attention to are:
- Phishing Attacks, discussed in the next chapter
- Laptop on the Loose
- Unintentional Access
- Unmanaged Risk of E-Mail and Instant Messaging
- Sabotage by Disgruntled Ex-Employees
- Social Networking Websites

We will discuss each of these threats in more details below.

Laptops on the loose

Leaving a company-issued laptop unattended while going to the rest room or buying snacks will not only cause inconvenience to the laptop owner, but could be costly to a company as well. If the stolen device contains sensitive customer information, the company could very likely face ethical, legal and financial consequences following such a security breach.

Stolen laptops are only one part of the security risk that companies face. Other portable devices such as iPods, Smartphones, external hard drives, and flash memory sticks also present dangers. Not only do these portable removable tools allow intruders to bypass a company's perimeter defenses such as firewalls or IDS, "but they also allow employees to remove proprietary information from a company's premises onto these devices" adds Cindy Waxer, an IT security expert (Waxer 2007).

Statistics below emphasize the severity of data loss to companies and the financial costs associated with it due to the loss of laptops and other portable devices:

From 2005 to 2006, there was an 81% increase in the number of companies reporting stolen laptops containing sensitive information.

- ✓ *2006 Annual Study: The Cost of Data Breach*. Ponemon Institute, LLC, 2007

One in five organizations surveyed by Symantec in 2007 said they had sustained financial losses due to attacks on mobile data platforms.

- ✓ EIU & Symantec's *Internet Security Threat Activity Research*, March 19, 2007

According to a study paper published by Ponemon Institute in 2007, the cost of preventative measures, on average, is four times less than the cost of a data loss.

- ✓ *2006 Annual Study: The Cost of Data Breach*. Ponemon Institute, LLC, 2007

According to an article published by Gartner, Inc., more than 51 percent of all data breach incidents reported in 2005 occurred at higher education institutions. Nearly 18 percent of these incidents were the results of stolen computers, and the personal data for more than 360,000 individuals were obtained by thieves as a result.

- ✓ Gartner, *Stolen Laptops Denote a Growing Data Security Breach for Higher Education*, March 10, 2006

An ordinary notebook holds content valued at 550,000 UK pounds worth nearly USD$972,000, and some could store as much as 5 million UK pounds — or USD$8.8 million — in commercially sensitive data and intellectual property.

- ✓ McAfee and Datamonitor's Data Loss Survey, 2007

To help highlight the risks inherent in removable devices of all types, Richard Stiennon, Chief Research Analyst at IT-Harvest, an independent analyst firm, constructed a list of the Top Ten Breaches by Removable Device(Steinnon, 2009):

Rank	Top Ten Removable Device Breaches
1	Russia's attack on US Military Central Command. The agent for this attack is apparently the USB born worm w32.agent.btz. According to F-Secure the worm is installed from an infected thumb drive and places itself on every drive on a computer including any USB drive that is attached to it.
2	Countrywide's theft of 2 million records. For more than two years, the employee was able to steal up to 20,000 records a time by copying files from the corporate network to a USB flash drive.

3	Indian Spy Incident. A CIA operative "Rosanne Minchew, third secretary in the US embassy in Delhi" reportedly paid $50,000 for a USB device loaded with Indian secret information. Note that the CIA pays considerably more for information than other agencies.
4	New Zealand man buys MP3 player with US military data. ONE News has gained access to the personal files of American soldiers, uncovering military secrets from the most powerful nation in the world.
5	USB Candy Drop. A Security investigator dropped 20 Trojan carrying USB thumb drives in a Credit Union Parking Lot. According to his report "Of the 20 USB drives we planted, 15 were found by employees, and all had been plugged into company computers" within three days.
6	US Military spy incident. A former U.S. military contractor has pleaded guilty to exceeding authorized access to a computer and aggravated identity theft after he was accused of selling names and Social Security numbers of 17,000 military employees, the U.S. Department of Justice said.
7	Apple ships iPods infected with a Windows virus. It turns out that manufacturers of removable media have to ensure antiseptic environments when they pre-load software and data on their devices. Also worth mentioning is Sony's inclusion of hidden files on USB devices that could prove useful to virus and worm writers.
8	Sumitomo Bank Heist. This incident is still the largest attempted bank robbery in history. A PS2 hardware keystroke logger was used to capture information used to attempt SWIFT wire transfers from the London Branch of Sumitomo Mitsui. More details are trickling out from the trial of the some members of the gang this month.
9	UK Prison inmate information loss. "A consultant for PA Consulting copied files containing records on all 84,000 prisoners in England and Wales onto a USB drive, which then got lost."
10	UK Policeman loses memory stick containing terrorist cell information. "The black 4GB stick was lost after being taken out of Castle Vale police station by an officer on patrol. It was reported that the memory stick contains details of terror cells being tracked by police but the force refused to comment." (Stiennon 2009)

Ways to improve

In order to reduce the risks associated with stolen computers and other portable devices Cindy Waxers (2007) suggests that companies should "require employees to protect their laptops with a startup password so that if they are stolen, at least the data is unusable." Companies should "make a practice of deleting old e-mails, text messages, call logs and unwanted files from all portable devices," added Waxer, "and it's always a good idea for employees to take advantage of a device's built-in encryption capabilities and password protection features." According to a recent technology report published in the Journal of Accountancy, there are several ways a company can encrypt both of its internal and external devices, and some software currently in the market can also support full-disk encryption as well as encryption of flash drives (Petravick and Kerr 2009).

Unintentional access

Information theft is beginning to replace viruses and hacking activities as the top security concern for 38 percent of participants surveyed, according to a poll of enterprise IT security chiefs conducted by Vanson Bourne at the second annual Cisco-sponsored survey in 2007. The survey states that “Viruses, the prime concern of 55 percent of respondents in 2006, were cited by just 27 percent as their top fear [in 2007]”(Leyden, 2007).

One of the many ways for sensitive information to be stolen from a company is through unauthorized access by internal employees. This sometimes seemingly innocent activity could endanger the security of mission-critical applications of the company. “Despite today’s sophisticated user provisioning systems,,” pointed out by Cindy Waxer in an article published on the IT Security website, “ many IT administrators are simply too time-strapped to actively update users’ access and privileges”(Waxer 2007).

Nearly one third of the security professionals surveyed by the Cisco-sponsored survey expressed great concerns about unauthorized access to company data by errant employees in 2007. (Leyden 2007)“Forty-three percent of respondents said they were more concerned with internal threats, such as staff passing on confidential information or stealing intellectual property, compared with 33 percent in 2006,” according to the survey(Leyden, 2007).

However, another alarming trend was revealed by the results of the survey. Despite the increased concerns of internal threats by security professionals, getting their views heard at board level continued to be difficult. Only 52 percent of respondents said IT security was a board-level issue at their organizations in 2007, compared to 54 percent in 2006. In addition, a significant 10% had only a reactive approach to security management. "Outside the government or financial sectors,” said King, “the imperative to discuss information security at board level simply is not strong enough." Letden 2007)

Ways to Improve

Various vendors offer several products to help organizations simplify and monitor the user provisioning process. Some notable companies, for example, are Entrust and Courion. While Entrust offers solutions that “automate policy enforcement and delegate administration for user provisioning which helps maintain security levels while managing large numbers of users,” Courion’s AccountCourier offers “automated user provisioning solution that instantly grants, revokes or modifies access to any operating system, application, Web portal, or other IT assets without manual intervention,” according to their company websites, respectively(Waxer, 2005).

The IT department and business units need to communicate more often about any recent human resource changes, and the changes should be reflected in the user’s access rights to the company network in a timely manner.

Unmanaged risk of e-mail and instant messaging

“A lot of the security threats that we’re seeing involve email somewhere along the line,” warns Paul Stamp, a Forrester Research senior analyst. The majority of companies in the U.S. currently lack e-mail retention policies, according to a recent survey. Another alarming fact is that one in five U.S. companies has had employee e-mail subpoenaed in the course of a lawsuit or regulatory investigation, according to the survey. Data leakage is a direct result of unregulated e-mail usage and has caused great concerns for organizations. According to the Ponemon Institute, 69 percent of organizations reported serious data leaks caused by either malicious employee activities or non-malicious employee error in 2006 (Waxer, 2007).

According to Nancy Flynn, the founder and Executive Director of ePolicy Institute, with the establishment of several compliance regulations in recent years, such as HIPAA and Sarbanes-Oxley, workplace lawsuits are on the rise. As covered by applicable regulations, companies must be able to prove that appropriate measures have been taken to retain e-mail and IMs. Failing to do so could result in millions of dollars in fines.

Another risk associated with e-mail for companies is that e-mail could be used in a workplace lawsuit against the company and they have to be constantly on the lookout for potential threats. According to Flynn, “e-mail and instant messages are a primary source of evidence in court cases. They are the electronic equivalent of DNA evidence"(Bowers, 2005). The term "vicarious liability" means that an employer can typically be held responsible for the actions of its employees, and it is often used in court against companies (Bowers, 2005).

The same retention and content policies should apply to instant messaging as well. It causes an enormous security issue for an organization if its employees are using the public Internet to discuss business issues, which could contain sensitive customer information.

The cost of creating and enforcing retention policies is one of the main reasons why a large number of companies in the U.S. lack such policies. However, statistics show that the cost is minimal compared to paying thousands of dollars in settlement fines if a workplace lawsuit is brought upon an organization, along with a loss of credibility and impaired reputation.

Corrective actions

Nancy Flynn created the Three E's of an E-Mail Risk Management system:

- Establish a written policy for e-mail and IM usage, content, and retention. Strict usage policies can prohibit employees from sending sensitive information via insecure e-mail or instant messages.
- Educate your workforce from the summer intern to the CIO. Organize training sessions, using presentation media, and illustrating with examples of real life workplace lawsuits involving e-mail or IM are some of the ways that a company can educate its workforce.
- Enforce your policies. "[U]se discipline – up to and including termination – for anyone who violates the policy," suggests Flynn, along with occasionally monitoring randomly selected users' correspondence with external technology such as Fortiva's product, Fortiva Supervision(Bowers, 2005). Fortiva is a Toronto based company that "specializes in email archiving solutions for legal discovery, regulatory compliance and mailbox management," as described on its official website. Fortiva Supervision serves the customers by giving users the chance to create a supervision process for selecting and reviewing the content of its electronic messages, which would enable an organization to view the contents of an employee's e-mail for a specified period of time.

Organizations can also seek other resources to help with e-mail content scanning tasks. There are various vendors that may charge a fee for the service.

Sabotage by disgruntled ex-employees

- *"On the night of April 27, 2009, just hours after he had resigned from his job as an auditor at the California Water Services Company, Abdirahman Ismail Abdi used his still active electronic key card to get into the secured facilities where he used to work. He then allegedly gained access to computers belonging to two senior executives in two separate buildings at the utility to initiate and confirm three wire transfers to a bank account in Qatar totaling more than USD$9 million. Early the next day, he put his wife and children on a flight to Frankfurt, Germany and then attempted to deposit a check made out to CWSC totaling more than $25,000, which he had apparently stolen, into his bank account in the U.S. On May 1, with federal authorities hot on his trail, Abdi cancelled a reservation he had on a flight out of San Francisco to London, and then over the next few days somehow managed to flee to Canada where he remains at large. The money itself, however, has since been recovered"(Vijayan, 2009).*
- *"[In early May of 2009], Wilbur Fondren, deputy director for the U.S. Pacific Command (PACOM) Washington Liaison Office was charged with conspiracy for selling classified government information to a Chinese agent. Fondren is alleged to have gotten at least some of the information from a classified government computer using his top secret clearances and access"(Vijayan 2009).*
- *"[In August, 2008], Rene Rebollo, a former financial analyst at Countrywide Financial Corp., used his access to corporate databases to steal personal information about customers which he then sold to information brokers" (Vijayan, 2009).*
- *"[In July, 2008], Terry Childs, a former network administrator for the City of San Francisco allegedly locked access to a critical FiberWAN city network for days by resetting administrative passwords to its switches and routers, and then refusing to divulge the new passwords" (Vijayan, 2009).*

Workplace sabotage happens when disgruntled workers purposely "damage or destroy equipment or interfere with the smooth running of a workplace"(Sabotage, 2010). This act can be carried out in a group setting or by the actions of one or a few workers for the purposes of retaliating against the organization in response to personal grievances.

In May 2005, the Carnegie Mellon Software Engineering Institute's CERT Coordination Center released its Insider Threat Study: Computer System Sabotage in Critical Infrastructure Sectors (ITS). As stated in the report, "the study focused on user intent to misuse computer resources to cause harm to the organization"(Insider Threat Study, 2005).

As a result of the ITS report, several red flags and example cases were concluded by the ITS researchers for organizations to watch for:

Sharing account passwords	In one of the incidents, an employee who had privileged access to an application used to maintain clients' Web sites was terminated and his access disabled upon termination. Because department employees occasionally shared their passwords among the team for testing purposes, he was able to log in to the application following termination using his supervisor's username and password, making malicious, embarrassing changes to the clients' Web site content.
Unprotected screensavers	A contractor, who was not escorted when visiting an organization's network operations center, was able to access consoles that were left logged on without password-protected screensavers. With malicious intent, he then deleted system files, a database, and all software from three of the company's servers.
Premise access to terminated employees	An insider with system administrator privileges was terminated from a research project that used a single, stand-alone computer to document the data. Although the employee's access card to the building was disabled immediately, he returned to the office after working hours, where another employee let him into the building believing that the "employee's" access card had malfunctioned. The insider then deleted 18 months of research data on which his office had been working.
Inadequate separation of duties	A programmer was given system administrator access, although system administration was not his responsibility. He used that access to plant a logic bomb on the organization's network that interrupted customer access to the organization's systems.
Noncompliance with two-person rule	When the sole system administrator of an organization was terminated without warning, he initially refused to divulge the system administrator passwords. Prior to leaving the building, he changed the passwords for all user accounts preventing anyone in the organization from logging in to the company's systems. He also changed the IP address of the Web server so no one could access the organization's Web site. Furthermore, after revealing the administrator passwords to the organization two days later, he remotely accessed a backdoor account that he previously created to run a password sniffer on the organization's network, which enabled him to obtain a list of employee passwords.
Absence of procedural and technical controls for system administrators	Management disabled access to a network administrator's computer and remote access accounts after he was reprimanded for behavioral issues. When returning to work the next day, the disgruntled employee gained physical access to a restricted workstation, logged in with a root password, and planted a time bomb that would delete all of the files on three company servers several days later. Two days following recovery, the servers were sabotaged again in the same manner, and recovery consultants discovered a destructive script on three of the company's file servers that was scheduled to run at 3 a.m. every Wednesday. During the investigation, the company learned that the insider had discovered a backdoor on 20 restricted workstations where he could gain root access.

Another recent sabotage case showed the importance of changing passwords and resetting access rights when an employee is terminated. David Ernest Everett Jr., a former employee working on the Eden Prairie, MN-based company's helpdesk for Wand Corporation, was let go in March, 2008. Approximately three weeks following his termination, Everett launched a 'malicious software attack' on the protected computer systems of Wand's clients, and created three malicious files designed to crash computer servers. The attack caused computer servers at 25 fast food restaurants throughout the nation to crash in April of 2008 and cost Wand Corporation an estimated USD4.25

million in damage. According to a news report in Secure Computing Magazine, Wand Corporations based in Arlington, MA, "provides computer systems to fast-food restaurants throughout the country which connect the cash registers in a restaurant to one computer server that stores information such as transaction data, as well as 'back office' information such as the restaurant's payroll, scheduling and inventory"("Ex-employee pleads guilty", 2009).

"People do, of course, leave jobs all the time and most of them would never dream of logging back in to their old place of work to cause mischief," said Graham Cluley, senior technology consultant for Sophos. "But it only takes one disaffected former worker to wreak havoc - so make sure your defenses are in place, and that only authorized users can access your sensitive systems"("Ex-employee pleads guilty", 2009).

Richard Brain, technical director for ProCheckUp located in the United Kingdom, believed that the case with Wand Corporation is only the beginning of a greater threat of internal attacks in the years ahead, as the world continues to experience an economic recession and more employees are being made redundant and terminated. Brian claims, "The risk of sabotage from disgruntled employees is even greater in 2009" (Raywood, 2009).

Ways to Improve

The following strategies or best practices were selected based on the findings in the ITS report mentioned above and by experts in the information security field. These proactive strategies for information security and human resources can easily be implemented by all levels of company personnel to mitigate insider threats:

Monitoring to ensure system access is disabled timely and completely following an employee termination.
Establishing formal grievance procedures as an outlet for insider complaints.
Creating a reporting process when a colleague notices or suspects concerning behavior.
Enforcing comprehensive password policies and computer account management practices.
Using configuration management practices to detect logic bombs and malicious code.
Monitoring system log activity.
Establishing and monitoring procedural and technical controls for system administrator and privileged system functions.
Providing layered security for remote access.
Monitoring compliance with backup procedures and testing recovery processes.
Ensuring procedures are in place to disable temporary employee and contractor access as thoroughly as that of permanent employees.
Informing employees of recently terminated workers, and ensuring passwords should be changed if current employees had shared their passwords with these terminated employees.

Creating a termination checklist to ensure procedures are in place and are followed to terminate physical access to the facility, as well as notify the guard station or reception area of the employee's termination or resignation.
Increasing risk and control awareness by employees, supervisors, and internal auditors to help deter insider threat incidences.
Conducting thorough background checks on new staff members, and performing more frequent in depth vetting procedures and reviews on staff members with high level or administrative network privileges. (Internal Security Threat 2009)

As suggested by Richard Brain, technical director for ProCheckUp, “Procedures have to be in place between human resources and IT management to communicate any changes in staff roles, to ensure that all appropriate permissions and access are revoked and known administrative passwords altered. At the same time, procedures to deal with the ex-staff member workstations and email backup and hand over to other staff members need to be followed”(Raywood, 2009).

Social networking websites

Social networking sites add to the list of insider threats as well, according to the recent global security survey by Deloitte in 2009. (Losing Ground, 2009) As reflected in the year’s survey, the greatest security threats for Technology, Media and Telecommunications (TMT) industry remain internal. Among other internal threats to organizations’ security, social networking sites, such as Facebook, LinkedIn, MySpace, Twitter and others have caused great concerns for the Chief Information Officer (CIO) or the Chief Security Officer (CSO) around the globe. Although these networks can be used by organizations in such ways that could help companies advertise their businesses, recruit new employees, improve brand recognition and reputation, get connected with the right resources, and teamed up with potential business partners. However, more often than not, what emerges with new technologies to embrace creativity and productivity are new vulnerabilities. The result of this year’s Deloitte survey indicates that 83 percent and 80 percent of respondents surveyed regard the “exploitation of vulnerabilities in Web 2.0 technologies” and “social engineering” as a threat to the company’s information security, respectively (Losing Ground, 2009)

Summary

Writing in ConnectITNews in 2009, Liam Lehey notes that “A recent survey from SailPoint Technologies Inc. reveals a disconnect between regulatory compliance and proactive risk management, the company says. Conducted in April 2009, the survey focused on how companies are approaching identity governance during the economic downturn, with a particular focus on insider threats. While 86 percent of the total respondents are concerned about insider threats, they cannot adequately manage the risk of data breaches because the majority of them can't summarize which workers have access to the most critical applications and data. The average company surveyed had 30,000 or more employees -- effectively Global 2000 companies.

The survey didn't ask why security measures were inadequate, said Jackie Gilbert, SailPoint's co-founder and vice president of marketing, but she added that medium-to-large companies are battling the complexity of managing user access controls for tens of thousands of employees across hundreds applications, is not an easy task”. (ConnectITNews 2009)

"The business risk from insider access that is inappropriate or misused is very real and can create serious operation impacts," said Brian Cleary, vice president of products at security vendor Aveksa, Inc., a private company that provides enterprise access governance solutions based in Waltham, MA. "This problem is very pervasive within organizations as they don't have the visibility and control over user access." However, according to John Pescatore, an analyst with Gartner Inc., “one big challenge companies face with insider threats is achieving the right balance of controls.” “Any security approach that falsely blocks legitimate user action will quickly be turned off," said Pescatore.(Vijayan 2009)

The IS security industry is well aware that a 100 percent secure network does not exist, but there are several ways for an organization to effectively protect its security perimeter from internal threats. Below is a summary of some of the measures an organization should take into account when it considers to strengthen its IS security.

Security begins with a formal policy to be followed and enforced strictly. Otherwise, that piece of paper won't stop a single attempt to destroy your network or steal its data. Develop, publish, strictly apply a security policy, limit and direct your users' activities, and monitor the network constantly and consistently.
Secure your intranet using the same reasoning and logic that you use to secure your external network Treat all connections, both internal and external, as potentially hostile.
Document your internal structure, and institute a consistent system for assigning access rights to all data resources. Obtain management approval for restricting users' access.
Develop a communications link between the IT and HR departments. Monitor outbound employees, and act immediately to disable their system access. As employees leave or are suspended, terminate their access.
Remove the “Everyone Group” from all network shares; there's no reason for everyone to be able to access everything. Apply “Group Access” lists to all shared directories, using the least permissions model. Create and manage group security permissions on a need-to-know basis.
Identify inactive user IDs, and find orphaned system accounts. Disable both, and mark them for deletion.
Maintain a list of all system accounts and service passwords. You should change system accounts/service passwords whenever someone with access to that password leaves, every 180 days, or after any network security breach.
Verify that all users with elevated privileges use and maintain a normal user account with which to browse the Web and read their e-mail. Viruses initiated with Administrative privileges are much more disastrous than those unleashed from a normal user account.
Institute a password policy that's stringent but not self-defeating. Policies should not force users to write down their passwords.
Password policies should include a provision for disabling the accounts of users who share passwords or compromise their passwords by leaving them written in a public place, such us on a sticky note posted above or under the employee’s working station.
Make sure users change their passwords every 180 days at a maximum; every 90 days is better.
Increasing risk and control awareness by employees, supervisors, and internal auditors to help deter insider threat incidences.

Risk assessment

According to the Handbook of Industrial Engineering by Gavriel Salvendy, a risk is the threat that “an event, action, or non-action could adversely affect an organization’s ability to achieve its business objectives and execute its strategies successfully”(1992, p. 45). In accounting terms, a risk equals to the question “what can go wrong,” which includes adverse impact on the business or lost opportunities.

New Systems and Old As described in the Global Text Information Systems book, “In an effort to speed delivery and reduce costs associated with the delivery of information services, many organizations short-change the planning and design phases of their information system projects. However, the consequences of adopting such a strategy often result in the delivery of services that do not adequately meet organizational requirements and may well end up increasing lifecycle system costs. The organization certainly leaves itself open to future problems if

requirements for information confidentiality, integrity and availability are specified for the original system design. IT professionals widely recognize that it is much more effective to design security and reliability directly into their systems from the outset than to try and add such capabilities after-the-fact. Consequently, the conduct of a risk assessment is essential in the planning of any major new information system or upgrade of existing capabilities"(Watson, 2007, p.274).

"A risk assessment essentially consists of:

- Clearly identifying organizational information assets, the data and information systems on which the organization depends
- Understanding vulnerabilities, the susceptibility of the asset to breakdown or malicious attack, associated with identified assets
- Identifying threats, objects, person or incidents capable of exploiting identified vulnerabilities.

"An analysis system risk, that is, the probability of threats being realized, is performed to determine the probabilities of loss. Based on expected losses, the organization is better able to determine which countermeasures or controls are appropriate to its needs.

"During the planning stage, organizations need to estimate the consequences of service failure, including how the consequences vary as a function of the duration of service failure, and the various threats capable of exploiting identified vulnerabilities. The participation of organizational management is critical to this process because they should best able to evaluate the consequences of system failure and determine the level of investment warranted to minimize adverse consequences. IT and security specialists can be expected to also play an important role by helping organizational managers to understand vulnerabilities, threats, and even probabilities associated with various threats.

"In short, effective IT planning should incorporate a rigorous assessment of threats and the inclusion of appropriate safeguards and countermeasures within the overall design of proposed information systems"(Watson, 2007, p.275)

Risk Concepts and Terminology Guidance: (Source: AICPA SAS 104-111 2007)

Types of Risks	**Definitions**
Inherent Risk	The susceptibility of an assertion (e.g., account balance or class of transactions) to a material misstatement, assuming that there were no related controls.
Detection Risk	The risk that we will not detect a material misstatement that exists in an assertion (e.g., account balance or class of transactions).
Financial Statement Risk	The risk that the client's financial statements, prior to the performance of any audit procedures, will be materially misstated.
Audit Risk	The risk that we may unknowingly fall to appropriately modify our opinion on financial statements that are materially misstated.
Business Risk	The potential for events, actions, or inactions to result in the client's failure to meet its key business objectives, or its failure to define business objectives that are responsive to its key stakeholders.
Control Risk	The risk that a material misstatement that could occur in an assertion (e.g., account balance or class of transactions) will not be prevented or detected and corrected in a timely manner by the client's internal control system.

Strategic Risk	The risk affecting achievement of the strategic objectives of the company (governance, strategic planning, major initiatives, etc.)
Financial Risk	The risk affecting the financial processes of the company (accounting and reporting, tax, capital structure, etc.)
Operational Risk	The risk affecting the operations of the company (sales and marketing, supply chain, HR, etc.)
Compliance Risk	The risk affecting the company's compliance with regulatory requirements.
Residual Risk	The risk that is not mitigated by current operating controls.

Risks are assessed on an inherent basis at the entity level of the organization, and it consists of two elements: impact and likelihood, which determine the overall risk ratings. Impact is the extent to which the risk, if realized, would affect the company, while the likelihood is the probability of a risk occurring over a predefined time period. The overall assessment of a risk is determined with reference to the risk assessment criteria (RAC), which does the following:

- Defines the likelihood and impact ratings;
- Maps the likelihood and impact ratings to determine the overall risk ratings; and
- Is used to consistently evaluate risks and help guide the prioritization and focus of activities.

Some examples of likelihood rating definitions are listed below:

Degree of Likelihood	Definitions	Description
Rare	Infrequently occurring	• Not likely to occur in the next few years
Unlikely	Has little chance of occurring	• Risk has less than a 25 percent chance of occurring • Could occur within three years
Possible	Capable of occurring	• Risk has a 25 to 49 percent chance of occurring • Could occur within two years
Likely	With considerable certainty	• Risk has a 50 to 75 percent chance of occurring • Could occur within the next year
Almost Certain	Slightly short of certainty	• Risk has a greater than 75 percent chance of occurring • Could occur within the next six months

Risk mitigation

As explained in Chapter 15 of Global Text Project's Information Systems book, "Risk Mitigation refers to the actions designed to counter identified threats. These actions are also referred to as controls and as with information system threats, there are numerous frameworks for categorizing the various controls intended to avoid system

failure or compromise. A framework that we have found to be both comprehensive and comprehensible divides mitigation controls into three broad categories:

- Management controls: managerial processes which identify organizational requirements for system confidentiality, integrity and availability and establish the various management controls intended to ensure that those requirements are satisfied.
- Operational controls: include day-to-day processes more directly associated with the actual delivery of the information services.
- Technical controls: technical capabilities incorporated into the IT infrastructure specifically to support increased confidentiality, integrity and availability of information services.

The remaining sections of this chapter present a general overview of managerial, operational controls and a subset of technical controls"(Watson, 2007, p.272).

Mitigating risks with management controls

As defined in Wikipedia, management controls are "systematic efforts by business management to compare performance to predetermined standards, plans, or objectives in order to determine whether performance is in line with these standards and presumably in order to take any remedial action required to see that human and other corporate resources are being used in the most effective and efficient way possible in achieving corporate objectives"(Control (management), 2010). As stated in Information Systems, "These controls include management activities related establishment of information system requirements, and control processes intended to ensure that those requirements are met. Critical information assurance management controls include:

- Creation of policies, procedures, standards and training requirements directly relating to the improvement of information system confidentiality, integrity and availability.
- Performance of risk analyses to evaluate risk potential of new information systems and re-evaluate risks associated with existing business applications and IT infrastructure.
- Management of information system change"(Watson, 2007, p.272).

Information assurance policies, procedures, standards and education

As stated above, "the overall objective of an information assurance program is to protect the confidentiality, integrity and availability of organizational information and IT-enabled services. Fundamental to the establishment of an effective information assurance program is the organization's establishment of appropriate information assurance policies, procedures and standards"(Watson, 2007, p.272).

According to Wikipedia, a policy is "typically described as a deliberate plan of action to guide decisions and achieve rational outcome(s). However, the term may also be used to denote what is actually done, even though it is unplanned"(Policy, 2010). Policies are high-level statements communicating an organization's goals, objectives, and the general means for their accomplishment. According to the IS book, "the creation of information assurance policies may be driven by the need to comply with laws and regulations or simply reflect executive management's analysis of the organization's information assurance requirements. There can actually be a hierarchy of policies with each lower layer providing increasing degrees of specificity, but still recognizable as policies by their focus on 'know what' content rather than 'know how.'. Policies might be used to identify information assets meriting special safeguards, delineating information related roles and responsibilities, specifying the establishment and performance of information assurance related tasks or processes" (Watson, 2007, p.272).

"Because policies have a tendency of being formulated in general terms, organizations will generally develop procedures and standards that more specifically elaborate what needs to be done" (Watson, 2007, p.272). "Standards can be thought of as a specific class of policies." For example, a policy might dictate that servers containing confidential information reside behind a network firewall, while a standard might specify the type of firewall to be used and the specific configuration of the firewall. Standards could be mandatory rules, technical choices, or a hybrid combination of the two, which usually all reside in a single policy document(Watson, 2007, p273).

Procedures are often created by organizations to "spell out the specific activities or steps required to conform to designated policies and procedures," as stated in the book. "The important point to understand is that the formulation of policies, procedures and standards constitute important elements of an organization's information assurance program and an organization's ability to avoid system failures"(Watson, 2007, p.273).

There are extensive guidelines concerning the development of effective policies, procedures and standards available for use. Below is a list of criteria selected by the authors of the IS book for creating good and effective policies.

Support of upper management. One can hardly imagine a factor more likely to undermine policy compliance within an organization than the realization that upper levels of management do not care about the policy, are unwilling to provide resources required to implement the policies or have no intention of conforming to the policies in their own behavior.

Clear, concise and well written. Every attempt must be made to reduce ambiguity by selecting appropriate language, identifying a clear scope to which the policy applies and ensuring the policies are consistent with other organizational policies and practices. Organizational members cannot comply with policies if they cannot understand them and ambiguity may encourage the development of undesirable policy interpretations.

Clearly delineate responsibilities and identify the resources required to support their implementation. If one commonly hears the phrases, "it's not my job" or "I don't have the resources" with respect to policy compliance, problems with compliance likely exist.

Living documents. It seems that the only constant in today's world is change. Policies can quickly become outdated. Out-of-date policies lead to two problems. First, the policies gradually become inadequate as organizational requirements change over time and as well as due to changes in the types of risks present in the organization's environment. Second, as policies become increasingly inaccurate and irrelevant to the organization's needs, there is a natural tendency for the policies to be ignored.

Specify enforcement provisions and a process for handling policy exceptions. If there are no adverse consequences associated with policy non-compliance, then compliance will likely suffer. As it is difficult if not impossible to anticipate every contingency in the formulation of policies, long term compliance will be enhanced by specifically including provisions for requesting policy exceptions.

The importance of education and training in establishing effective policy compliance. The effectiveness of policies, procedures and standards are seriously undermined if organizational users are able to claim ignorance of their existence. This is particularly true with respect to compliance with specific standards and procedures. Education and training requirements will vary depending on the job responsibilities. Employees who deal with confidential information may require guidance concerning legitimate use of the information. IT professionals may require specialized training in order properly configure and employ technology used to increase reliability and security of information services. In short, the establishment of a comprehensive information assurance training program constitutes a critical a critical management risk mitigation control.

Managing change and system configurations

According to a widely cited Gartner research report published on small and midsized businesses concluded that "80 percent of mission-critical application service downtime is directly caused by people or processes failures. The other 20 percent is caused by technology failure, environmental failure or a disaster." Often these failures, as pointed out in the IS book, “resulted from the modification of software, loading a software patches to fix a security flaw or add some new functionality or the mis-configuration of critical servers or network devices.” “Change management processes are intended to ensure that system changes are properly authorized, prioritized and tested, and that all interested parties are informed regarding proposed changes. Element of an effective change management process include:

- Selection of the appropriate and qualified staff to participate on the change management team.
- Establishment of formal change request and tracking system.
- Regular scheduling of change management team meetings.
- A formal means of ensuring that approved changes, including their implementation schedules) are communicated relevant stakeholders.
- A formal means, such as regularly scheduled system audits, to ensure that change management practices are being followed.”

Organizations must assess the consequences of particular system failures to determine the level of investment in change management that is warranted for a particular system. Even though highly formalized procedures can

pose an unacceptable financial burden on smaller organizations, the benefits from managing changes will likely outweigh the costs.

One other important terminology closely relates to change management is configuration management, and the terms are sometimes used interchangeably. According to Wikipedia, the definition of configuration management (CM) for information assurance is "the management of security features and assurances through control of changes made to hardware, software, firmware, documentation, test, test fixtures, and test documentation throughout the life cycle of an information system"(Configuration management, 2010). As explained in the IS book, "properly conceived and implemented, a configuration management database (CMDB) will include information documenting movement, maintenance, and problems experienced with various configuration items. Configuration items, those elements under configuration management and recorded in the CMDB, can include policies and procedures, human resources in addition to the hardware and software one would typically expect to find in an asset inventory database. Configuration management provides a necessary foundation for an effective change management process and as we shall see below contributes to the effectiveness of multiple service, infrastructure and security management processes"(Watson, 2007, p.276).

Mitigating risks with operational controls

The true distinction between management and operational controls is often hard to define. "The easiest way to think about it is that management control functions are performed by managers, and operational controls are performed by operators"(Watson, 2007, p.276). "The three operational controls commonly associated with maintaining system availability as concluded in the book are:

- System monitoring and incident response;
- Performing system backups;
- Planning for disaster recovery" (Watson, 2007, p.276).

These operations controls are described in the Disasters, Contingency Planning Process section in the IS book chapter referred to previously.

Mitigating risks with technical controls

The final set of controls associated with the avoidance of systems failures is related to technology. "That is, organizations often make additional investments in their IT infrastructure with the explicit goal of avoiding or at least minimizing the consequences of information system failure.

There are numerous technical controls associated with information security." These include:

- Redundant critical components (equipment, communications, etc.)
- Power conditioning and backup power
- System backup capabilities
- Network and system monitoring tools

These technical controls are described in the Disasters, Contingency Planning Process section in the IS book chapter referred to previously.

Others

Some other ways for companies to mitigate risks are improving their internal controls in regards to security, having better segregation of duties, and conducting a self-assessment survey.

According to Indiana University's Internal Controls website, internal controls are "the methods employed to an organization to help ensure the achievement of an objective"(Internal Controls).

Separation of duties (SoD) is the "concept of having more than one person required to complete a task"(Separation of duties, 2010). Below is a list of some examples of having better segregation of duties within an organization:

Accounting Department Titles	Definition	Segregation of Duties
Accounts Payable	An account that contains money that a customer owes to the suppliers.	Processing of accounts payable invoices and updates to vendor master files should be separated. Check preparation and posting to vendor accounts should be separated. Check preparation and mailing of signed checks should be separated.
Cash Receipts	A printed document that is logged by a business when cash is received for goods or services provided.	Receiving cash should be separated from posting to customer accounts. Issuing receipts should be separated from deposit preparation.
Accounts Receivable	A series of accounting transactions dealing with the billing of customers for the goods and services provided.	Processing of accounts receivable invoices should be separated from posting to the sub-ledger. Posting to the accounts receivable sub-ledger should be separated from cash receipts.
Inventory	A list of goods and materials held available in stock by a business.	Receipt of inventory should be separated from issuing materials. Recording of inventory accounts should be separated from ordering materials. Identification of obsolete and surplus materials should be separated from the sale and disposal of such materials.

A self-assessment survey can “produce a useful evaluation of entity-wide controls and make it likely that control environment weaknesses will be identified”(Roth, 2004).. A useful self-assessment survey includes the following:

Ask for the level of agreement with statements.
Ask for specifics.
Eliminate the fear of retribution.
Make it an “upward evaluation.”
Use skilled, independent evaluators.
Use unambiguous questions and provide clear instructions for completing the survey.

Use the results to make improvements.
Keep it short and simple.
Enhance an existing survey.
Balance confidentiality with the ability to follow up on issues.

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Review Questions:

Internal Controls:

1) encompass virtually everything that keeps the organization on course toward accomplishing its objectives
2) maximize the probability of success and decrease the probability of loss
3) provide reasonable assurance regarding the achievement of objectives
4) should be cost justified so that there is a balance between the cost and the benefits derived
5) all of the above
6) none of the above

(Answer: 5)

When assessing risk, an organization will usually choose to:

1) ignore the risk
2) accept the risk
3) eliminate the risk
4) manage the risk
5) all of the above, depending on the circumstances

(Answer: 5)

Which of the following accountability and control red flags is a factor in most of the fraud cases experienced by corporations?

1) Lax management style
2) Poor system design
3) Inadequate internal control training
4) Lack of segregation of duties
5) Lack of physical security over assets

(Answer: 4)

Which of the following would be considered a detective versus preventative control?

1) Reconciliations
2) Policies and procedures
3) Separation of duties
4) Physical security over Assets
5) Reviewing exception reports
5) 2 and 3
6) 1 and 5

(Answer: 6)

Chapter 8: IT Security - External Threats

Learning Objectives

- Understand threats posed by external attacks on information systems
- Obtain and of overview of the serious threats malware, botnets and cybercrime pose
- Understand the of types of attacks System Administrators can expect on their systems
- Appreciate government actions to make the Internet a more secure place to conduct business
- Understand 11 key infrastructure points the US Government has identified as "vulnerable to Cyber Terror"
- Identify action steps to decrease the likelihood of external intrusion to your Information Systems

Introduction

"This is not a war we will ever see an end to."
on securing information systems
Jim Routh, Chief Information Security officer, The depository Trust and Clearing Corp in New York
(Anthes, 2009)

The discussion of threats to organizational Information Systems now moves to external breaches and the intentions of those who wish to find and exploit flaws in business Information security.

The Internet was not built with security in mind. It's foundation is simply interoperability and efficiency. In this vast interconnected system it does not take much for free riders, pranksters, and outright criminals to wreak havoc or attempt to make large amounts of money using other people's information resources. (Cyberspace, 2009)

Security systems and policy are only as good as those who know how to use them. Thus, CIOs are realizing the financial importance of raising awareness of IS security throughout the entire business. It is not enough to rely on software or automated systems to prevent external intrusions. For every firewall built there is an army of malicious computer users eager to see what they can (and cannot) do - and the new attackers are not afraid to use any means they can find to gain access to private information.

Between January '08 and January '09 RSA, the security division of EMC, detected 130,000 phishing attacks against over 200 major brands and financial institutions. This RSA trend analysis shows that the US and Europe are predominately on the receiving end of the attacks. The attackers are suspected to be mainly located in China and the former Soviet Union but tracking cyber criminals is difficult. (RSA, 2009). Phishing is covered in more detail below, in the Pretexting/Social Engineering section of this chapter.

According to Wikipedia, "malware, short for *malicious software*, is software designed to infiltrate or damage a computer system without the owner's informed consent. The expression is a general term used by computer professionals to mean a variety of forms of hostile, intrusive, or annoying software or program code" (Wikipedia 2009a).

Estimates of the financial effects of malware differ widely. Computer Economics attempted to quantify the worldwide costs of damages caused by malware. The survey of 52 information technology professionals and managers estimated the direct worldwide damage due to malware to be USD$ 13.2 billion in 2006. This was a decline from the figures of USD$ 14.2 billion in 2005, and USD$ 17.5 billion in 2004 (Computer Economics, 2007). The decline is believed to be due to improving anti-malware software implementation and a shift in the motivations of malware authors from causing destruction to gaining financially from their handiwork.

Networked computers with exposed vulnerabilities can be disrupted or taken over by an attacker. Computer criminals routinely scan the Internet looking for computer systems that have known vulnerabilities and have not yet been "patched" or configured correctly. Even computers with up-to-date software patches are vulnerable to attacks known as "zero-day-exploits" - a vulnerability that the hardware or software manufacturer is not yet aware

of (CRS, 2003). These vulnerabilities result in a large part to poor security practices and procedures, inadequate training in computer security and poor quality in software products (SANS, 2008). Like the Internet, Information Security is in it's infancy. It is currently analogous to an escalating arms race between the good guys and the bad guys with both sides building bigger and better mousetraps to thwart one another (Markoff, 2009)

Businesses have long balked at increasing spending on Information Security since it is difficult to quantify a return-on-investment. But is becoming increasingly clear that businesses can't afford not to treat the threat as the serious threat to business that it is.

Know your enemy

"Should we fear hackers? Intention is at the heart of this discussion."
Kevin Mitnick

In popular culture right now there are two common names for people involved in unauthorized computer breaches: hackers and crackers. The media tends to use them interchangeably (if the term "cracker" is used at all) but experienced computer users tend to place them in two very different camps. Hacker is a term used to mean "a clever programmer" but it has also come to mean "someone who tries to break into computer systems." The term derives from "good hack" or a clever solution to a programming problem - "hacking" being the actual act of doing it.

Eric Raymond, compiler of The New Hacker's Dictionary, lists five possible characteristics that qualify one as a hacker:

- someone who enjoys learning details of a programming language or system
- someone who enjoys actually doing the programming rather than just theorizing about it
- someone capable of appreciating someone else's hacking
- someone who picks up programming quickly
- someone who is an expert at a particular programming language or system, as in "Unix hacker"

A Cracker, while sometimes having those attributes, is defined as someone who breaks into someone else's computer system, often on a network; bypasses passwords or licenses in computer programs; or in other ways intentionally breaches computer security. A cracker can be doing this for profit, maliciously, for some altruistic purpose or cause. Or they can be doing it just because the challenge is there.

Crackers have been derided and dismissed by their Hacker counterparts over the years as not being as knowledgeable about computer systems and languages as the Hacker community has tended to be. The Hacker community generally chided the Cracker community as petty thieves who were more interested in procuring copyright-protected software, music, games and movies or used software tools they did not understand for malicious purposes. Whatever intellectual threshold there may have once been that prevented those who didn't know what they were doing from doing bad things online has collapsed with the increasing monetary incentive available for those with loose morals. Cybercrime kits available off-the-digital-shelf can kick start a budding young criminal with a laptop, $1,000 and time on their hands (Sachs, 2007).

Blurring the line further in the hacker/cracker separation is the need for "White Hat" hackers with "Black Hat" skills. The good guys need to know how the bad guys operate to try and keep the bad guys out. The US government's urgent push into cyber security and plugging cyber holes has created a demand for computer skills that only a few years ago would have been snapped up by Silicon Valley.
(Markoff, 2009)

The global recession of 2009 and an increased sense of urgency in cyber crime and cyber war prevention measures has given rise to “hacker soldiers” who use their skills to help governments prepare for new threats from the digital domain. They describe themselves as “hackers with security clearances”. (See Cyber War section below).

Fraud as a Service

Groups of Crackers have evolved and organized to an extent in the last several years into hired guns on the Internet. They will hire their services to perform malicious acts and advertise their expertise overtly around the Internet.

A new trend noted by the RSA is cracker specialization and the offering of "Fraud as a Service." The division of labor crackers have broken into are:

- Creating Trojan horses and Phishing kits
- Building and directing BotNets and Fast Flux networks
- "Cashing Out" - cracker slang for monetizing or finishing the particular area they are exploiting (this could

be cleaning out financial accounts, stealing data for future use or to hold for ransom, using human money mules for money laundering, or sale of stolen credit cards or other account data.)

Jason King, CEO of security software firm Lavasoft, says that since much of the cracker landscape is profit-driven, criminals use business and software development models to maximize return on investment. "As time goes on, this level of sophistication will drive innovation and competition among competing 'malware businesses.' As the levels of sophistication increase, the malware landscape will become increasingly intractable. With that said, the anti-malware industry will also continue to innovate to combat these threats."

King does point out that a plus for consumers is that as these criminal organizations proliferate, they have become more visible and begun to attract attention from law enforcement agencies and governmental regulators.

Financial incentives for crackers to use malware

During the past two decades, the production and dissemination of malware has grown into a multibillion dollar business. Damages created by fraudulent and criminal activities using malware and the costs of preventative measures are expected to exceed that number in the coming years.

Activities associated with spam and malware generate various revenue streams. Fraudulent and possibly criminal revenues include the renting out of botnets, bullet-proof hosting services, commissions on spam-induced sales, and stock price manipulation schemes. Making it difficult to fight, spam and malware provide legal business opportunities which muddies the waters of who is engaging in illegal practices and who is running a legitimate, if annoying, business. Coherent responses to the problem are complicated.

A diverse cast of actors with widely differing motives populate the malware economy. The main groups identified to date are:

- innovators seeking to find security problems to improve the working of information system
- amateurs seeking fame and notoriety without malicious intent
- copy cats who usually only replicate simple attacks but often with malicious goals
- insiders, usually employees with experience at a particular work place, that breach security
- a range of actors in the realm of organized crime

During the past few years, the generation, distribution, and use of malware has increasingly become organized as illegal business activities.

Participants in the malware economy will continue their activities as long as the benefits of semi-legal and illegal activities outweigh the costs, including the expected costs of getting caught. Fear of legal retribution is not very high at this point in time (Bauer, 2008)

Some malware variants carry a guarantee by the seller to remain undetectable by anti-malware software. Certain versions may include “service level agreements” by which a seller promises to provide a newer undetectable version in case of detection (Bauer, 2008).

The crackers “cashing out” have been observed selling people's identities for as low as $5. This is appropriated information containing a person’s name and address, a passport or driver’s license scan, credit card numbers and bank account details. Identities may be sold sorted by country, industry, role, and credit cards sorted by remaining balance. Credit card numbers will sell for 2-5 percent of the remaining credit balance on the cards (Schipka, 2007).

Trojan Horses and Droppers

"NASA has confirmed that laptops carried to the ISS in July were infected with a virus known as Gammima.AG."
(BBC News 2008)

Cyber criminals use the overwhelming numbers found on the Internet to their advantage in putting forth their malicious intentions. By automating and distributing their malware in a wide net they put the odds in their favor of finding the one-in-a-thousand, or million, weak spots that they can exploit – be it firewalled data or the single person to click on a virus laden Spam message.

The malicious software tool of choice tends to be surreptitiously placed software on unsuspecting private computers or “Trojan Horses.” A "Trojan" or is any programs that installs itself secretly. Once installed, the trojan's controller has the ability to take control of the infected PC and steal information or destroy the system. Trojans are most commonly distributed as unsolicited email attachments, or bundled with freeware and shareware programs. There is also a rising trend in Trojans being set up to look like a video player but instead will download and install itself from video played when it is clicked on. (See Case Sudy - “Meet Zlob” at the end of this chapter).

A "Worm" is a form of trojan that secures itself in a compromised machine and immediately scans for unsecured

holes in other Internet-facing machines to exploit and self-replicate into the new hosts. Many worms repeat this process until they are noticed.

Trojan horse payloads are almost always designed to cause harm. They are classified based on how they breach and damage systems. The six main types of Trojan horse payloads are:

- Remote Access
- Data Destruction
- Downloader/dropper - part of a program which is designed to install malware on the targeted computer.
- Server Trojan (Proxy, FTP , IRC, Email, HTTP/HTTPS, etc.)
- Disable security software – so called "Back Door" access
- Distributed Denial of service attack (DDOS)

The entire Cracker toolkit - from Remote Access Tools, key loggers, to spoofing tools - are accessible online. System administrators should investigate what is out there and how they are used. Having an understanding of what is out there and how a Cracker may use the tools will give an IT specialist a better understanding of how a system can be configured to minimize external breaches.
(Appendix B, 5 cracker tools to explore)

The proliferation of malware has gotten to the point where consumers are being warned that factory sealed hardware could contain trojans. In 2009 security software developer Kaspersky Labs discovered 3 pieces of malware on an out-of the box Windows XP netbook. The malware was traced back to the factory where an infected thumb drive was being used in the manufacturing process to load drivers onto the netbooks. Installed along with the worm was a rootkit and a password logger that harvested log-ins for online games such as World of Warcraft (Keizer, 2009).

Vint Cerf, one of the original developers of the Internet, estimated in 2007 that 1 in 4 Internet facing computers had been infected by some form of malware and could effectively be considered compromised. (At that time the number of Internet enabled computers worldwide was estimated at 600 million. That number has since doubled to an estimated 1.2 billion.) (F-Secure, 2009). Another estimate made by Panda Security in 2008, is that 30 percent of computers on the Internet were infected and posed latent threats. About half of these machines were active.

For this reason US government agencies, especially military or information gathering entities, have banned some portable media devices (e.g. memory sticks, thumb drives and camera flash memory cards). It is too easy for viruses to jump into unsecured memory holding devices and let them act as a means of transferring them to new and unsecured locations.

Rise of the Botnets

One of the more disturbing trends in the malicious attacker arsenal is the rise of the Botnet. A botnet is usually defined as "a group of computers infected with the malicious kind of robot software, the bots, which present a security threat to the computer owner. Once the robot software (also known as malicious software or malware) has been successfully installed in a computer, this computer becomes a zombie or a drone, unable to resist the commands of the bot commander. A botnet may be small or large depending on the complexity and sophistication of the bots used. A large botnet may be composed of ten thousand individual zombies. A small botnet, on the other hand may be composed of only a thousand drones. Usually, the owners of the zombie computers do not know that their computers and their computers' resources are being remotely controlled and exploited by an individual or a group of malware runners through Internet Relay Chat (IRC)." (TechFaq 2009).

Estimates fluctuate across the board but the potential for botnet exposure if there are 1.2 billion Internet facing computers is staggering.:

1% 12,000,000 machines
5% 60,000,000 machines
25% 300,000,000 machines

Botnets are the soldiers behind most Spam, Phishing, Click Fraud, Networks for Hire and Distributed Denial of Service (DDOS) attacks - attempts to prevent or impair the legitimate use of computer or network resources. A DDOS attack uses a network of thousands of these enslaved computers (robots) all controlled by the cracker who has infected unsecured systems. When the cyber attacker gives the order, all the robots send a tidalwave of requests to the targeted server. The huge amount of simultaneous requests floods the DNS servers. As long as the DDOS keeps going, all websites served by the victim's content delivery systems are degraded or unreachable.

A DDOS attack can be perpetrated any number of ways. The five basic types of attack are:

- Consumption of computational resources, such as bandwidth, disk space, or processor time

- Disruption of configuration information, such as routing information.
- Disruption of state information, such as unsolicited resetting of TCP sessions.
- Disruption of physical network components.
- Obstructing the communication media between the intended users and the victim so that they can no longer communicate adequately.

New and creative DDOS attacks arise alongside the creation and deployment of new services on the web (see CASE STUDY: Pirate Bay founder devises "Denial of Dollars" attack at the end of this chapter).

A DDOS attack may include execution of malware intended to:

- Max out the processor's usage, preventing any work from occurring.
- Trigger errors in the microcode of the machine.
- Trigger errors in the sequencing of instructions, so as to force the computer into an unstable state or lock-up.
- Exploits errors in the operating system to cause resource starvation and/or thrashing, i.e. to use up all available facilities so no real work can be accomplished.
- Crash the operating system itself (Wikipedia, DDOS).

It doesn't take as much bot power as some might think to crash a server. Most will collapse quickly with 200 zombies flooding e-mail servers with a steady stream of junk messages. (RSA) But botnets tend to have zombies in the thousands rather than hundreds. Botnets can be leased for around US$50–60 per 1,000–2,000 bots. Prices are also quoted at 2.5 to 6 cents per bot/per week depending on the configuration. Entire botnets can be rented for as little as $100-per-hour (Warner,2004). Interestingly, despite evidence of co-operation between botnets there is also competition within the botnet economy. Security experts have observed attacks against rival botnets as each botnet tries to protect its compromised node. Malware and trojans have been found with instructions to remove known competing malware that may have been surreptitiously stashed in a machine for later use. (Leyden, 2008)

There are no short-term solutions to eliminate DDOS attacks. Today's best practices involve making computers and networks more resilient in the face of an attack. All systems have their limits. One way to make a system more survivable is to increase resources; the more resources there are, the better the chances are that the system will survive an increased demand for use. To maximize a businesses protection from infection and potential downtime or loss of resources a CIO needs to make sure their tech team is vigilant about: Email filtering - stopping the initial infection, Web filtering - stopping the install download, Employee awareness – an explanation of why measures are in place makes staff more likely to comply, Firewalls – block all ports not used by system (Ianelli, 2008). Routinely updating software with patches to prevent known exposures from being exploited is a simple and effective step of preventing infection (Wang, 2007).

Pretexting/Social engineering

Social engineering "is a form of hacking that relies on influencing, deceiving, or psychologically manipulating unwitting people to comply with a request."
-Kevin Mitnick

In terms of specific threats users are faced with today, social engineering scams continue to thrive, attempting to scam users through fake websites, e-mail, and social networking sites (Zorz, 2009). Social engineering is one of the oldest and most reliable tricks of the cyber criminal trade. Social engineering attacks are difficult to detect (and defend against) because the type of information that attackers seek is often identical to information requests from legitimate inquiries, such as those made to a help desk or call center. It relies on the basic assumption that people will attempt to help you, or at least trust you, if you appear to know what you are doing. They use information that makes them seem legitimate and credible – and each call, even unsuccessful ones, adds to their knowledge for the next call.

Shannon Kellogg, Director of Information Security Policy, Office of Government Relations at EMC Corporation, pointed out in an RSA speech that social engineering is done with “time, patience and perseverance.” A social engineer will use "10-degrees of separation" to get to what they want and collect as much information as they can along the way. "He might want what is on the CEO's desk but he will start 10 steps away. Along the way he will get people to help him by being the 'poor guy in trouble.'" (Hinson, 2008a)

A lack of meaningful metrics make it difficult to quantify the money lost to social engineering scams. It has been estimated that social engineering costs businesses worldwide between $400 million and $12 billion a year in losses, prevention and security.

(Rogers, 2004)

The difficulty with stopping social engineers from getting what they are after is the balance that has to be struck between providing customer service and defending against social engineering.
Information that is susceptible to social engineering includes user IDs, passwords, and other account and identifying information. Social engineers seek information that will build their credibility, such as:

- general information about the company and its employees
- name of projects and names of physical sites
- company lingo, terms for the way things are done, and the names of procedures and even online documents (order forms, loan application forms)
- company IDs' structure (first name, last name; last name, initial)
- physical maps of company facilities and locations
- telephone directories and a list of user names
- emails with a long carbon copy (cc) list

Raising awareness is the most important preventative measure since inquiries of this type sound innocent when coming from a skilled attacker. Given that the only truly effective control is through people, it is imperative to:

- make people aware of the possibility that they might be socially engineered
- give them tools and techniques to identify social engineering attempts and attacks
- make sure they know who to contact if they receive a suspicious inquiry
- have clear, enforced policies and procedures in place

(Hinson 2008b)

An effective anti social-engineering training technique is to treat suspicious callers as though they were a pushy sales representative – and then try to deflect them by asking for more information, asking them to call back later, or asking them to send an email to verify that they are a legitimate caller. A legitimate caller will take the time to provide more information. If you train people to report suspicious calls to a central point and then correlate this information, there is an opportunity to identify an attack that is underway and send out an alert. Make employees aware that it occurs and establish educational program to inform that it occurs. Falling victim to social engineering can be an embarrassing position to find yourself in, so employees need to know that they can report incidents without repercussions even after the exposure has occurred. If the social engineer is doing his job right victims don't realize that they've been fooled – and when they do realize they've been tricked, they don't like to admit it. It is difficult to identify an act of social engineering based on an isolated event because a serious social engineer will persist with the attack over days and weeks (Mitnick, 2003).

"Phishing" and "Spear Phishing" fall under the category of social engineering. Phishing is the act of attempting to get private or non-public information by masquerading as someone the intended target trusts. This could include spoofing websites -false websites that look the same as trusted websites but are at a different URL and collect private information from the target; spoofing urls - creating similar URLs to trusted brands or institutions, sometimes with as little as transposition of letters in the original's URL, email and phone phishing or pretexting - attempting to gain non-public information under false pretenses. If you train people to report suspicious calls to a central point and then correlate this information, there is an opportunity to identify an attack that is underway and send out an alert. Make employees aware that it occurs and establish educational program to inform that it occurs. Falling victim to social engineering can be an embarrassing position to find yourself in, so employees need to know that they can report incidents without repercussions even after the exposure has occurred."Spear phishing" is a more targeted version of this type of attack. Spear Phishing is the act of phishing with prior knowledge that helps narrow the targeted victims to a more select target audience. Knowledge may have come from any of the previously mentioned "soft targets" the attacker may have gleaned: email structures, company information or names, fraudulent forms (Rogers 2004).

Cyber Terror/ Cyber War

"America's vulnerability to massive cyber crime, global cyber espionage, and cyber attacks has emerged as one of the most urgent national security problems facing our country today."
Senator Olympia Snowe, Republican from Maine

As dependence on computer networks, specifically the Internet, grows so too have concerns that a crippling Cyber Attack is inevitable on a country's information infrastructure (CRS 2003). The low barrier of entry for a cyber attacker to cause damage far out of proportion to the financial investment is an alarming development to militaries

around the world and most are scrambling to bulk up their cyber warfare capabilities. For example, n 2007 the "Aurora experiment" at the Idaho National Laboratory was set up to test US energy infrastructure from cyber attack. Testers were able to get into the control programs of a demonstration power plant and cause a giant electric generator to blow itself up. The results of the test proved that physical damage can be caused from cyber attacks. (Fickes, 2008)

Information security experts generally accept that a computer attack can be called a cyber terror attack if the effects are sufficiently destructive or disruptive to generate fear comparable to that of a physical attack - causing death or injuries, extended power outages, airplane or train crashes, water contamination, or major loss of confidence in portions of the economy. The Aurora experiment was a dramatic argument that the threat of Cyber Terror should be taken seriously.

Government reports have suggested that with the emphasis countries place on security of physical national infrastructure, a cyber attack offers terrorists a form of attack that offers lower risks of detection with the potential for greater damage. Some experts dismiss this notion saying a cyber attack doesn't have the potential to attract as much media attention as a physical terrorist attack thus making it less desirable to a potential adversary.

Governments believe that future adversaries may be unwilling to use conventional forces against larger military powers and instead may resort to "asymmetrical warfare" where a less powerful opponent uses other strategies to offset and negate technological superiority. Dan Kuehl, professor at the US National Defense University school of Information Warfare and Strategy, has pointed out that a high percentage of US military messages flow through commercial communication channels creating a vulnerability during conflict. Worldwide this is an issue that has to be addressed and no clear solutions have been offered yet (Cyberpolicy, 2009).

Without obvious fixes countries must protect the most vulnerable areas open to attack. The United States military has determined 11 critical National level infrastructure assets that are vulnerable to cyber attacks (DCSINT, 2006):

- Agriculture and food
- Water
- Public Health
- Emergency services
- Defense industrial base
- Information and Telecommunications
- Energy
- Transportation
- Banking and Finance
- Chemical and Hazardous materials
- Postal and Shipping

President Obama has proposed an expansion of the $17 billion, five-year program that Congress approved in 2008, the appointment of a White House official to coordinate the effort, a Cyber Czar, to end the bureaucratic patchwork indicating who is responsible for defending against cyberattacks.

Protocol to follow if External Breach detected

The most important issue in Information Security is to have a plan in place before a breach occurs. Having a team in place that know what their individual jobs are and what needs to be done during the emergency can mitigate further damage caused by the breach.

A simple and universal framework for managing and reporting a privacy breach are as follows:

Step 1 – Identify the Breach and take Immediate Action to Contain or Remedy It
Step 2 – Notify the appropriate people about the Breach (IT, management, law enforcement, public affected by breach)
Step 3 – Manage the Breach
Step 4 – Investigate and Document the Breach
Step 5 – Follow up

The US department of Justice keeps an updated list of who to contact for specific external threats and the list can be extrapolated by country to create their own "emergency call list."
(Appendix C)

Incident Management/ Contingency Planning

The fact that technology is not perfect (there will always be a risk of hardware or software failures) coupled with the internal and external threats discussed in this chapter and the preceding one suggests that a wise CIO have plans in place to deal with incidents. This section discusses some of the considerations involved in managing incidents as they occur as well as considerations in developing a contingency plan.

- Define "business continuity" for your business
- Seven tiers of Information System continuity
- Contingency planning process

Business Continuity Planning

Planning for the continuous operation of a business' essential functions during a disaster or emergency should be high on any CIO's list of priorities. It is vital to be proactive; just responding to an event is a recipe for disaster. An end-to-end inventory of activities and interdependencies across the organization needs to include many departments rather than just IT.

A business continuity audit needs to be performed and a plan created and distributed. At it's most basic level a Business Continuity manual consists of:

1. Analysis - Impact analysis, threat analysis and recovery requirement documentation
2. Solution design - Hierarchy of roles and responsibilities, physical location of contingent workspaces
3. Implementation
4. Testing and organization acceptance - "Fire Drilling" the plan into employees
5. Maintenance - reviewing and updating the plan as circumstances change - additional locations, staff, change of information systems (Lennon, 2002).

The seven tiers of business continuity solutions described below offer a simple method to define current service levels and associated risks. The **Seven Tiers of Disaster Recovery** was originally defined by Share to help identify the various methods of recovering mission-critical computer systems as required to support business continuity. Although the original known published concept dates back to the 1990's, Business Continuity Planning (BCP) and Disaster Recovery Specialists today continue to use the 7-Tiers to illustrate continuity capabilities and costs at a very high level. The definitions for the various Tiers have been updated as technology has evolved in support of today's business requirements and their associated Recovery Time Objective (RTO) and Recovery Point Objective (RPO) (Wikipedia 2009b)

The Seven Tiers of Information Systems continuity (Please see full description in Appendix A)

Tier 0: No off-site data – Possibly no recovery
no saved information, no documentation, no backup hardware, and no contingency plan
time necessary to recover is unpredictable

Tier 1: Data backup with no hot site
back up of data sent to an off-site storage facility

Tier 2: Data backup with a hot site
regular backups on media combined with an off-site facility and infrastructure (hot site)

Tier 3: Electronic vaulting
mission critical data is electronically vaulted typically more current than that which is shipped.
Less data recreation after disaster, less downtime

Tier 4: Point-in-time copies
used by businesses that require both greater data currency and faster recovery than lower tiers.

Tier 5: Transaction integrity

Tier 6: Zero or near-Zero data loss
the highest levels of data currency. Used by businesses with little or no tolerance for data loss and who need to restore data to applications rapidly.

Tier 7: Highly automated, business integrated solution
recovery of the applications is automated

Secondary Sites

The CIO must present a cost/benefit analysis to determine how ready the business is prepared to be in an emergency. Having a secondary site where IT operations can be quickly restored in the event of an outage makes sense for some businesses and is cost prohibitive for others. Secure secondary sites are broken into three categories:

Hot sites

Hot sites are the most reliable, and most expensive, contingency if the foundation site goes down during an emergency. Hot sites are an exact duplicate of the Information System - data and hardware- in a geographically different location. Depending on the disaster, down time is mitigated by using a hot site.

Warm Sites

Warm sites are a geographically different location with the most critical of hardware. Warm sites may not have synchronized data backups. Off site data archives or vaults could be converted to warm sites. Warm sites are not capable of the fast recovery that hot sites can offer.

Cold sites

Cold sites are off site data storage. No hardware, data stored on media. Lag time to business recovery is considerable.

A contingency plan needs to describe why and what needs to be done, it needs to be concise and it needs a strong hierarchy delineating roles and responsibilities and how to contact those people 24 hours a day. There are six required responses within a disaster contingency framework:

1. Detect / determine disaster condition
2. Notify recovery team members
3. Initiate Business Continuity Plan
4. Activate designated hot site
5. Create Public Information plan
6. Support services to aid recovery

Some disasters are harder to detect than others. A hurricane wiping out a server farm is obvious, a DDOS causing downtime is not immediately identifiable as an emergency.

Regulatory and Legislative protections

The US currently has several major legislative initiatives to fight cyber crime and secure data systems. The measures tend to be isolated from one another and lack jurisdiction to follow and prosecute cross-border crimes.

CIOs worldwide must address an abundance of regulatory mandates and recommendations. In order to do business in the cyber world businesses must be aware of compliance requirements in:

- Payment Card Industry Data Security Standard (PCI DSS)
- European Data Privacy Directive
- Federal Financial Institutions Examination Council (FFIEC)Guidance
- Health Insurance Portability and Accountability Act (HIPAA)
- ISO 27002 Standard
- Fair and Accurate Credit Transactions Act (FACTA)
- Homeland Security Presidential Directive 12 (HSPD-12, U.S.)
- Monetary Authority of Singapore Internet Banking Guidelines
- Customer Proprietary Network Information (CPNI)
- Sarbanes-Oxley

(The requirements for compliance in each of these are outside the scope of this chapter, but a brief summary of these initiatives can be found in Appendix B).
(RSA)

Conclusion

In general, the incentives are to keep fraud and business downtime at acceptable levels rather than to reduce or eliminate it. Security experts are well aware of the inventiveness and persistence of crackers. They realize that attaining perfect protection against external threats is extremely difficult, if not impossible. They also realize that the amount of time and money constructing barriers too external threats depends on the potential damage to an organization if its IT security is breached.

A well prepared CIO will bring as much of the company on board as possible to be aware of the threats faced in Information Security. Maintaining well-documented plans for many of the threats discussed will reduce the likelihood of the business facing debilitating or damaging interruptions to the day-to-day operations.

Appendix A

The seven tiers of business continuity

Tier 0: No off-site data – Possibly no recovery

Businesses with a Tier 0 business continuity solution have no business continuity plan. There is no saved information, no documentation, no backup hardware, and no contingency plan. The time necessary to recover in this instance is unpredictable. In fact, it may not be possible to recover at all.

Tier 1: Data backup with no hot site

Businesses that use Tier 1 continuity solutions back up their data and send these backups to an off-site storage facility. The method of transporting these backups is often referred to as "PTAM" - the "Pick-up Truck Access Method." Depending on how often backups are created and shipped, these organizations must be prepared to accept several days to weeks of data loss, but their backups are secure off-site. However, this tier lacks the systems on which to restore data.

Tier 2: Data backup with a hot site

Businesses using Tier 2 business continuity solutions make regular backups on tape. This is combined with an off-site facility and infrastructure (known as a hot site) in which to restore systems from those tapes in the event of a disaster. This solution will still result in the need to recreate several hours or even days worth of data, but the recovery time is more predictable.

Tier 3: Electronic vaulting

Tier 3 solutions build on the components of Tier 2. Additionally, some mission critical data is electronically vaulted. This electronically vaulted data is typically more current than that which is shipped via PTAM. As a result there is less data recreation or loss after a disaster occurs.

The facilities for providing Electronic Remote Vaulting consists of high-speed communication circuits, some form of channel extension equipment and either physical or virtual Tape devices and an automated tape library at the remote site. IBM's Peer-to-Peer VTS and Sun's VSM Clustering are two examples of this type implementation.

Tier 4: Point-in-time copies

Tier 4 solutions are used by businesses that require both greater data currency and faster recovery than users of lower tiers. Rather than relying largely on shipping tape, as is common on the lower tiers, Tier 4 solutions begin to incorporate more disk based solutions. Several hours of data loss is still possible, but it is easier to make such point-in-time (PiT) copies with greater frequency than tape backups even when electronically vaulted.

Tier 5: Transaction integrity

Tier 5 solutions are used by businesses with a requirement for consistency of data between the production and recovery data centers. There is little to no data loss in such solutions, however, the presence of this functionality is entirely dependent on the application in use.

Tier 6: Zero or near-Zero data loss

Tier 6 business continuity solutions maintain the highest levels of data currency. They are used by businesses with little or no tolerance for data loss and who need to restore data to applications rapidly. These solutions have no dependence on the applications or applications staffs to provide data consistency. Tier 6 solutions often require some form of Disk mirroring. There are various synchronous and asynchronous solutions available from the mainframe storage vendors. Each solution is somewhat different, offering different capabilities and providing different Recovery Point and Recovery Time objectives. Often some form of automated tape solution is also required. However, this can vary somewhat depending on the amount and type of data residing on tape.

Tier 7: Highly automated, business integrated solution

Tier 7 solutions include all the major components being used for a Tier 6 solution with the additional integration of automation. This allows a Tier 7 solution to ensure consistency of data above that which is granted by Tier 6 solutions. Additionally, recovery of the applications is automated, allowing for restoration of systems and applications much faster and more reliably than would be possible through manual business continuity procedures.

Appendix B

Brief Overview of Worldwide Regulatory practices CIOs need to be aware of

Worldwide regulations and compliance standards are constantly changing and CIOs have to be vigilant to keep up to date with many. The following is simply definitions of some of the regulatory practices a worldwide business will encounter.

Regulatory acts such as the **Gramm-Leach-Bliley Act of 1999 and HIPPA,** require that personally identifiable information must be kept secure. The measure spells out legal actions against several of the mentioned malicious acts including noting that "pretexting by individuals is punishable as a common law crime of False Pretenses."

The **Sarbanes-Oxley Act of 2002** requires that Finance and IT departments of publicly traded companies define and enforce specific internal controls

Regulating external attacks at this point is an inefficient hodgepodge of bureaucracies reacting to the problem after they occur. The **Cyberspace Policy Review** is an effort to set up a hierarchical structure to make a clear process for reporting, tracking and prosecuting these cross-border crimes.

PCI DSS
The PCI DSS (Payment Card Industry Data Security Standard) is a set of comprehensive requirements for enhancing payment account data security. It was developed by the 5 major payment brands of the PCI Security Standards Council: American Express, Discover Financial Services, JCB International, MasterCard Worldwide and Visa Inc. Inc. International. It's objective was to help bring about the broad adoption of consistent data security measures for digitally processed payment. While it is required that merchants comply with the PCI DSS 12 regulatory points in order to do business with the major Credit Card institutions a conflict-of-interest is raised between the two parties. The larger the institution the more the Credit Cards are incentivized to do whatever it takes to do business with them and not lay onerous or expensive regulations on the business.

The PCI DSS framework is divided into 12 security requirements (VISA refers to them as the 'Digital Dozen') which are organized in six categories as follows:
PCI DSS
Build and maintain a secure network
Requirement 1: Install and maintain a firewall configuration to protect cardholder data
Requirement 2: Do not use vendor-supplied defaults for system passwords and other security parameters
Protect cardholder data
Requirement 3: Protect stored cardholder data
Requirement 4: Encrypt transmission of cardholder data across open, public networks
Maintain a vulnerability management program
Requirement 5: Use and regularly update anti-virus software or programs
Requirement 6: Develop and maintain secure systems and applications
Implement strong access control measures

Requirement 7: Restrict access to cardholder data by business need-to-know
Requirement 8: Assign a unique ID to each person with computer access
Requirement 9: Restrict physical access to cardholder data
Regularly monitor and test networks
Requirement 10: Track and monitor all access to network resources and cardholder data
Requirement 11: Regularly test security systems and processes
Maintain an information security policy
Requirement 12: Maintain a policy that addresses information security for employees and contractors
https://www.pcisecuritystandards.org/

ISO/IEC 27000 – Family of standards

'ISO27k' for short comprises information security standards published jointly by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC).

The series provides best practice recommendations on information security management, risks and controls within the context of an overall Information Security Management System (ISMS), similar in design to management systems for quality assurance (the ISO 9000 series) and environmental protection (the ISO 14000 series).

The series is deliberately broad in scope, covering more than just privacy, confidentiality and IT or technical security issues. It is applicable to organizations of all shapes and sizes. All organizations are encouraged to assess their information security risks, then implement appropriate information security controls according to their needs, using the guidance and suggestions where relevant. Given the dynamic nature of information security, the ISMS concept incorporates continuous feedback and improvement activities, summarized by Deming's "plan-do-check-act" approach, that seek to address changes in the threats, vulnerabilities or impacts of information security incidents.
(ISO/IEC 27000-series, 2007)

FISMA

The Federal Information Security Management Act of 2002 recognized the importance of information security to the economic and national security interests of the United States. The act requires each federal agency to develop, document, and implement an agency-wide program to provide information security for the information and information systems that support the operations and assets of the agency, including those provided or managed by another agency, contractor, or other source.
The act states the following purposes:

1. provide a comprehensive framework for ensuring the effectiveness of information security controls over information resources that support federal operations and assets;
2. recognize the highly networked nature of the current federal computing environment and provide effective government wide management and oversight of the related information security risks, including coordination of information security efforts throughout the civilian, national security, and law enforcement communities;
3. provide for development and maintenance of minimum controls required to protect federal information and information systems;
4. provide a mechanism for improved oversight of federal agency information security programs;
5. acknowledge that commercially developed information security products offer advanced, dynamic, robust, and effective information security solutions, reflecting market solutions for the protection of critical information infrastructures important to the national defense and economic security of the nation that are designed, built, and operated by the private sector; and
6. recognize that the selection of specific technical hardware and software information security solutions should be left to individual agencies from among commercially developed products.

(The 2002 Federal Information Security Management Act (FISMA))

California Security Breach Information Act
Companies doing business in California are required to give such notice under California statute SB 1386. The law requires that each individual whose Personally Identifiable Information was lost, receive timely notification of such a breach. Any company that does business in California and collects California PIIs is subject to the law.

The law has gained national attention after several high-profile data breaches and several states have stated intentions to create a similar statute if privacy data breaches are not addressed at the national level.

The cost involved with notifying potentially millions of customers is considered an incentive for businesses to take data security much more seriously in the future.
http://www.oecd.org/dataoecd/53/17/40722462.pdf

Health Insurance Portability and Accountability Act (HIPAA)

Health insurance portability act of 1996 contains data privacy provisions that must be followed by businesses active in the United States.

Fair and Accurate Credit Transactions Act (FACTA)

Established in 2003 under George W. Bush to improve access to credit cards and protect consumers from credit card fraud.

The act established "Red Flag Rules" requiring banking agencies, the National Credit Union Administration, and the Federal Trade Commission to jointly create regulations regarding identity theft prevention applicable to financial institutions and creditors. The Red Flag Rules also address how card issuers must respond to changes of address. Regulations that were established as a result include:

- financial institutions develop an Identity Theft Prevention Program which included reasonable policies and procedures for detecting, preventing, and mitigating identity theft
- special requirements on issuers of debit or credit cards to assess the validity of a change of address if they receive notification of a change of address for a consumer's debit or credit card account and, within a short period of time afterward they receive a request for an additional or replacement card for the same account
- prohibits businesses from printing more than 5 digits of any customer's card number or card expiration date on any receipt provided to the cardholder at the point of sale or transaction

Monetary Authority of Singapore Internet Banking Guidelines

The central bank of Singapore, the Monetary Authority of Singapore (MAS), created the Internet Banking and Technology Risk Management (IBTRM) Guidelines. The guidelines are best practices aimed at preventing data loss and increasing security, without overburdening investors or consumers. The guidelines require banks to:

- Establish a sound and robust technology risk management framework
- Strengthen system security, reliability, availability and recoverability
- Deploy strong cryptography and authentication mechanisms to protect customer data and transactions

Customer Proprietary Network Information (CPNI)

CPNI is the data collected by telephone companies about consumers phone calls. It is time, date, duration of the call. The new rules in the CPNI Order includes:

- limits the information that carriers may provide to third party marketing firms without first securing the affirmative consent of their customers
- defines when and how customer service representatives may share call details
- creates new notification and reporting obligations for carriers (including identity verification procedures)

(All regulations taken from regulatory bodies Briefs.)

Appendix C

US Department of Justice
Appropriate federal investigative law enforcement agencies

Type of Crime Computer intrusion (hacking) Password trafficking

FBI local office
U.S. Secret Service
Internet Crime Complaint Center

Internet fraud and SPAM

FBI local office
U.S. Secret Service (Financial Crimes Division)
Federal Trade Commission if securities fraud or investment-related SPAM e-mails, Securities and Exchange Commission (SEC and FTC only two that have online complaint capabilities at this time)

The Internet Crime Complaint Center
(USDOJ 2005)

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Chapter 9: Technical Trends

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Learning Objectives

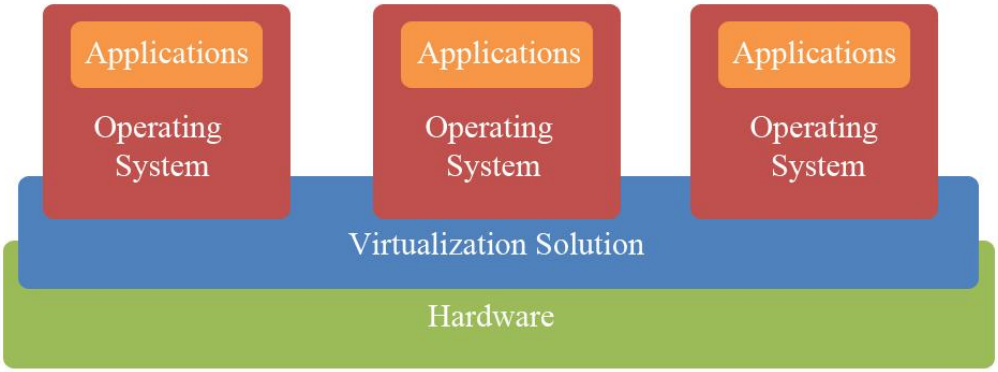
- Understand virtualization
- Understand what cloud computing means and the benefits of cloud computing
- Understand Grid computing
- Understand Service-oriented Architectures (SOA)
- Understand Ubiquitous Computing

Introduction

This chapter will look at technical trends in 2009 of particular interest to Chief Information Officers (CIOs). The chapter will start with some technical applications that are in current use and then give the reader exposure to some of the broader technical trends at this time.

Virtualization

Figure 1: Schematic of a Virtual Operating Environment



Virtualization is rapidly becoming a standard technology for IT systems infrastructure. In simple terms, virtualization is a technology that allows you to run multiple operating systems on one physical computer, as illustrated in Figure 1 . Each of the operating systems runs as a self-contained computer with no "knowledge" that it is sharing physical hardware. For example, in a virtual solution a Microsoft Exchange server and a Linux web server can run on the same physical computer. Removing the tie between software and hardware opens the door to many performance and cost savings advantages.

Virtualization has two components, the host computer and the guest operating system. The host computer consists of a physical computer and virtualization software. Most modern computer hardware configurations can be used as a host computer. The amount of computing power needed by a host computer depends on the computing demands of the guest operating systems.

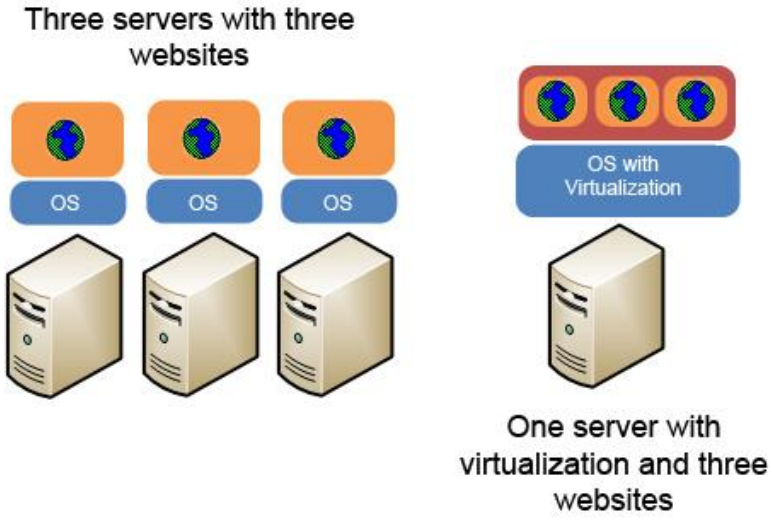
The second component is the guest operating system. The guest system is the operating system that runs within the virtualized environment created on top of the host computer.

Types of Virtualization

There are three basic types of server virtualization: operating system virtualization, hardware emulation and paravirtualization.

Operating system virtualization

Figure 2: Operating System Virtualization



Operating system virtualization is the process of running multiple applications within an operating system in their own virtualized space and is illustrated in Figure 2. The operating system makes a set of libraries available to each application in a way that an application runs as if it had sole control of the operating system. A typical implementation of operating system virtualization is creating multiple virtual web hosting environments for different groups on the same machine.

The virtualized application only sees and interacts with applications within the same virtualized environment. It has no access or knowledge to any application outside of the virtualized environment it is running in beyond the services those applications open up via network access.

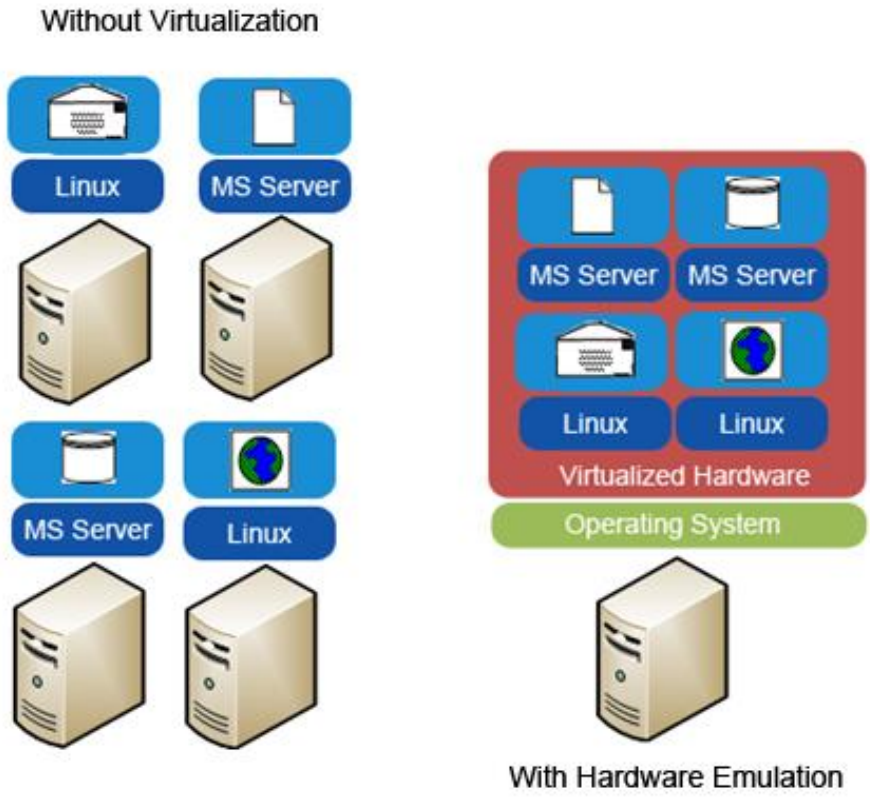
Operating system virtualization is good choice if the goal is to offer similar operating system functionality to different user groups. Each group's applications will run independent of the other groups' applications creating an environment that allows multiple groups to run similar applications.

An advantage to using operating system virtualization is utilization load management. Operation system virtualization requires little overhead because applications use the system's normal system calls. An additional feature available with some implementations of operating system virtualization is system resource management. The amount of resources made available to each virtual environment can be controlled, allowing more resources to be allocated to one environment over the other. Resources can also be controlled to prevent one environment from using most or all of the hardware system's resources.

Operating system virtualization has been used for decades for security purposes. It allows the system to isolate an application from the rest of system. It is common to use operating virtualization when running the Domain Name System (DNS) resolution software, the Berkeley Internet Name Domain (BIND). BIND has been the most used DNS software in the world for decades. Unfortunately it has also had security issues over the years. It is typical to install BIND in a virtualized application technique chroot (pronounce "change root") environment. The chroot virtual environment creates a separate file directory system preventing BIND from seeing or accessing any files on the system outside of those in the BIND directory.

Hardware Emulation

Figure 3: Hardware Emulation



With hardware emulation, as illustrated in Figure 3, the virtualization software emulates a complete set of hardware that a guest operating system can be installed on. This type of virtualization software is called a hypervisor or virtual machine monitor (VMM).

The VMM appears as a standard set of hardware to the guest operating system, which is completely separate from the host system hardware. VMM usually emulate fairly generic industry standard hardware. This simplifies the process of developing the VMM and makes it easier to load a guest operating system using the drivers included with the operating system. The guest operating system interacts with the virtual hardware as if it were the real hardware. The VMM translates the hardware requests made to the virtualized generic hardware using drivers specific for the hardware on the host system and transmits guest calls to the host system's hardware. The process also runs in reverse. The VMM will translate communications from the host system hardware into the generic drivers format and then transmit those up to the guest operating system.

Because hardware emulation uses a generic set of hardware, guest operating systems can be migrated between different physical machines with different hardware configurations. The new host system only needs the same hardware emulation software. The simplest form of this is to move the guest image files from one machine to another. For example let's say an organization needs to retire an older piece of hardware and replace it with a new piece of hardware. Once the emulation software is loaded on the new machine you simply:

1. Shut down the guest machine
2. Copy the machine image files over
3. Configure the hardware emulation software so that it can recognize the machine image files
4. Start the guest on the new machine

When changing hardware this process eliminates the time needed to load an operating system, load applications, and then restore the configuration files from the old machine.

Large organizations will run many virtual hosts at the same time. More advanced hardware emulation software will allow organizations to move a running guest between two hosts with no noticeable impact to the end user. This

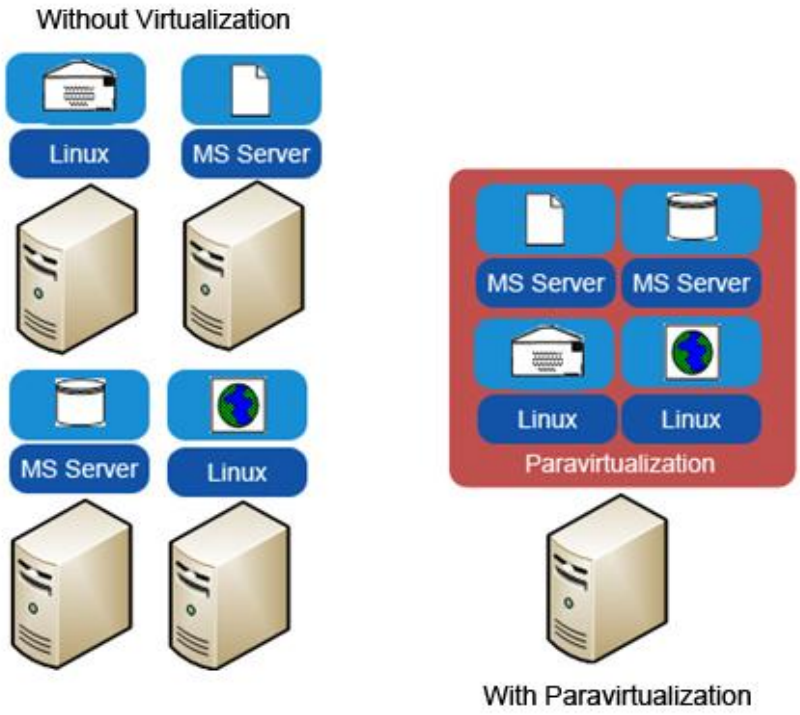
allows organizations to allocate guest machines to achieve more evenly distributed workloads. It also allows for moving a guest to new hardware, like the example above, without any downtime.

An advantage of machine virtualization is that it allows you to run different version of operating systems on the same machine. It also allows you to consolidate systems to better utilize hardware resources. The use of generic hardware is both an advantage and a disadvantage. The advantage is a wider variety of operating systems will come with compatible drivers. The down side is that generic drivers may not be the most efficient drivers.

Another disadvantage is performance. Applications do run slightly slower when running on guest operating systems. The overhead of running the hardware virtualization and translating hardware calls impacts performance. The impact, however, is typically minimal, but organizations should do benchmark testing before implementing a hardware virtualization solution.

Paravirtualization

Figure 4: Paravirtualization



With Paravirtualization the virtualization software runs as a thin layer between the guest operating systems and physical hardware. The paravirtualization software controls the guest operating systems' access to the hardware. This is different from hardware virtualization in that paravirtualization does not emulate a complete set of hardware for the guest operating systems to use, but instead controls access to physical hardware with minimal emulation.

Paravirtualization has to have tight integration within the guest operating system to overcome the issue of multiple guests having access to the same hardware. It needs the ability to control when guest operating systems make calls to the hardware. Integration is accomplished by running custom kernels on the guest operating systems.

An advantage to paravirtualization is that it runs faster than hardware virtualization. Because the hardware emulation part of the virtualization has been removed from the process, guest systems communicate directly with the host's hardware. This direct access to the hardware allows applications on paravirtualization systems to run faster than they do on hardware virtualization systems.

Like hardware virtualization, paravirtualization also has the advantage of being able to migrate between machines, but there are limitations to migrating paravirtualized machines. Hardware virtualized machines easily migrate to any new machine because the guest systems only see the virtual hardware, so the guest is not exposed to the new hardware. Paravirtualized systems, however, run custom kernels and have drivers loaded for the specific hardware they are running on. Depending on the virtualization solution, it may be required to migrate paravirtualized machines between similar hardware, or load a new kernel and possibly new drivers.

Utilization Advantages to Virtualization

Hardware Utilization

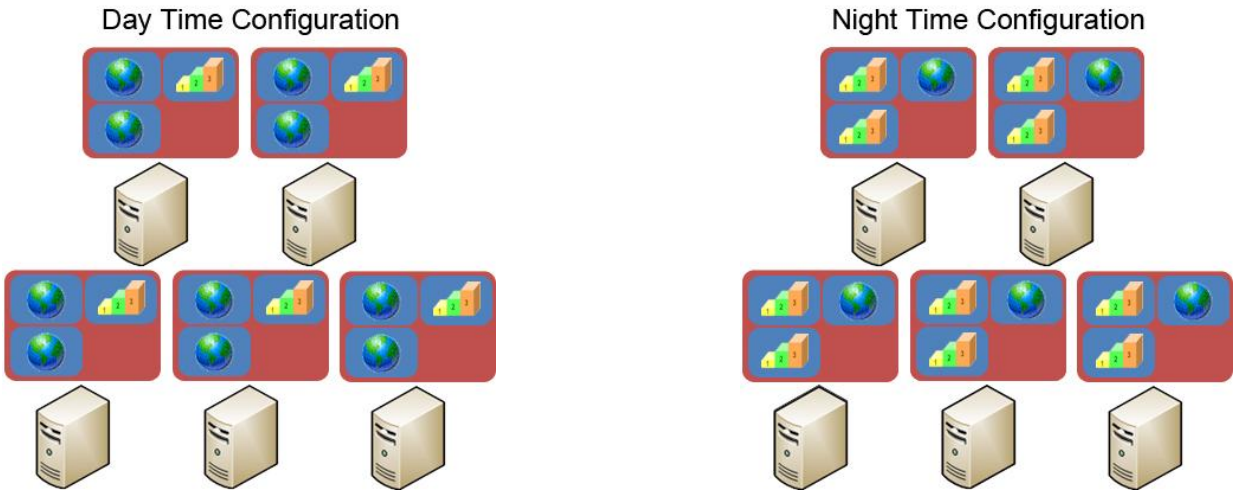
Today, many data centers have machines running at only 10 or 15 percent of total processing capacity (Golden and Scheffy, 2008). This is due to the traditional policy of running one application at a time per machine. One reason for this is that some applications are resource intensive, such as a large database system. But more often than not this is because systems administrators do not want one application to affect the performance of another application. When applications fail they can use up all of the system's resources, such as CPU power or RAM, which would in turn cause any other applications on the system to fail. It is even possible for an application with a bug in it to cause the host system to shut down completely, what MS Windows users call the "Blue Screen of Death".

An advantage of virtualization is better hardware utilization by loading several virtual machines on to one physical host. As an example, if four physical servers running at 10 to 15 percent load were to turn into four guests on one physical machine, conservatively you would have one physical server with about eighty percent load. By creating virtual machines two objectives have been accomplished: First is better utilization of the capital investment by using idle server capacity; Second is the seventy five percent reduction in the number of machines needed.

Load Balancing Through Virtualization

Virtualization can also be used to better load balance system demands. With virtualization architecture's ability to load and unload machine images at any time systems administrators can adjust the number of machines running each type of service to better meet demand.

Figure 5: Load balancing example



As shown in Figure 5, suppose an organization runs a website that specializes in real time stock market information for a large customer base. Every night the website compiles custom reports for its customers using that days stock market data. Without virtualization the organization would have to architect a systems solution that had enough web servers to handle the traffic during the day while the markets are open, and also enough systems to calculate all of the customer reports each night. For this example let's say ten servers for the web are needed and ten servers for reporting are needed. Without virtualization the server hardware hosting the web servers would be busy during the day and near idle at night, and the report generating computers would be idle during the day and busy at night. If all of the servers were moved to virtualized guests, servers could be turned on and off as needed. So in the example, five virtual hosts hosting fifteen virtual machines would handle the load. During the day ten web servers and five reporting servers would run, and at night five web servers and ten reporting servers would run. Not only has the number of physical servers decreased by running more than one guest per physical server, the number of physical servers has been reduced by load balancing machines to match demand. To simplify the numbers, assume one guest per host machine. In this scenario there would be fifteen servers (the maximum number of servers needed at one time) instead of the twenty needed to run without virtualization. In reality you would gain even more by running multiple guests per host system.

Datacenter Utilization through Virtualization

With virtualization comes better data center utilization. Because multiple guest machines run on one server the number of physical servers is reduced, which reduces the need for space and power. Many organizations rent space from co-location companies. Co-location companies run large datacenters that rent space, power and internet access to third parties. Typically, the space is rented on a per rack or per cabinet basis. A rack or cabinet is a metal frame that holds servers in a vertical stack. Because organizations are renting spaces from the co-location center they want to maximize the number of systems they can run per rack, which can be accomplished by running server virtual machines on one physical machine.

With the growing trend of dense server configurations, such as blade servers, datacenters are starting to run out of power capacity before they run out of physical capacity. With virtualization, total power requirements can be reduced by reducing the number of physical servers running. Regardless if a company co-locates its equipment or host its equipment in its own datacenter, space and power are limited resources.

The green movement is also adding momentum to the popularity of virtualizations. As stated before, virtualization enables a business to run fewer physical servers, which means less power consumption. It also means that you are consuming fewer raw materials and at the end of the life of the hardware you are disposing of less.

Reduced Systems Administrator Costs

Reduction in the number of physical servers needed to operate also means a reduction in labor costs. Physical servers require systems administrators' time to maintain the hardware, update firmware, maintain the network equipment and install the wire plant needed for the additional physical servers. With virtualized machines, it is simpler for administrators to perform maintenance. Administrators are able to move running systems off equipment that needs maintenance by migrating the guest system to another virtual host. This reduces downtime and the need to schedule maintenance times to take a service offline.

Disaster Recovery

When leveraged completely, virtualization can simplify and reduce the cost of disaster recovery. Disaster recovery is the process of moving services during a "disaster" at your primary data center facility to another facility. Disasters range from temporary loss of power in your primary data center to organizations having to evacuate to secondary locations for extended periods of time. A prime example of an extended disaster recovery is when Hurricane Katrina hit the US city of New Orleans in 2005. Many organizations were forced to operate in other parts of the US for months before they could restore their IT services in New Orleans. For disaster recovery to work, similarly configured machines in another facility with current configurations and data are required. If the systems are installed directly on the hardware it is a costly and difficult task to maintain a complete set of identical disaster recovery hardware with up-to-date configurations. System administrators must maintain two systems for every one in production, making sure the same changes are made on each system, or they need to maintain complete offsite tape backups. (From an offsite tape backup a system administrator can load the most current version of the production system's configuration onto a server in the disaster site. The down side is that recovery from backup tapes is a slow process).

Virtualization can leverage the flexibility of copying machine images and the flexibility of using different hardware. With virtualization systems, administrators can schedule jobs to regularly copy the complete guest machine image from the primary site to the backup site. If the need arises to fall over to the disaster recovery site it is a simple process of booting up each of the guest systems on host systems in the disaster recovery data center.

Along with convenience, virtualization in your disaster recovery plan can reduce hardware costs. Typical disaster recovery periods should be short. To reduce capital expenditures it is common to have fewer or less expensive servers at the disaster recovery center. While operating out of the disaster recovery center performance will not be as fast as the primary site, but it is often more costly to have hardware sitting idle than to have slow performance during a brief disaster time period that your organization may or may not ever see.

Cloud Computing

The term cloud computing has become more popular in recent years. Like many technical terms turned into a marketing tag, cloud computing has been used to describe many different things. Two formal and rather technical descriptions of cloud computing are:

- Cloud computing is a style of computing in which dynamically scalable and often virtualized resources are provided as a service over the Internet (http://en.wikipedia.org/wiki/Cloud_computing)
- Cloud computing enables users and developers to utilize services without knowledge of, expertise with, nor control over the technology infrastructure that supports them. (Danielson, Krissi).

In simpler terms, cloud computing is delivering IT resources as a service. These IT resources can range from applications that are available on the web to solutions that allow you to run virtual machines in someone else's environment. Cloud computing has been used to describe application, computing power, storage capacity, networking, programming tools, even communication services and collaboration tools offered as a service (Sun Microsystems, 2009).

Cloud Services

There three basic groups cloud services can be broken into: SaaS, Platform as a Service and Infrastructure as a Service.

SaaS

SaaS (SaaS), which we also discuss in Chapter 8, is the technique of providing access to software on a usage basis, usually over the internet. A key difference between shrink wrapped software and SaaS is the pricing model. (SaaS), is almost always sold as a subscription or pay for what you use utility model.

One of the most widely known SaaS, providers is Salesforce.com. Salesforce.com provides a web based Customer Relationship Management (CRM) software application to a diverse subscriber base. Prior to Salesforce.com if a business wanted to utilize a CRM they had to buy or build the software in house, which requires developers to maintain the software and system administrators to maintain the systems the CRM runs on. With a SaaS provider like Salesforce.com you pay for access to the application and Salesforce.com provides all of the support needed to host, develop, and maintain the software.

An advantage of utilizing a SaaS application is that there are no out of pocket expenses due to upfront hardware purchases. There is also the advantage of not having to employee technical staff to maintain the software. By not spending time and resources on software, organizations can be better focused on the things that create competitive advantages.

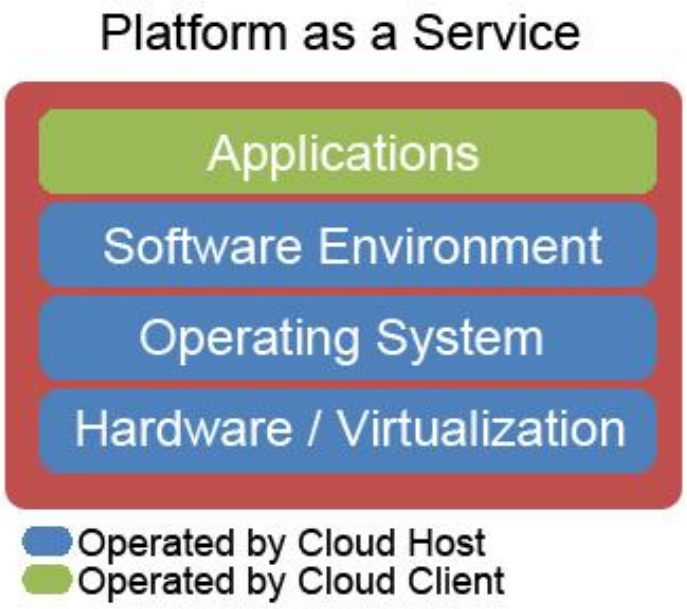
The disadvantage of SaaS is interoperability, control, and security. Because development of the software is under the control of a third party, a client of SaaS has little control over functionality. If a SaaS does not provide a functional piece a client would like, the client may have no way to get that service added to the application. The same can be said for interoperability. The functionality of communication between the client application and the SaaS application may not exist, creating "islands" of data. The good news is that the larger SaaS providers often offer ways for developers to access data contained within the application. This allows organizations and third party developers to build custom functionality that may not be available from the SaaS provider directly.

With SaaS there is also the concern of placing the organization's information into a system controlled by a third party and intermingled with other organizations' information. Oganizations should consider all of the security issues before placing company sensitive data in a SaaS application.

With a SaaS provider there is potentially a high switching cost. Like any software product, getting your data out of a SaaS to move to another platform could be very difficult. Clients need to rely on the SaaS provider to supply tools to extract the data from the application. Unlike traditional applications the client typically does not have access to the systems or database the data resides in.

Platform as a Service

Figure 6: Platform as a Service



Platform as a Service, illustrated in Figure 6, provides an environment to develop and run custom applications. The Platform as a Service providers offer environments where developers can write code and have that code run within the Platform as a Service provider's network.

The advantage of using a Platform as a Service provider is that the client does not have to maintain a development or production environment. The provider furnishes all of the hardware and software needed to run the client's applications. This reduces the client's capital expenditures on hardware and reduces technical staff requirements.

Platform as a Service allows the client to rapidly scale their environment up or down. If the client needs additional resources for their application or additional environments to develop in they simply provision the additional resources from the provider. For example, if a production application starts to slow down it is simple to obtain additional resources to handle the load.

The downside to using a Platform as a Service is that there are limits on the choices of languages that applications can be written in, and there are limits to the tools available from the provider. Google App Engine and Salesforce.com are two of the larger Platform as Service providers. Google only supports the programming language Python, and has replaced some of the Python built-in functions with ones designed to work in Google's environment. Salesforce.com has graphical user interface (GUI) tools that are used to build software via drag and drop. If the desired application is not simple enough to be built with Salesforce.com's drag and drop or Python does not meet development requirements neither of these providers can host the application.

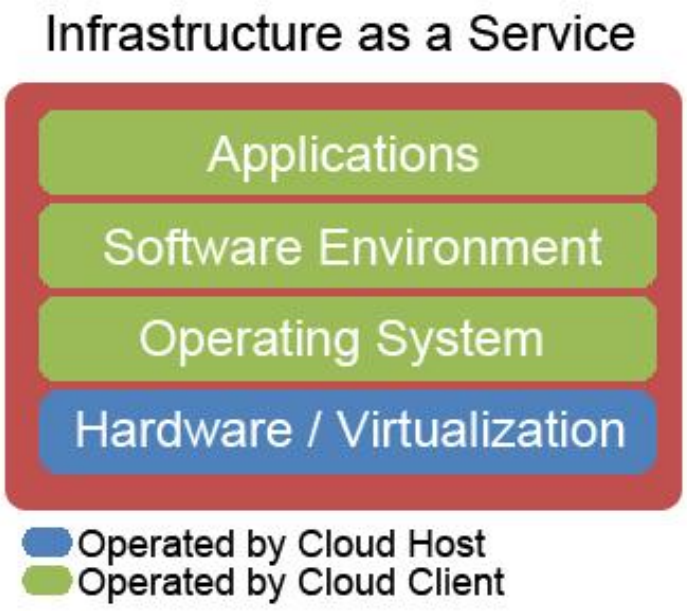
The requirement to use the language and functions of the provider can create a high switching cost. For example, to move an application off Google's App Engine, any code that references Google specific functions would need to be replaced with the standard Python functions or those functions provided by the new Platform as a Service provider.

Another shortcoming of Platform as a Service is that prebuilt applications cannot be loaded into their system. For example, if a web application written in Python used a database backend it could be run in Google's App Engine's environment. But database applications such as Microsoft SQL or MySQL cannot be run in Google's App Engine's environment. The database would have to run in one environment and the application in another, which would slow down communication between applications.

There is also a security issue with Platform as a Service. Clients' are trusting a third party with their data and propriety applications. Clients' applications run within the same environment as other organizations. Clients must also trust the Platform as a Service provider to keep other "misbehaving" applications from affecting their applications.

Infrastructure as a Service

Figure 7: Infrastructure as a Service



Infrastructure as a Service is the lowest technical level of cloud computing. Infrastructure as a Service providers supply all of the computing, storage, and network services to the end user. The end user must supply the operating system and all of the applications needed to build his/her solutions.

Infrastructure as a Service leverages virtualization. In its simplest form, Infrastructure as a Service providers give clients the ability to start and stop guest operating systems that run on top of the Infrastructure as a Service provider's host machines. The Infrastructure as a Service provider will typically charge the end user a set rate for each hour a machine runs. Buying computer resources on a usage basis is often referred to as utility computing. Utility computing is the idea that computing resources have been become a commodity that you can pay for on a usage basis like municipal utilities such as electric power.

There are several advantages to Infrastructure as a Service. The first is flexibility of applications. Because the client chooses the OS platform they can run just about any third party application in an Infrastructure as a Service environment. It also allows the client to write custom applications in any language supported by their choice of operating systems.

Infrastructure as a Service allows a client to build an environment similar to what they can build if they built it in their own datacenter. Several machines running different applications can be loaded into the environment that can interact with each other over the network just like they would in a datacenter environment. There are storage services available to the client to store system data, and backup options to secure that data. There can also be firewall and load balancing services available from the Infrastructure as a Service provider. It is quite feasible to completely duplicate production environments running in a datacenter in an Infrastructure as a Service provider's environment.

Just like SaaS and Platform as a Service, Infrastructure as a Service has the advantage of utility pricing. The Infrastructure as a Service provider has converted all of the infrastructure pieces into a commodity to be sold on a consumption basis. Clients only have to pay for what they use. Clients will reduce capital investment by not having to buy hardware to host services.

Infrastructure as a Service also has the advantage of scaling. The client has the ability to turn machines on and off as needed. So, if the client has a web business that does more traffic in the holiday shopping season, they can turn on additional machines to meet that load during holiday shopping months. When the load returns to normal a they can shut down the additional machines. Through this process the client is able to meet peak demands and only pay for the additional computer time used. If the client hosted the systems themselves they would have had to purchase enough computing power to handle the holiday shopping season even though they did not need that much computing power most of the year.

Another usage of the scaling ability of Infrastructure as a Service is scaling up to do large batch processing. A good example of this is when the New York Times wanted to convert all of the TIF images of their newspaper from 1851-1922 to Adobe PDFs in a short time. A developer with the New York Times was able to upload the four

terabytes of images to Amazon's S3 storage services. He then provisioned 100 machines to convert the images. The whole process only took twenty four hours to run. With a few assumptions on machine size and using today's Amazon EC2 pricing, the computing time cost the New York Times $480. Even as big as the New York Times is, I am sure they do not have a spare 100 machines sitting around they could have run this process on (Gottfrid, Derek).

A constant need in enterprises is the need for development environments. These needs span from environments replicating the production environment to test code in, to development environments to evaluate new third party software. Infrastructure as a Service allows enterprises to add and remove development environments as needed.

A new trend in third party applications, especially open source, is the ability to access pre-built machine images to test applications built by the vendor. The advantage of this is the application provider does all the work of loading their application onto a machine with all of the correct configurations. The end user then can load the machine image into the Infrastructure as a Service environment without having to go through the effort of learning how to load and configure the software just to evaluate the software.

Just like the two other cloud services, Infrastructure as a Service has the disadvantage of loss of control. Although the client has more control then SaaS and Platform as a Service they are still giving up control of the infrastructure and they are entrusting their provider with their information.

The switching cost of Infrastructure as a Service is something to watch for. To move from one provider to another, or back to your own equipment could require the cloud based systems to be rebuilt. But on the other hand, because Infrastructure as a Service leverages virtualization it may be as easy as copying the machine images and data from the current cloud environment to the new environment.

Cloud Environments

Cloud computing can be structured in several ways depending on the amount of control, responsibility, knowledge and security levels desired.

Public Cloud

Public cloud computing is the main configuration of cloud computing most people think of when they hear cloud computing. Public cloud computing is an environment where the IT resource being offered as a service is maintained by a third party and is available to multiple users.

The advantages of public cloud computing is the purchasing and maintaining of all hardware is the responsibility of the provider, reducing capital and labor costs of the client. It also allows the client to scale up and down with little or no constraints.

Private Cloud

Private cloud computing is a term used to describe a cloud environment hosted by an enterprise solely for that enterprise. There is discussion among experts if this should be called a cloud or if it is just a virtualized environment. A private cloud would be a computing environment that could be dynamically scaled with the user not needing expertise in the technology that provides this capability. This type of configuration would be found in large enterprises where a cloud environment is built by a technical group and provided as a service to other groups within the organization.

The advantages of a private cloud are security and control. Because the cloud is operated by the enterprise, there is no concern with third parties having access to the enterprise's data. The enterprise also has the advantage of controlling the environment of the cloud. The cloud can be customized to meet the enterprise's software and utilization needs. If the enterprise requires a special piece of hardware then it can be easily added to their cloud environment.

The downside is the loss of utility usage. To host the cloud within the enterprise the organization must purchase all of the hardware, configure the environment, and maintain the cloud. This also requires maintaining a highly technical staff to administer the cloud. The private cloud also does not have the advantage of scaling. The enterprise must build the environment large enough to handle the peak demand needed by the organization, and carry the cost of idle systems when demand falls.

Hybrid Cloud

Hybrid cloud computing is a combination of public cloud computing and private cloud computing. It is an environment where part of the cloud is hosted by a public cloud provider and part is hosted by the enterprise itself.

The advantages and disadvantages are a mix of the public cloud computing and private cloud computing advantages and disadvantages.

The advantage of this configuration is a mix of security and scalability. The enterprise maintains control of its sensitive data in its private cloud. They can also gain flexibility to configure the systems as need within the private cloud portion of their environment. At the same time, the enterprise can leverage the scalability and utility pricing of public cloud computing. They can scale up and down production and test environments to meet demand without having to purchase hardware, maintain systems or staff.

A disadvantage is that hybrid cloud computing requires hardware to be purchased and staff maintained to a level to meet peak requirements of the private cloud environment. A second issue with this approach is the physical separation of the environments. There could be a performance decrease due to the pubic cloud systems and the private cloud systems having to communicate across the Internet. In the other cloud environments, all of the systems are communicating across local connections which are typically many times faster than communicating across the internet.

SOA

Service Oriented Architecture (SOA) is often a misunderstood term. It has been described in technical terms as if it was a technical solution similar to Infrastructure as a Service. In the broad sense SOA is not a technology in and of itself. SOA is an architecture style. Three good descriptions of SOA are:

"The primary goal of Service Oriented Architecture (SOA) is to align the business world with the world of information technology (IT) in a way that makes both more effective. SOA is a bridge that creates a symbiotic and synergistic relationship between the two that is more powerful and valuable than anything that we've experienced in the past. Moreover, SOA is about the business results that can be achieved from having better alignment between the business and IT". (High, Kinder, Graham 2005)

"SOA is a design style for maximizing IT interoperability, and for sharing and reusing business services in a distributed environment. Service orientation isn't a new approach to software design, but it has become increasingly viable because of the widespread adoption of Web services technology that makes creating an SOA practical and cost effective". (Systinet, 2006)

"Service-Oriented Architecture (SOA) is an IT architectural style that supports the transformation of your business into a set of linked services, or repeatable business tasks, that can be accessed when needed over a network. This may be a local network, it may be the Internet, or it may be geographically and technologically diverse, combining services in New York, London, and Hong Kong as though they were all installed on your local desktop. These services can coalesce to accomplish a specific business task, enabling your business to quickly adapt to changing conditions and requirements". (IBM 2009)

As the name implies, SOA is architecture that focuses on building technical solutions around services. The goal of using SOA is to identify the services that make a business process perform and build technologies around those services. SOA improves alignment between business functions and IT solutions. SOA's popularity is increasing because businesses are becoming more focused on the business process and how IT can support it.

"In a recent survey of 1,400 CIOs by Gartner Executive Programs, the top business priority identified by CIOs was business process improvement. This has led to a renewed focus on core business processes -- how they are performed today, how they can be improved and how quickly they can be changed". (Gilbert, 2006)

Inside SOA

Before going too much further, it will be helpful for you to understand how a service is defined in the context of SOA. There are many definitions, but this is one I like:

"Services are software chunks, or components, constructed so that they can be easily linked with other software components. The idea behind these services is simple: Technology should be expressed in chunks that business people can understand rather than as an arcane application such as ERP or CRM.

At the core of the services concept is abstraction, the idea that you can assemble software code into a chunk meaningful enough that it can be shared and reused in many different areas of the company. For example,

there is a lot of software code that goes into creating an automated task such as sending a query to a credit reporting website to find out if a customer qualifies for a loan. But if the programmers at a bank can abstract all that code to a higher level—that is, take all the code that was written to perform the credit rating check and package it into a single unit called "get credit rating"—the programmers can reuse that chunk the next time the bank decides to launch a new loan product that requires the same information rather than having to write the code from scratch.

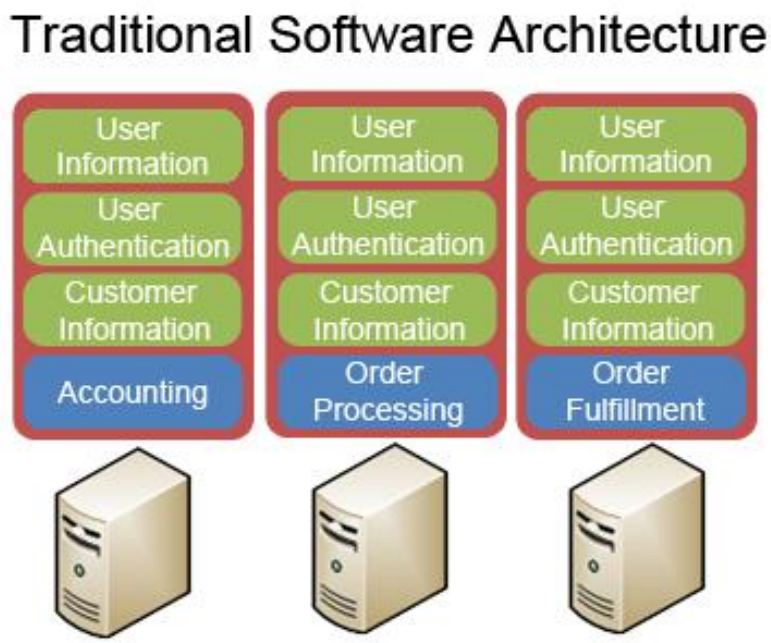
Developers create the abstraction by building a complex wrapper around the bundled code. This wrapper is an interface that describes what the chunk does and how to connect to it. It's an old concept that dates back to the 1980s, when object-oriented programming first appeared; the only difference is that today, the ambition for the size and sophistication of these software objects is far more grand".(CIO 2009)

The first part of SOA is to break down the business's services to the lowest level they can reasonably be broken into. It is these independent services that IT should architect technological solutions around, which will create alignment between business services and technology services.

The second part of SOA is loosely coupled communications between the services. When people describe SOA they often only focus on the communication between application's services. Loose coupling is when services communicate with other services using industry standard methods. Each service needs to expose its services on the network to other services on the network so that the combination of all the services can create a complete business process. In a SOA environment, all of the services use standards-based communications applications, which means that any application can communicate with any other application with no modification. Because of loose coupling, one can replace a service without having to change the services that communicate with it. The recent advancements in communication have made SOA a hot topic. When people describe SOA they often only focus on the communication between applications feature. The fact that the services are loosely coupled is important, but it is not the only aspect of SOA.

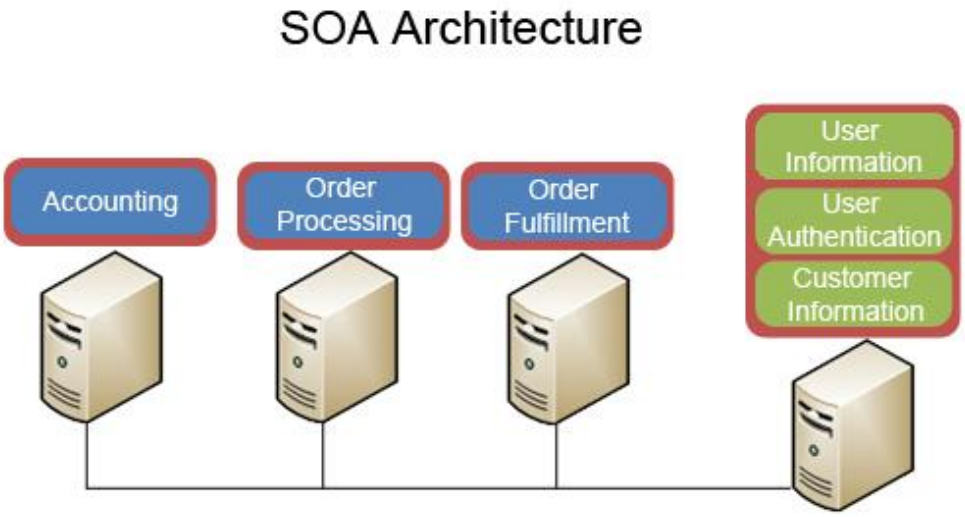
As an example of SOA, let's take a look at a fictitious widget manufacturing company. It has three systems running independently: accounting, order processing, and order fulfillment. Each system stores user information, authenticates users, and stores customer information as illustrated in Figure 8.

Figure 8: Traditional Software Architecture



To apply SOA to the example environment, all of the redundant application services would be separated from the applications they are part of and implemented as independent services. Each of the new services would allow each of the existing applications to access the new service via the network. The new configuration performs the same tasks as before, but the redundancy has been removed, as illustrated in Figure 9.

Figure 9: SOA Architecture



This example highlights the advantages of splitting business services out into independent technology services. The new SOA environment has reduced redundancy and has reduced the chance of error due to keeping two copies of the data.

As organizations implement SOA methodologies there are a few things that should be considered. The first is that SOA adoption should be done via incremental development. It is not feasible and it does not make sense to try to re-engineer an entire IT environment at one time. Focus should be shifted toward interoperability; without it the business processes will fail. IT agility is also an important component within SOA. Service solutions should be designed so they are easily accessed and easily updated as requirements change. The last consideration is that organizations should architect in terms of business solutions. The IT environment should align with the business solutions and the services that make up those solutions. (Systinet)

Advantages of SOA

In a recent Forrester survey, close to 70 percent of enterprises worldwide reported that they are planning to increase their SOA usage over the next 12 to 24 months. The main driving force behind this trend is the improved application and business flexibility that SOA promises.(IBM, 2006)

According to Sysnet's article "A Practical Guide to SOA for IT Management" there are several basic business drivers to implementing SOA. The first is agility. SOA's loosely coupled services oriented around business services are more flexible than traditional integrated services. As business services change it is simpler to change the corresponding loosely coupled IT service in a SOA architecture then it is to change services that are not independent and use proprietary communication technologies.

SOA also has cost savings advantages. SOA may have some additional expenses in developing the loosely coupled communication structure but overall it is less expensive. By isolating services, each service needs to be built only once. This reduces unwanted redundancy, application development cost and maintenance cost. By leveraging SOA based applications already on the network developers, do not need to recreate common services in each application they are developing. allowing them to produce new applications faster.

SOA maximizes IT investment by eliminating the process of IT ripping out old investments to implement a new solution. SOA encourages organizations to wrap and reuse existing IT investments to make the applications available to a wider audience. The reuse of existing systems increases the return on the investment in the original system.

At the root of SOA is the business advantage of aligning IT to business processes. With SOA, IT services are aligned with business solutions, which improves the effectiveness of those services in advancing the business requirements. Because IT and business solutions are aligned, IT can have a large positive impact on the organization. IT goes from delivering a set of unrelated services to delivering a set of services that are solutions to the business needs. (Systinet)

In an IT environment that has been designed around SOA, IT services can be used as a place to implement changes to a business process. Because IT services align with business services, the performance and procedures

within IT services can indicate areas of improvement within the business process. SOA based architecture can also be used to track business goals and identify places to improve efficiencies.

GRID

Grid computing is the utilization of many technical resources to simultaneously satisfy a technical need. Two of the better definitions of GRID computing are:

> *"Grid computing, most simply stated, is distributed computing taken to the next evolutionary level. The goal is to create the illusion of a simple yet large and powerful self managing virtual computer out of a large collection of connected heterogeneous systems sharing various combinations of resources". (Berstis, Viktors)*

> *"The simplest way to think of grid computing is as the virtualization and pooling of IT resources, such as compute power, storage and network capacity, into a single set of shared services that can be provisioned or distributed and re-distributed as needed". Demarest)*

A GRID consists of many technical resources often called, "nodes", "resources", "members", "donors", "clients", "hosts" or "engines". Each part contributes to the GRID system as an available resource (node) that performs a specific function in the GRID, such as job scheduling.

GRID Types / Parts

Processor

Grids can be architected to provide processor resources to process intensive tasks. The goal of an application that runs on the grid is to split the task into as many parallel processes as possible. GRID based applications need complex mathematical algorithms to split tasks into independent processes. A GRID application can be thought of as a CPU application that can be broken down into many subtasks that can run on separate CPU's. A perfectly scalable application would process a request twenty times faster in a GRID of twenty machines than it would on single machine.

GRID processing can be put into three groups. The first is an environment where there are many resources available to perform a given task. When a task enters the system to be processed the job scheduler finds an idle resource to process the request. An application does not have to be broken down into multiple jobs to take advantage of this type of GRID. Performance is gained by being able to find idle systems to run applications.

The second GRID grouping is the style that is most often thought of when talking about GRID computing. This style of GRID computing is when a request is split into many different jobs that can be run in parallel. A simple example of this is processing a week's worth of user hit logs from a popular website. One way to build a report of who visited what webpage would be to start with the first record in the log and work through it one line at a time. A faster way to get the results would be to split the log apart into chunks. Each chunk then can be sent out to a different node in the GRID to have that node process it. At the end of the process, the chunks would then be aggregated into one report.

The third GRID group type is when an application that needs to run the same task multiple times utilizes a GRID to increase efficiency. In this situation, an application needs to process many distinct jobs. Instead of running of an application on one machine and processing one job at time, the application runs on many machines in the GRID and processes each job in parallel.

Data Grid

Data GRID is a term applied to storage architected in a GRID. A Data GRID combines storage within the GRID into a more efficient solution. The goal of a Data GRID is to aggregate storage so that it is available to more resources and that unused storage is utilized. By combining storage across the network, larger storage solutions can be created and then repartitioned out to resources on the network as needed. Data GRIDs use storage technologies including Andrew File System (AFS), Network File System (NFS), Distributed File System (DFS), or General Parallel File System (GPFS). These technologies offer varying degrees of performance, security features, and reliability features. (Berstis, Viktors).

One of the more advanced solutions for Data GRID is a Global File System. A Global File System allows multiple machines to treat storage on the network as if it was on a local disk. Each node in the Global File System is allowed read/write access to the disk and acts as a peer.

Advantages

Resource Balancing

Storage combined into a Data GRID can be greater than the sum of the disks. Too often in server farms, there is isolated storage that is not being utilized or the storage available in each of the individual storage devices is not large enough for the organization's needs. When that storage gets aggregated into a larger disk it becomes more usable.

Data GRID also increases performance in the system. In a Data GRID, data is distributed across many devices. By separating data across multiple devices communication speeds increase and the chance of data being lost is reduced by increasing data redundancy.

Resource balancing is an advantage of GRID processing. In a GRID, as jobs are added they can be distributed to CPU resources that are not in use or queued for the next available CPU resource. A fully implemented GRID will have a job scheduler that will prioritize jobs. With prioritization, the queue system will not only assign jobs to CPU resources base on CPU utilization, but it will also assign higher priority jobs ahead of lower priority jobs.

Access to additional resources

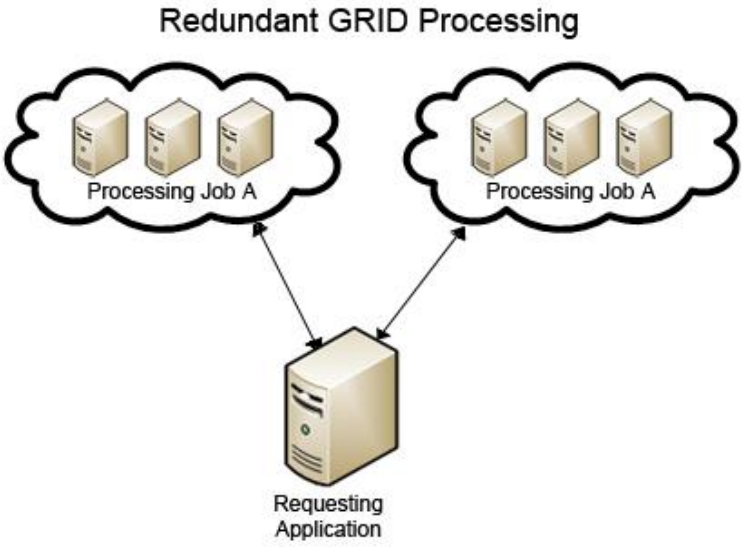
In addition to access to CPU and storage resources, GRIDs can grant access to special hardware or licensed software. For example a node in the GRID may have an expensive licensed application on it. Jobs that need to be processed by that application can be submitted anywhere in the GRID and routed to the machine with the special software.

In addition to granting access to special software, GRIDs can control access to special hardware. A node on the GRID might have a special blueprint printer or a DVD juke box printer that can produce a larger volume of disks. Or, the special hardware may just be of a different architecture such as a mainframe used to crunch large computational requests.

Reliability

GRID computing can also increase reliability. Through self monitoring, GRIDs can watch for issues within the network and route jobs to other resources on the network when an issue is found. If a node on the system goes down, jobs that were queued to be processed and ones that are currently processing on the down node will be rerouted to another node. This architecture can almost eliminate outages due to hardware failure.

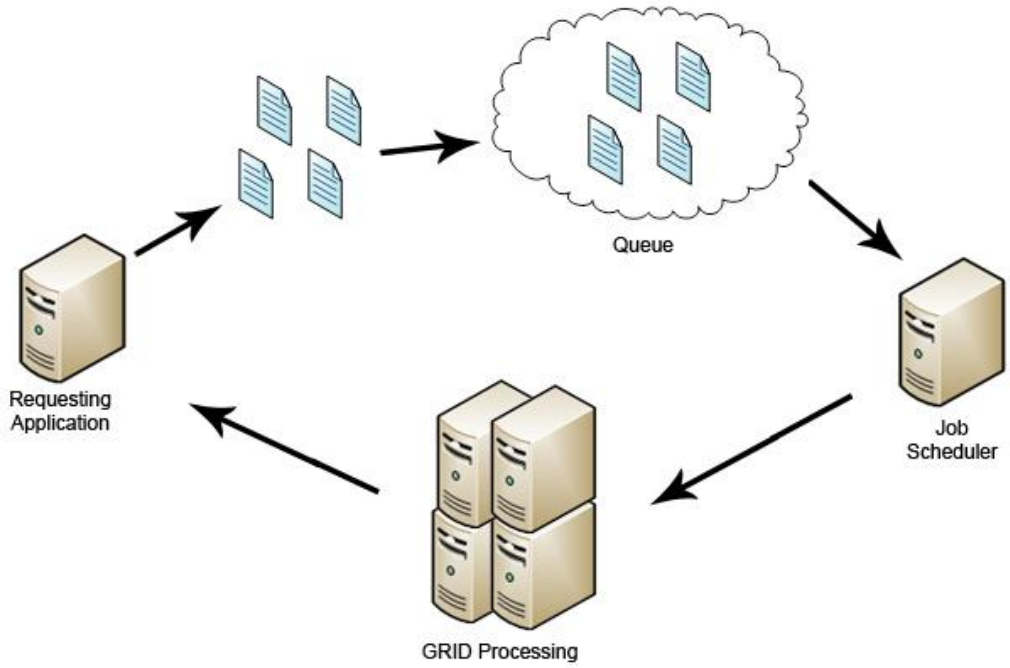
Figure 10: Redundant GRID Processing



If a process is extremely important or it needs to run in real time it can be run simultaneously on two different parts of the GRID at once. In this architecture, if the primary occurrence of the application fails the second application continues on with the process or service reducing /eliminating any lag or outage of the service.

Architecture

Figure 11: Grid Processing



There are many resources a GRID can provide, but primarily GRIDs provide processing services to applications. In a GRID, an application is broken down into jobs and if possible those jobs are broken down into sub-jobs. The application submits the jobs and sub-jobs into a queue in the GRID. The job scheduler will send the jobs and sub-jobs to multiple GRID resources to be processed. The results of the processing are sent back to the applications. It is typically the application's job to aggregate the results back to one solution or result.

Ubiquitous Computing

Ubiquitous computing is a computing environment where computer interaction is everywhere in the user's environment. The user may or may not be aware of the existence of computers. Each of the computers within the uses environment will interact with each other sharing information and performing tasks interactively.

The concept is that everything in your environment has some kind of processing power and it can interact with you to perform tasks specific to your needs. Your refrigerator and cabinets will know what foods are in them and can suggest recipes or produce a shopping list. Your lighting and environmental controls will react to your presence, time of day, day of the week, and possibly your mood. As you travel out into the public, the environment will react to you. For example, you could walk into a coffee shop you have never been in before and be served your coffee just the way you like it. The shop would know your preferences based on information the environment "learned" from information your phone shared with them or by identifying you by some unique key and pulling your preferences from a central data warehouse.

Despite the work that has been done on ubiquitous computing since the idea was first suggested around 1987, it still only can be seen in universities and technical labs. Although computing speeds have grown at a faster rate than we might have predicted, and computing costs have dropped at astronomical rates, the proliferation of computing has not reached the level of ubiquitous. The widespread adoption of the Internet starting the in the mid 1990's has moved us much closer to the goal. The Internet has created the network needed to for mass communication between devices.

The latest trends in smart phones have also moved us one step closer to ubiquitous computing. Currently, the Apple iPhone has over 35,000 applications developed for it. Some of the applications use GPS functionality in the phone to create location aware applications. For example, there are applications that will find retail shops in your area based on criteria you supply the applications. The advancements in smart phone applications are bringing us closer to computing everywhere we go, but is not quit the same as the ubiquitous goal of computing everywhere around us.

Two researchers have built a ubiquitous application for cell phones that is aware of whom you are near. The application is designed to create reminders to be trigged the next time you are near a particular person or a particular group of people. The application works off the unique identifiers in the Bluetooth system. Without invading individuals' privacy the application goes out and reads the public Bluetooth identifier for any Bluetooth device in the area. (Osbakk and Rydgren) For example, let's say you want to remember to talk to Mary about a project next time you see her. The application on the phone will constantly scan for Bluetooth devices. When you

come into close proximity with Mary, the application will become aware of Mary's phone via its Bluetooth address. The application will then remind you about your desire to talk to Mary about a project.

Conclusion

The topic of technical trends is a difficult topic to pin down. As you can see with ubiquitous computing what may have been predicted 20 years ago as a future trend may or may not be where technology goes. Technology changes fast. The trends that do come tend to leverage new technical advances and are adopted because they have real world applications. Virtualization and Cloud computing are two trends that are creating real business benefits for their users. Because they have real application possibilities they are seeing fast acceptance and growth.

Chapter 10: Managing emerging technologies

Chapter editor: Ian Jaffe, MBA, Daniels College of Business, University of Denver

Learning objectives

- Understand the benefits and uses of Web 2.0.
- Understand collaboration.
- Know how social networking is impacting business.
- Realize the benefits of virtual worlds.
- Realize how SaaS can simplify and improve how business is done.
- Learn the differences between knowledge management and knowledge mapping.
- Grasp the concept of business intelligence.
- Learn about analytics.
- Discover the benefits and uses of AI.
- Learn about competitive intelligence and how to use it.
- Understand the process of managing emerging technologies.

Examples of emerging technologies

Emerging Technologies are developments in Information Technology that gain popularity over time as they evolve. Some of these technologies evolve from other similar technologies. For example, **Knowledge Management** has created the need for **Knowledge Mapping**. In this case the ability to capture and organize business knowledge created the need to filter and create business intelligence that can be used to find meaning within the information. Some technologies affect business organizations immediately while others transform from one medium to another; such is the case with **social networking**. Technologies each have their own maturity lifecycle. **SaaS** (Software as a Service) for instance has been around for years and now that average Internet speeds are increasing and browser security is improving this technology is becoming increasingly mature. Other technologies such as **virtual worlds,** which are online environments where users meet to communicate and collaborate, are relatively young in their lifecycle. Throughout this chapter we will be exploring these emerging technologies and others and will be identifying their effects on the business environment, the positive and negative benefits that are associated with them, and how one can go about making sense of them. There are several processes for managing these technologies that an organization can follow and those processes will be introduced and broken down so they can be discussed in detail.

How are emerging technologies managed?

It can be overwhelming for organizations to try and manage emerging technologies. Organizations need to understand which technologies are relevant to them, what the benefits are, what technologies and methods to avoid along the way, and where to learn more. Managing emerging technologies is a two-step process. The first-step involves identifying the technologies that will be of potential benefit to the organization. The second-step involves deploying that technology and being able to make adjustments to fine-tune how it is used over time.

This chapter will explore some of the technologies that have been emerging recently including: Web 2.0, Collaboration, Social Networking, Virtual Worlds, SaaS, Knowledge Management, Knowledge Mapping, Business Intelligence, Analytics, Artificial Intelligence, and Competitive Intelligence. This may seem like a lengthy list of technologies, each technology will be explained in a way that makes sense, which will help make it easier for you to learn how to evaluate and take advantage of these technologies in your organization.

There are many informational vehicles that can be used to explore emerging technologies in more detail. Many are websites. One website worth accessing is Slashdot (http://slashdot.org) which collects “News for Nerds” from across the web. Many of the technologies discussed in this chapter appear on this website on a regular basis. A

second website that serves as a great source for this information is ZDNet (http://www.zdnet.com) whose parent company publishes many of the popular computer magazines. ZDNet contains articles from several publications, valued blogs, definitions of the latest IT jargon, and lots of webcasts. Additional valuable sources of emerging technologies will be identified throughout this chapter.

There are a variety of processes that can be used to manage emerging technologies in the workplace. One such process starts with pilot testing, where a technology is first evaluated to determine if it provides benefits. In this phase one is able to see if a new technology can integrate into an existing system within an organization, or if a new system is needed in order to use it. The second phase of this process is engaging the enterprise where one works to gain buy-in from management and from other business entities involved. It is very important that one does this initial round of testing and collects buy-in before trying to integrate a technology into an organization's IT infrastructure. There is no value in spending the time improving an existing product or creating a new product if no one will use it. The third phase in this process is application pilot testing where the organization's users and technical staff evaluate an application of the new technology and make further improvements to the application. The final phase of this process is the roll-out where the product is deployed to all affected organizational units. This may involve updating an Internet application, an internal software tool, or creating a new process entirely.

Visibility over time

The visibility of emerging technologies can be charted on a graph that shows the five phases of technology exposure over time. These phases are technology trigger, peak of inflated expectations, trough of disillusionment, slope of enlightenment, and plateau of productivity. Here is a chart that shows how many of the technologies identified in this chapter fit into this model along with a few others.

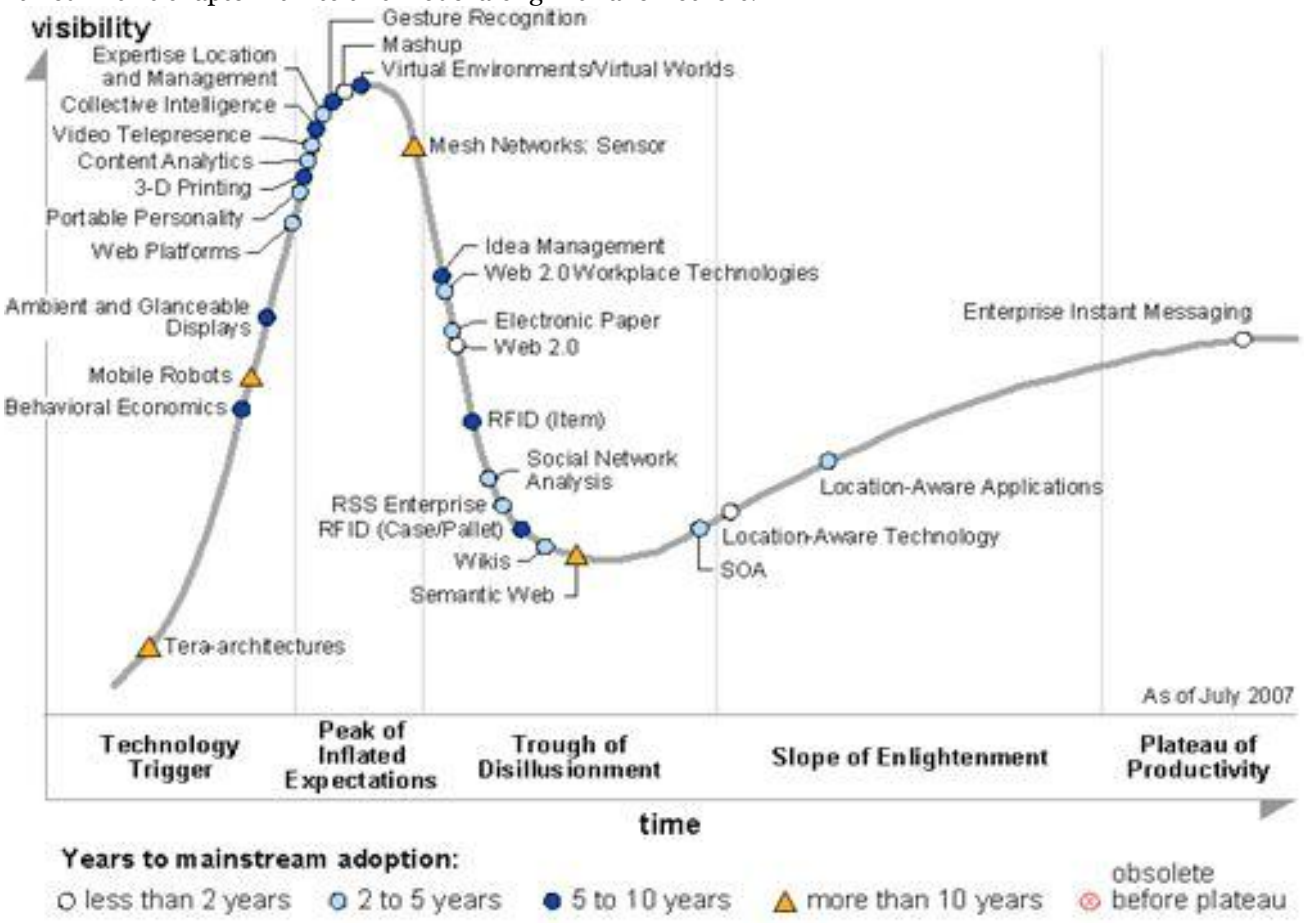


Figure 10.1: Hype cycle for emerging technologies (Gartner 2007)

According to Wikipedia, "A hype cycle in Gartner's interpretation comprises 5 phases:

- "*Technology Trigger*"—The first phase of a hype cycle is the "technology trigger" or breakthrough, product launch or other event that generates significant press and interest.
- "*Peak of Inflated Expectations*"—In the next phase, a frenzy of publicity typically generates over-enthusiasm and unrealistic expectations. There may be some successful applications of a technology, but there are typically more failures.

- "*Trough of Disillusionment*"—Technologies enter the "trough of disillusionment" because they fail to meet expectations and quickly become unfashionable. Consequently, the press usually abandons the topic and the technology.
- "*Slope of Enlightenment*"—Although the press may have stopped covering the technology, some businesses continue through the "slope of enlightenment" and experiment to understand the benefits and practical application of the technology.
- "*Plateau of Productivity*"—A technology reaches the "plateau of productivity" as the benefits of it become widely demonstrated and accepted. The technology becomes increasingly stable and evolves in second and third generations. The final height of the plateau varies according to whether the technology is broadly applicable or benefits only a niche market.

The term is now used more broadly in the marketing of new technologies". (Wikipedia 2009a)

Virtual Environments and World, Mashups, Collective Intelligence, and Content Analytics are all heading towards this peak. The trough of disillusionment, the third phase, is the point at which the technology becomes unfashionable and the press abandons it because it did not live up to the hype. Wikis, Social Networks, and Web 2.0 are all falling towards the bottom of disillusionment. Some point after the state of disillusionment, organizations begin to realize the technology's applicability, risks and benefits, and tools become available to them to ease in the development process. Finally, at some point the plateau of productivity is reached. This is when technologies can no longer be deemed as emerging as they are fully accepted and integrated a workplace in a stable state. Gartner says that "the final height of the plateau varies according to whether the technology is broadly applicable or only benefits a niche market" (Gartner 2009). Enterprise Instant Messaging is certainly in this phase as of mid-2009.

Realizing the benefits of a new technology takes a varying amount of time depending on the technology's complexity and on its intended purpose. It is often hard to predict what the true benefit of a technology is when it first emerges on the market. The chart below shows the level of benefit of several technologies in comparison to the number of years it took until they were widely adopted. Note that Web 2.0 was adopted in less than two years and had transformational benefit. Competitive intelligence on the other hand took five to ten years before it had mainstream adoption. Content analytics and wikis have only provided moderate benefits thus far. Based on this analysis, organizations will see the greatest benefit when they invest in Web 2.0, Web 2.0 Workplace Technologies such as collaboration, and Web Platforms such as SaaS.

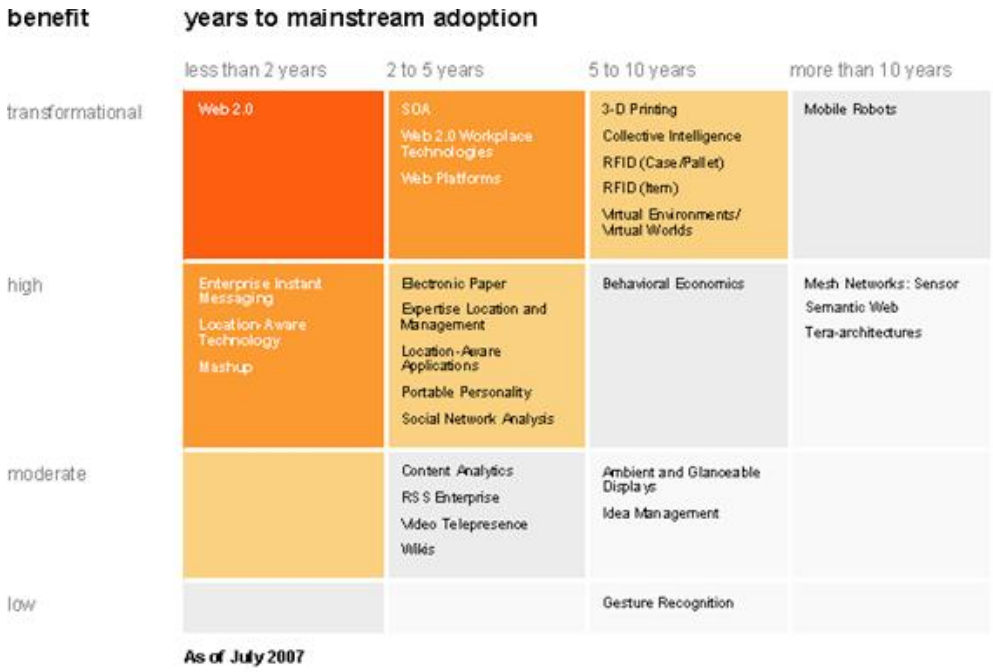


Figure 10.2: Priority matrix for emerging technologies (Gartner 2007)

An introduction to Web 2.0

Internet technologies have evolved over the last forty years from Arpanet, the world's first packet-switching network (Wikipedia 2009b) to the introduction of a browser that eventually supported images and web forms to the second generation of the web, Web 2.0. **Web 2.0** refers to a re-envisioning the Internet as a platform for applications where users can control their own data, applications are service-based rather than packaged software,

where there is an intrinsic architecture of participation, scalability is cost-effective, data sources are combined seamlessly, software is portable to a variety of devices, and collective intelligence is harnessed (O'Reilly, 2005).

According to O'Reilly, while Netscape was the standard bearer for Web 1.0, Google is the standard bearer for Web 2.0. Netscape represented a platform while Google has always represented a service. Google is successful because of the data it has collected and the online experience it provides. Web 2.0 has replaced other Web 1.0 Internet applications with web services that better suit the new generation of users. For example, AdSense replaced DoubleClick. These are two very different models for collecting Marketing data from web browsers. DoubleClick's focus was on banner ads and pop-ups, which were eventually seen as intrusive by users, while AdSense delivers context-sensitive and consumer-friendly ads.

Web 2.0 services are able to harness **collective intelligence** by gathering information from their users and using that information to improve the content that they deliver. For example, RSS feeds collect information that is valuable to a user and delivers it to them automatically as updates are available. Web users can use RSS to subscribe to blogs where businesses and Internet users share their thoughts or to stocks and weather updates. Another example of collective intelligence is Wikipedia, where users all over the world contribute their expertise to create and constantly improve an online encyclopedia. With Web 2.0, the information that servers have and can make available to users is what determines their ultimate value. Amazon's list of products and MapQuest's map databases are just two examples of this. There are many other examples of Web 2.0 applications available online.

Organizations that want to take advantage of Web 2.0 in their product offerings or internally need to understand their core competencies may employ services with cost-effective scalability, control over unique informational sources, trusting users as co-developers, harnessing collective intelligence, leveraging customer self-service, software that works on multiple devices, and lightweight user interfaces (O'Reilly, 2005). According to Paul Graham, Web 2.0 accomplishes three things: (1) the utilization of Ajax which allows web-based applications to work more like desktop applications in the way that data is refreshed without needing to reload a webpage, (2) it gives users a democratic experience, one where users' ideas and their production contribute to the application and (3), users are quickly given the information that they desire (Graham, 2005)

How does collaboration help organizations?

Collaboration is one of the common uses of Web 2.0 technology. Collaboration enables us to share information as we are working together, to write on a blog collectively, or to communicate via audio and video conferencing. More and more of today's collaborations are taking place over the Internet through Web 2.0 services. However, some forms of collaboration are only made possible through tools specifically designed for the purpose. An example of a Web 2.0 collaboration service is Adobe Connect, which allows users to create personal meeting rooms for audio and video conferencing, to share files easily with peers, and to brainstorm through white boarding sessions. Adobe Connect also allows users to share their screen with each other in order to review applications or to browse Internet sites. Another example of Web 2.0 Collaboration service is Campfire which is a real time chat room that makes it easier for teams to work together because they can share pictures, transfer files, and all communication is saved. As mentioned, some forms of collaboration are not based upon Web 2.0 technology. One tool that fits this description is Skype, an advanced Internet messaging tool that enables users located anywhere in the world reached by a broadband Internet connection to meet in group chat rooms, audio and videoconference, and call real phone numbers. Skype enables users to save time, save money, and collaborate more easily. These three tools are examples of emerging technologies that are transforming the business landscape.

Organizations need to take advantage of collaboration's benefits in order to pave new and better ways of operating. Collaboration helps organizations increase sales, create opportunities, improve customer service, and decrease costs (Stahl, 2001). Thankfully, it is becoming increasingly easier to collaborate online. There are three types of collaboration: electronic communication, electronic conferencing, and collaborative management. E-mail, Wikis, Blogs, and Adobe Connect and Campfire's document and file sharing capabilities are all examples of electronic communication. Skype, Adobe Connect, and Campfire are examples of electronic conferencing tools. Collaborative management is another form of collaboration that has been evolving and improving how groups can work together. Collaborative management includes electronic calendars, project management systems, workflow systems, knowledge management, and social software. Google has a collaborative management tool that they call Google Apps (7 Things, 2008). This application makes it easy for users to share content without transferring files or worrying about software compatibility. At this point there is one general concern related to these applications, however, which is access rights and security. Some users are concerned that by sharing information online their data is not as secure as it would be if stored locally. But overall, the benefits that collaboration can provide an organization usually outweigh the concerns.

Social networking? At the office?

Social networking applications provide us with improved ways of communicating with each other in real-time. Social networking takes place through the use of Web 2.0 applications that offer chat, message boards, blogs, photo sharing, and a variety of ways to find connections. Social networking started as a way for friends to connect online. Over the last few years, business professionals have begun exploring these networks and some new networks have come online that offer additional features. New features include online references, the ability to post career and educational information in a searchable database, and the creation of organizational networks. Organizational networks are a way of grouping internal users with related interests, backgrounds, or profile information.

LinkedIn was one of the first Web 2.0 social networks to appear for business users. This website is often used as a recruiting tool as it allows recruiters to find job candidates and candidates to find organizations that are hiring. LinkedIn also allows users to create online profiles that serve as online resumes. As a user adds their previous employers to their profile, each company becomes a social network. The same is true with each educational institution. Using LinkedIn makes it easy for one to add users to their network they have worked with or gone to school with. LinkedIn also provides users with a testimonial capability where users ask their contacts for references and those references are visible to users browsing a profile. Many organizations use LinkedIn to evaluate candidates that are being interviewed for various job positions. Organizations also use LinkedIn to get personal references. When searching for a candidate, managers are able to find out if any of their contacts (or contacts' contacts) know or have worked with the candidate. Before LinkedIn, all online job searching was done through career search websites such as Monster and Career Builder. These websites worked great in the early days but other than being able to reply to postings there were no social networking capabilities. Career search websites are still used by organizations as one way to locate candidates along with phone, e-mail, etc but new Web 2.0 services such as LinkedIn are yielding better results.

Organizations are beginning to take advantage of the same websites that were once used by groups of friends or college/high school students such as Facebook and Twitter. Facebook allows co-workers to connect with each other. The downside of using Facebook with co-workers is it combines one's work friends with one's social friends. If one was out at a bar with a friend who took an embarrassing picture of them and that picture was put on Facebook it might be seen by co-workers and talked about at work. One advantage of connecting with co-workers in this way, however, is Facebook makes it easier to stay in touch and to reach out to multiple contacts simultaneously. Twitter allows co-workers to communicate with each other through status updates. Organizations can take advantage of Twitter to get opinions from current and potential customers, to promote a product or an upcoming event, give advice, and share the human side of the organization. The downsides of Twitter are that it takes time, it takes employees away from work, it requires a strategy, it does not replace customer service, and it opens up organizations for more criticism and griping (Brogan, 2008).

For organizations that are interested in taking advantage of social networking it is important to be aware of these tools but it is also important to be warned of potential pitfalls of this technology. Social networking applications are highly addictive and introducing one of these tools to an organization may increase the amount of time that employees spend browsing the Internet and being distracted by their friends. There are also security concerns that organizations need to be aware of. These applications make it easy for friends and co-workers to share files with each other, which may increase the risk of exposure to viruses and the sharing of confidential information. The same however, can be said for organizations where employees are frequently browsing their personal e-mail accounts. To learn more about security concerns in the workplace please see Chapters Seven and Eight.

Signing up for social networks is free and relatively easy as only a few fields are required initially. Once signed up it is easy to e-mail others and ask them to join the same network and for them to be connected to you. Organizations can also take advantage of social networks for advertising. Since social networks group users with common interests, organizations can use them to get in touch with users that fit into their target marketing demographic. Advertisements are becoming increasingly context sensitive as well. This means that user profiles are mined for certain keywords and advertisements that directly target them are displayed on their profile page. Such advertisements are beneficial to organizations because they can get more return for their advertising dollars. They are beneficial to users because they are no longer bothered by advertisements that do not apply to them.

Pressures to innovate and to increase the capabilities of information technologies are encouraging organizations to take advantage of social networking systems. The systems that they choose to adopt may be along the lines of Facebook, Twitter, or LinkedIn due to their highlighted benefits or they may instead prefer systems that provide knowledge management capabilities. Social networks can simply facilitate communication and the development of relationships between employees and they can be used to promote organizational learning, encourage innovation, and improve business performance, flexibility, and responsiveness. Knowledge managers can use social networks to create the following types of environments:

- Functional networks where employees that perform similar functions in an organization interact and share knowledge and experiences about their work to solve problems collaboratively.
- Cross-functional networks that link employees from different parts of an organization. Everyone that is involved in product development, for example, can be linked together to make decisions and share information.
- Interpersonal networks are informal networks where employees meet to share information on social activities and personal accomplishments.
- Innovative networks connect individuals with diverse backgrounds and knowledge to lead innovation and brainstorming sessions.
- Inter-business unit networks combine business units such as marketing combined with engineering to address common issues and develop solutions.
- Customer networks are professional online networks where a company makes itself available to their customers to discover new ideas for products and services. (McKeen, 2007b)

Additional approaches to knowledge management are discussed later in this chapter.

Effective social networks must include mechanisms for users to understand and make use of their common attributes such as context, background, history, common knowledge, and social resources (McKeen, 2007b). Such systems can then be used to solve business problems, stimulate local action, motivate employees in new ways, and legitimize cross-boundary communication. Longer-term benefits include facilitating a strategic process, developing staff, rapid communication, uncovering new sources of value, and improving quality of work life (McKeen, 2007b). Getting the greatest benefit from social networks takes time and work. There are a variety of strategies that organizations can follow in order to more effectively integrate social networks into their organizations:

- Develop absorptive capacity – Take innovative ideas and transform them to practical reality. It is important to provide employees with the ability to transform networking outcomes into larger scale learning and capacity development opportunities.
- Organizations need to create environments where networks can flourish. Networks can flourish through e-mail, conference calls, or online. Employees must be given time to interact.
- Employees should be encouraged to interact with those that they do not know. The real value of social networks comes from people reaching out to each other and encouraging cross-departmental communication.
- Managers need to decide what type of social network is most valuable, whether it is regional, departmental, or common interest.
- Management controls should be loosened and communication should be encouraged. (McKeen, 2007b)

Social networks can be highly effective in the workplace as they help employees build new relationships, create new sources of value, find new sources of knowledge, and generate new business and industry models. A lot of valued information can come from social networks and organizations need to know how to take advantage of them in order to be as effective as possible.

Exploring virtual worlds

Virtual worlds are both fun to explore and beneficial as they take communication into a third dimension. Virtual networks have been around for a long time. From the point in time when they emerged to when they were more widely adopted, virtual worlds have had a long lifeline. Virtual worlds were first used in games during the early days of the Internet when people connected online through MUDs, or Multi User Dungeons. These MUDs were text-based worlds where users would interact through commands such as “go north”, “go left”, and “pick up sword”. MUDs evolved and began taking on graphical features, which gave them a greater sense of reality. In the more recent years Internet users have migrated to 3D MMOs, which are Massive Multiplayer Online communities. In these worlds thousands of users meet in virtual 3D space where they are working towards common goals. Some MMOs are games that are intended only for gamers while others are designed for social networking use and offer a variety of capabilities. In the MMOs one may be spend their time fighting trolls in a dungeon, finding a superior weapon or armor, or learning advanced spells. These games have evolved along with their communication capabilities. Originally users would type text to each other and sometimes that text would appear above their virtual avatar. Later on, virtual worlds started to use voice chat where users could talk to each other in real-time. Virtual worlds were once only available to computer users but later became available through video game consoles.

As mentioned, not all virtual worlds are games. In fact, more and more of the virtual worlds that are appearing are for social networking. In these communities, instead of fighting, users are reaching out and talking to each other, exploring shared space, building houses and villages, and making friends. Similar to the Web 2.0 social networks virtual worlds help friends stay in touch and collaborate. More recently, organizations have begun to learn how to take advantage of virtual worlds in order to improve their online presence, to advertise, and even for interviewing. Second Life is one of the most popular Internet tools at this point in time. Second Life allows users to create real estate, in the form of buildings or worlds. Second Life was one of the first virtual worlds to introduce a

currency exchange system where users trade their local currency for in-game Linden dollars, which can be used to create buildings and environments or buy clothing or props to dress up ones' avatar. In Second Life it is easy to jump from one world to another and once one has found their location of interest they can fly through the environment, write text messages to other inhabitants of that community, use voice chat to communicate, and perform certain actions with others such as dancing. Organizations are using Second Life as an advertising tool. For example, Adidas created a virtual store where users can go and check out the latest products, communicate with others, and even buy shoes. Adidas sells their a3 Microride shoes in Second Life. When an avatar is wearing these shoes they can bounce as if they are on a pogo stick which represents Adida's advertising slogan "the ultimate blend of bounce and flexibility with minimum weight" (Wallace, 2006). Other organizations have discovered that Second Life can be used to conduct business meetings or even for interviewing. Organizations such as IBM have their own corporate environment and as IBM's employees are becoming increasingly distributed, virtual worlds are bringing them closer together. One may attend a virtual meeting with other avatars, where each avatar picks a location at a virtual table, views slides or video that is presented to them, and communicates via text or voice. In fact, IBM used Second Life to conduct world conferences during the last two years. IBM estimated that they saved $320,000 in travel and venue costs and productivity gains and 75% of attendees thought the event was successful (IBM 2009). Organizations are also using Second Life as an interviewing tool. They are meeting candidates at specific locations in Second Life where they have a face-to-face avatar-to-avatar interviewing session. IBM is unique in their way of approaching Second Life in that they purchased several servers that are dedicated to running their Second Life portal (Reuters, 2008). A time may come when organizations need to have a virtual presence in Second Life or other virtual environments in order to be productive entities.

A Denver-based software company, Think Like a Genius, has created a virtual world modeling application where young students can create virtual worlds and share them with their friends as a way of expressing themselves. A user assembles these worlds by selecting objects and shapes that best match what they are trying to create. Users will soon be able to take the models and environments and post them on social networking websites such as Facebook. Users will be able to browse each other's worlds, rank their favorites, and send their creations to their contacts. A company may want to use this software to model their latest product, model a new work environment, or just to generate creative synergy. Think Like a Genius is an example of a mash-up because it combines two unlike tools, social networking and virtual worlds, in a new way.

Virtual worlds embody a community, create a system of micropayments, and fulfill the desire of users for identity. They can be used to emphasize the business proposal for a company by reinforcing brand awareness (Cagnina, 2009). At their best, virtual worlds provide components of achievement, socializing, immersion, advancement and competition amongst users, building of relationships, and teamwork. All of these features directly impact the business environment. When organizations are considering using virtual worlds to facilitate collaboration between employees or between their businesses and their customers they need to decide which of these features help them accomplish their goals.

What is SaaS?

SaaS, or Software as a Service, is an improved way in which organizations are able to offer software products to their customers. The term SaaS is essentially a new term for an existing concept, ASP or Application Service Provider. The concept involves making applications available to users through the Internet for a fee (or sometimes for free), in contrast to having the software installed on the customers' computer(s). Applications often provide users with the ability to import data into or export data so that the applications' data is also stored on the vendor's computer along with the application software.

Two of the most popular SaaS applications are Salesforce.com and Google Applications. Salesforce.com helps organizations "manage customer information for sales, marketing, and customer support, providing clients with a rapidly deployable alternative to buying and maintaining customer information, and tracking customer interactions" (Hoovers, 2009). Salesforce.com can be accessed from PCs, cellular phones, and personal digital assistants (PDAs). Salesforce.com enables users to manage accounts and contacts, secure their data, get email alerts, search in a variety of ways, read in multiple languages, generate reports and dashboards, and integrate third-party applications. Salesforce.com has helped users manage their finances, improve their Customer Relationship Management (CRM) capabilities, increase profitability, manage risk, customize applications, make their organization more efficient, and find new opportunities. As of midyear 2009, Salesforce.com has 55,400 customers and over 1,500,000 subscribers.

Google Applications help businesses share information, innovate, and be productive in a secure environment. Some of the available applications include Google mail, Google Docs, Google Calendar, Google Video, and Google Sites. Since Google Apps are free, you should try them out.

Organizations may want to adopt SaaS to save money on integration, development, server, and maintenance costs. Small, medium, and large organizations are taking advantage of SaaS. Hosted products "offload the management of some non-mission critical applications" and keeps "IT budget costs consistent and often lower than packaged or homegrown software" (Fonseca, 2008). The use of hosted products in organizations with more than

1,000 employees has grown 33% from 2006 to 2007. During troubled economic times hosted applications have become increasingly desirable. (To learn more about implementing SaaS applications please see Chapter Five). Gartner believes that "corporate adoption of hosted software will grow by 22.1% annually through 2011, more than double the projected growth rate for packaged applications" (Fonseca, 2008). Adopting SaaS solutions however is not always easy due to capacity-planning difficulties, spending restrictions, and lack of resources to handle business requests. Also, many organizations are change-averse and need to decide if they are ready for a change (Watson, 2008).

What do I do with all of this knowledge?

Managing knowledge and information has been a challenge that many organizations have faced for a very long time. The ways in which organizations can manage, store, and organize information has been changing and improving. Some of the latest features include unstructured tagging, weblogs, and advanced search capabilities (Grudin). Long gone are the days of storing important files in filing cabinets and hoping to be able to find relevant information based on category or on a particular letter of the alphabet. Knowledge management is a process of "acquiring or creating knowledge, transforming it into a reusable form, retaining it, and finding and reusing it" (Grudin).

Knowledge Management "has to do with the management of all stages in the generation, codification, refinement and transmission of knowledge" (Wensley). Generation includes activities such as creation, acquisition, synthesis, fusion, and adaption. Codification is capturing and representing knowledge so that others can use it. The transmission of knowledge involves moving knowledge from one location to another and its absorption. Ruggles says that "Knowledge management tools are technologies, broadly defined, which enhance and enable knowledge generation, codification, and transfer" (Knowledge). Knowledge management tools offer a variety of functions depending on the context in which they are being used. Great care must be put into the integration of a knowledge management tool into an organization.

Currently there are three key obstacles to successful digital storage: digital objects are difficult to find, objects are difficult to assess, and systems are not strong at identifying people who can help find or assess objects (Grudin). Tagging emerged from Web 2.0 and Social Networking technologies. Tagging is the process of applying keywords to a digital artifact that makes it easier for others to search for and identify a particular file. On social networking sites these artifacts are often in the form of photos that have been tagged with the names of the people in the photo, the location where the photo was taken, etc. The problem that arises with tagging is that ,tags are typically freeform and there is no system of controlling which keywords are used or how those keywords are spelled. One could also use pre-defined labels or categories/sub-categories but the desirable categories are not always available. Unstructured tags are a suggested alternative for organization because new tags can be created if needed but by typing in a keyword as a tag, suggestions for tags are made to the user (Grudin). This way, a user selects tags that have been used by others, which in effect creates categories.

Although files can be organized and searched it does not mean that one can make sense of the information. A project blog can be linked to a document library which links individual files to blog posts. Those interested can subscribe to blog posts and be notified of updates. Blogs are collaborative in nature so it is easy for multiple individuals to contribute information, and blogs can serve as effective marketing tools (Grudin). Wikis are a common alternative to blogs but they are different because they "provide more structure, are not wedded to the reverse chronological posting sequence, and are open to authorship by all team members" (Grudin). Wikis, however, are not lightweight and may require restructuring at a later point in time as it is not always easy to know how to organize the information up front.

One software product that has been gaining popularity as a knowledge management tool is Microsoft's SharePoint. SharePoint not only offers document library, blog, and wiki features but also makes it easy to create distinct pages for internal departments or teams, provides security features to protect certain documents or certain pages, and can manage an entire organization's infrastructure of applications (Microsoft). SharePoint, however, has its limitations such as document level options are not available which means that markups cannot be added to files as layers. SharePoint stores all of its documents within a database allowing it to be optimized by search, which makes it harder to back up and manage files independently. SharePoint's offering is broad but not deep and there is room for the software to be developed more tightly with the core of Microsoft's infrastructure. Lastly, there is need for heavy customization in order to get SharePoint to meet one's needs. (The Disadvantage, 2008)

There are many other knowledge management tools available and deciding which one best fits an organization is not an easy task. Tools range in price from free open source products to thousands of dollars for products like SharePoint and Novo Knowledge Base. Features of common knowledge management tools include WYSIWYG editors, data import options including images, Microsoft Office files, and Media, Custom Field Support, document version history, scheduled publishing, data recovery, custom reports, and RSS syndication for the delivery of information. Each product also offers varied approaches to publishing information including the number of targets, categories, and Cascading Style Sheet (CSS) options.

How do I make sense of all of this knowledge?

Knowledge Mapping is the process of building intelligence around the collected information. It is the practice of keeping a record of information and knowledge you need and being able to obtain it easily and efficiently so that an organization can run smoothly. Denham Gey says that Knowledge Mapping "is an ongoing quest within an organization (including its supply and customer chain) to help discover the location, ownership, value and use of knowledge artifacts, to learn the roles and expertise of people, to identify constraints to the flow of knowledge, and to highlight opportunities to leverage existing knowledge. Knowledge mapping is an important practice consisting of survey, audit, and synthesis. It aims to track the acquisition and loss of information and knowledge. It explores personal and group competencies and proficiencies. It illustrates or "maps" how knowledge flows throughout an organization. Knowledge mapping helps an organization to appreciate how the loss of staff influences intellectual capital, to assist with the selection of teams, and to match technology to knowledge needs and processes" (Grey, 1999).

Knowledge Maps include the outcomes of an entire process and their contributions to key organizational activities, logical sequences of all of the activities needed to achieve a goal, knowledge, and the human resources required to undertake each activity (Tandukar). Knowledge can be found in internal documents, libraries, archives of past project documents and proposals, meetings, best practices, experience, and corporate memory (Tandukar). The benefits of knowledge mapping include being able to find key sources of knowledge creation, encouraging knowledge reuse and preventing reinvention, finding critical information quickly, highlighting expertise, providing an inventory and evaluation of intellectual and intangible assets, improving decision making and problem solving, and providing insights into corporate knowledge (Tandukar).

There are a variety of tools available for knowledge mapping including Mindjet, ConceptDraw, and MindGenius. Each of these tools offer features that help organizations manage to-dos, run effective meetings, accelerate project planning, brainstorm, and organize business information. These tools are different from traditional knowledge management tools in that their intention is to organize information by allowing users to draw complex diagrams that illustrate relationships between various portions of collected knowledge. Then one can plan resource allocations, assign categories, and sort. These tools provide built-in symbols and images for drawing and various input/output options (Staz, 2006). ConceptDraw provides users with a variety of ways to capture and organize information including visual mind mapping with radial diagrams, an outlining method that can be used to create a hierarchy of related items, and brainstorming methods. MindGenius is unique in that it targets both business users and those in the educational market. MindGenius is designed to help with planning, presentations, managing meetings, solving problems, brainstorming, mind mapping, managing workload, writing reports, and performing SWOT Analyses. MindGenius helps teams explore possible outcomes, expectations, constraints, and dependencies, by helping them focus on ideas and leaving formatting for last, by assigning actions, by facilitating collaboration, by compiling large amounts of data, and by providing for organized restructuring or reordering of ideas. Ideally a Knowledge Mapping product would automatically collect desired knowledge.

Business intelligence is transforming how organizations operate

Business Intelligence (BI) refers to the skills, technologies, applications and practices used to help a business acquire a better understanding of its collective information. BI applications provide historical, current, and predictive views of business operations. Typically, BI applications feature reporting, online analytical processing (OLAP), analytics, data mining, business performance management, benchmarks, text mining, and predictive analysis. The intention of business intelligence applications is to support better business decision-making

As mentioned before, Web 2.0 applications are successful because of the data that they own and control. YouTube would not exist if it did not host the video files that it does. Google would not be able to provide users with search results if they did not possess the information that they do supported by their unique algorithms. The ten largest databases in the world contain valued collections of information and use business intelligence software to provide that data to users. The US Library of Congress has "more than 130 million items ranging from comic books to colonial newspapers to U.S. government proceedings" (Top). The text portion of the library is estimated at 20 terabytes of data and the library expands at the rate of 10,000 items per day. Amazon, the world's largest retail store, has 59 million customers. They have 250,000 full textbooks available online and millions of items in their inventory totaling 42 terabytes of data (Top). YouTube quickly amassed the largest video library in the world during their first two years amounting to 100 million clips viewed per day and accounting for more than 60% of all videos watched online (Top). In 2007, Google processed 91 million searches per day, accounting for close to 50% of all Internet search activity. Google stores each and every search their users make into their database. In one year that amounts to more than 33 trillion database entries (Top).

The amount of information being stored in databases is truly remarkable, but this information would not be of any value unless there were BI systems that could properly handle that amount of information. Microsoft is one of

the many organizations that have a BI offering. In 2006 Microsoft unveiled their BI software to consumers. This software helps "decision makers improve business performance at strategic, tactical, and organizational levels" and "provides employees with reliable access to information they need to make informed decisions so they can respond swiftly and appropriately to changing conditions that impact business" (TechNet). Microsoft says that their software helps organizations get real-time information, find profitable customers, pivot on a dime (react quickly), find inefficiencies, and save money. They deliver this intelligence through familiar environments such as Microsoft SQL Server, Microsoft Office, and SharePoint Server. Microsoft's software is strong in the consumer market when low cost is desirable, when strong mid market channels are needed, when tight integration with MS Office is desirable, or when an OLAP system is preferred. However, their software lacks analytics, performance management, extract, transform and load (ETL, a data cleansing process), data warehousing, and CRM (Pradhan, 2008). Microsoft is beginning to offer analytics tools with the SQL Server 2008 database software. Large organizations will not be satisfied with Microsoft's suite and instead will want to consider IBM's or Oracle's.

IBM says that their BI software helps organizations set targets, see results, understand what drives their numbers, identify trends that may be benefits or threats, take action with decision making tools, or identify and analyze opportunities. Their software can report data from any data source, communicate business goals with scorecards, monitor performance, analyze trends, communicate complex information with dashboards, and extend business intelligence to mobile devices. Oracle built their Oracle Business Intelligence Applications offering off of one that they purchased from Siebel in 2006. Oracle's product focuses on analytics. They recently expanded their analytics offering to include two new products, one for Project Analytics and one for Loyalty Analytics (Henschen, 2009). New dashboards are being added to their Human Resources and Procurement applications. Oracle has more than 2,000 customers using their BI applications (Henschen, 2009).

Gartner makes five predictions for business intelligence during the next three years. First, they predict that 35% of the top 5,000 global organizations will regularly fail to make insightful decisions about significant changes in their business and markets. This is because Gartner feels that most organizations do not have the information, processes, and tools needed to make informed decisions. Second, by 2012 business units will control at least forty percent of the total budget for business intelligence. Business units will increase spending on packaged analytic applications, corporate performance management, online marketing analytics, and predictive analytics. Third, by 2010, 20% of organizations will have industry-specific analytical applications delivered via software as a service (SaaS) as a standard component in their BI portfolio. Information aggregators will increase their reliance on SaaS to deliver domain specific analytical applications. Fourth, in 2009, collaborative decision-making will emerge as a new product category that combines social software with BI Platform capabilities. IT leaders will tap people's natural inclination to use social software to collaborate and make decisions. Finally, by 2012, one-third of the analytics applications used in business processes will be delivered through coarse-grained application mashups. These mashups overlay analytical queries, calculations, metrics, and graphs onto operational applications (Pettey, 2009).

But what about analytics?

Analytics applications provide ways of abstracting and making use of information stored in business intelligence systems. As mentioned, Oracle's system ships with a variety of analytics tools which focus on the effective use of data and information to drive positive business actions. Business Analytics includes performance management, the definition and delivery of business metrics, data visualization, and deployment. Tom Davenport first coined the term "analytics" in his book, "Competing on Analytics" (Davenport 2007). **Analytics** is "the study of business data using statistical analysis in order to discover and understand historical patterns with an eye to predicting and improving business performance in the future. Analytics are used for enterprise decision management, marketing analytics, predictive science, strategic science, credit risk analysis, and fraud analysis.

SAS, one of the leaders in the industry, is a major proponent of business analytics. Their software enables organizations to transform information assets into a true competitive advantage in order to solve complex business problems, manage performance to achieve measurable business objectives, drive sustainable growth through innovation, and anticipate and manage change. SAS says that their solution is different because it helps organizations make proactive, forward-looking decisions, that go beyond answering questions like "what happened? How many? How often?" to answering "What will happen next?" and "What is the best that can happen?"

There is a clear gap between the relevant analytics and the critical needs of business users. In order to eliminate this gap the following changes need to be made (Kohavi, 2002):

- The time that it takes to collect, analyze, and act on enterprise data must be reduced.
- The experience necessary to analyze the data must also be reduced.
- Clear business goals and metrics must be defined. Unrealistic expectations lead to misguided efforts.
- Data collection must have clear goals defined.

- Analysis results must be distributed to a wide audience. Analysis tools should be designed for business users rather than quantitative analysts.
- Data must be integrated from multiple sources. ETL processes are complex and expensive.

A variety of emerging trends and innovations in analytics are taking place including:

- verticalization,
- the building of comprehensive models,
- analytics are becoming a part of a larger system,
- analytics are appearing in new areas, and
- analytics are creating new measurements.

Verticalization helps reduce discovery time, facilitates the definition and achievement of business goals, and deploys analysis results to wider audiences. The results from analytical engines are increasingly being sent to mobile devices. Straightforward visualizations and task-relevant outputs are desired and they are being delivered through comprehensive (Khavi, R., Rothleder, N., and Simoudis, E 2002). The University of Denver uses analytics and comprehensive models in Second Life to display the weather from around the country in a highly visual three-dimensional manner. In this model weather patterns appear above each of the United States. This way one can quickly tell what the weather is like across the country and make analytical decisions based on the data.

Data systems use analytics to collect data, to generate unique identifiers when merging information, to integrate multiple data sources, and to properly size hardware so that the appropriate amount of hardware is being consumed for each task (Kohavi, et al, 2002). Lastly, the analysis of customer data has attracted the attention of e-commerce merchants. Integrating analytical tools with existing systems is essential in order for them to provide their desired value.

Organizations are recognizing the value of analytics and are increasingly using them to create business value. Capital One, a large US bank, is using data analysis to differentiate among customers based on credit risk, usage, and other characteristics and is using that information to match them with targeted product offerings (Davenport, 2007). Google, Amazon.com, Netflix, and Capital One were all "founded with the idea of using analytics as the basis of competition" and they "have attained the highest level of analytical capability" (Davenport, 2007). There are four types of analytical approaches: paper and pencil, simple statistical and optimization software such as Excel spreadsheets, statistical software packages such as Minitab, and complex business intelligence suites like SAS, Cognos, and BusinessObjects (Davenport, 2007).

The intelligence in AI

Artificial Intelligence (AI) in its nature is not an emerging technology. In fact, modern AI can be traced back to 1956 with a conference that took place at Dartmouth College. Following this conference AI laboratories were created at MIT, CMU and Stanford. H.A. Simon, an American psychologist, said in 1956 that "Machines will be capable, within twenty years, of doing any work a man could do" (Dreyfus, 1972). This prediction, as we now know, did not come true. In the 1990's and the early 21st century AI achieved its greatest successes in the fields of logistics, data mining, medical diagnosis, and many other areas. "The success was due to several factors: the incredible power of computers today (Moore's law), a greater emphasis on solving specific problems, the creation of new ties between AI and other fields working on similar problems, and above all a new commitment by researchers to solid mathematical methods and rigorous scientific standards." Even after fifty years AI can be seen as emerging technology because new applications are being created on a regular basis and organizations need to be aware of these technologies in order to be able to make intelligent business decisions.

Artificial Intelligence "is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable." AI simulates human intelligence in order to solve problems.

We have seen incremental progress in AI rather than the groundbreaking outcomes that were predicted. One of the headlining moments was the IBM's Deep Blue computer in 1997 when it defeated the chess world champion Garry Kasparov (AI, 2006). Artificial intelligence is improving all of the time and we are constantly trying to create super intelligent computer software.

Another use of Artificial Intelligence is Genetic Programming, which "is a systematic, domain-independent method of getting computers to solve problems automatically when given a high-level statement of what needs to get done. Using ideas from natural evolution, GP starts from an ooze of random computer programs, and progressively gets refined through a process of mutation and sexual recombination, until a solution emerges. This process happens without a user knowing or specifying the form or structure in advance" (Poli, 2009). This is one way in which Artificial Intelligence is helping businesses find answers and evolve over time.

Another emerging use of AI is emotional intelligence. Emotional intelligence is a machine's self-perceived ability to identify, assess, and manage one's emotions, the emotions of others, and the emotions of groups. Intelligence can be broadly described as the capacity for goal-oriented adaptive behavior and it has to do with self-knowledge and

social adaptation. The four major emotional intelligence skills are self-awareness, self-management, social awareness, and relationship management. Having a computer with emotions vastly improves the machine's ability to interact with users and it is an "enormous leap forward to have systems that learn about people and the world in which they live" (Reingold, 1999). One recent application of emotional intelligence is Survivor Buddy, an emotional rescue robot that is designed to keep victims company while rescuers are trying to reach them. These robots helped navigate the ruins of the World Trade Center after 9/11 and the darkest depths of the Crandall Canyon mine in Utah to help rescuers locate six trapped mine workers (Awesome-o, 2008). Affective computing is one way in which emotional intelligence is being used. Affective computing relates to, arises from, or deliberately influences emotion. Researchers at the Massachusetts Institute of Technology (MIT) have designed new ways for people to communicate, have created new techniques to assess frustration, stress, and mood indirectly, have shown how computers can be more emotionally intelligent in responding to a person's frustration from negative feelings, have invented personal technologies for improving self-awareness, have increased our understanding of how personal health is affected, and have pioneered studies related to ethical issues. Affective computing can be used for e-therapy, psychological health services such as counseling, and more.

The competitive factor

Competitive Intelligence (CI) is the process of gathering and analyzing information about the market and competitors through sources that are open to the public. Without the proper knowledge a company is at risk for losing money and competitors could reap the benefits of emerging trends. An organization needs to constantly analyze information on their competitors, changes to the legal aspects of their industry, and technological trends.

CI is necessary in order for organizations to stay ahead of their competition. The key to a successful process is recurrence and careful planning. The process needs to be done by an entire organization in order for it to be a sustainable one (Deltl). Planning starts with determining what topics are relevant and transforming those topics into questions. One needs to determine what sources to use to collect valued information. Examples of sources include search engines such as Google, directories, databases, consulting with other interested parties such as public institutions and consultants, and going to tradeshows. Another helpful resource is the Society of Competitive Intelligence Professionals (SCIP). SKIP has chapters in several countries that meet regularly to discuss developments in CI. There are a variety of different forms of analysis that can be performed on the collected information. It is important to define how to communicate information so that it is simple, clear, and understandable (Deltl). Finally, one needs to collect feedback and make decisions based on the assembled information.

CI is a process that should involve may functional areas within an organization. It is not just an IT project. (Tools such as Excel, Access, Lotus, or Competitive Intelligence Portals can be very useful for the process). CI should be done by Research and Development, Sales, Strategy Department, Marketing, Market Research, Information Center, and in-staff units (Deltl). The costs involved in CI include qualified employees, IT systems, access to paid data sources, training and continuous education, and an external service provider. The ten success factors for CI are management must stand behind the topic and act as a mentor, it should be kept simple and smart, a company should start by finding out what data already exists, work should be done systematically and structured, one should start small, start pragmatic and later boost strategic components, the distribution department should be on board from the beginning, define clear competencies and responsibilities, and have fun (Deltl).

CI provides "independent verification on corporate strategy by benchmarking your company in the market" (Deltl). CI allows organizations to become more proactive in their practices. It allows organizations to concentrate on both consolidation and innovation. For CI initiatives to be successful, organizations must use it to answer strategic questions. CI can provide a complete market landscape, competition profile, can aid in product development, can be used for channel analysis, customer analysis, and key personnel profiling. It is important to not only assess the market landscape but also assess the strengths of the management team. When a company is valued the strengths of the management team are often overlooked. Monitor what a competitor's management team is saying and what they are out to accomplish. CI can be used to assess any potential competitive threats before they come to fruition. CI can help an organization come up with an in-depth SWOT profile. CI can be used to obtain insight into how competitors will react and decide on the right pricing strategy when introducing new products. In reality, CI can provide insight at all levels because it assesses the customer experience. (Deltl)

Is there a process of managing these technologies?

Now that we have explored various emerging technologies and some of the applications of each of them it is time to dive into the process of managing these technologies so that they can be properly utilized.

One method for managing the introduction of a new technology is strategic experimentation. This process involves collaborating with marketing, business development, research and development, and introducing a few new information technology skills such as forecasting and market timing (McKeen, 2007a). Christensen says that

there are two types of innovation: sustaining and disruptive. Sustaining innovation "improves an existing product or enhances an existing service for an existing customer" while disruptive innovation "targets non-customers and delivers a product or service that fundamentally changes their current product portfolio" (McKeen, 2007a). Sustaining innovation leaves organizations in their established markets with their known customers while disruptive innovation is the complete opposite in that when done right it attracts new customers and enables an organization to grow into new markets. Innovation requires experimentation and learning is paramount whether the experiment succeeds or fails. Strategic experiments "represent a rather unique management challenge" in which organizations face the "highest-risk, highest-return category of innovation and require a unique, managerial approach" (McKeen, 2007a). Organizations can create an innovation process within their workplace by building infrastructure, articulating procedures, and providing incentives. New ideas and opportunities need to pass through three filters: relevance, technical readiness, and economic viability (McKeen, 2007a). If an idea passes these three qualifiers then one of the organization's functional units (e.g. sales and marketing) must be willing to sponsor an experimental pilot. The idea then becomes part of an "upscale pilot" in which it expands its range and reach and is eventually adopted. This whole process usually happens within a year.

A second innovation process, that one organization follows, consists of four stages. Their process starts with an idea that is generated from either formal or informal processes. Formal processes can be brainstorming sessions or a competitor's actions. Informal processes involve market research or industry trend analysis. Ideas come from vendors, peers, product and marketing, customers, or laboratories. In order for ideas to be picked up they need to be specific and targeted objectives that address "pain points" or core business offerings, they must be measurable through technical means, and one must identify business sponsors or champions (McKeen, 2007a).

The second stage is the proof of concept where teams are assigned to specific ideas and testing is done in a formal or informal laboratory setting. The process is very agile and adaptive and the original idea can morph substantially. The team is highly focused and kept small. This stage takes place over a one to four week timeframe.

Requirements for moving into stage three are issues of intellectual property protection and service descriptions must be met. The third phase is the Trial or Pilot Stage where "production exposure" takes place and the idea is exposed to the market. The market may be internal (e.g. employees) or external (e.g. customers). Measurements are taken to reveal the marketing/branding issues and the financial and operational impacts. The trial phase usually takes four to twelve weeks.

Requirements to enter stage four include complete product designs and business and system requirements. The final stage is the Transition stage where the idea is brought to market and enters the system development life cycle to be evaluated by its industrial strength.

Both of these innovation processes have some things in common. For example, in both, the strategic experimentation phase begins after the idea is deemed relevant. In order for employees to be motivated to innovate and integrate new technologies organizations must reward their employees for strategic experimentation. Some employees see experimentation as risky and resist it. Therefore, experimentation must be encouraged and rewarded in order for it to be done and everyone in an organization must do experimentation. Organizations should consider making innovation a part of their annual performance measurement. Secondly, for experimentation to be successful an organization's infrastructure must be set up to support it. Creating a focus group with a chief scientist whose mission it is to innovate may help a company set up the proper infrastructure. There are two distinct strategies involved: insulation and incubation. Insulation is the process of creating innovation centers where all functional areas come together to address common problems, thus fostering synergies across the organization. The second strategy is incubation, which involves placing innovation centers in specific lines of functional areas, and emphasizing local ownership (McKeen, 2007a). Organizations should take the attitude that experimentation is successful if there is a lesson learned that is strategically important to the organization. This lesson may involve customer value or core business processes.

A third innovation process is acculturation which occurs when "the meeting of two or more different cultures results in the combining of existing cultural elements, generating new features and forming a new culture" (Pan, 2008). This process can be applied to integrating a new technology into an existing information technology infrastructure or into an organization with limited technology capabilities. Acculturation is a five-step process: initiation, fascination, disenchantment, mental isolation, and adjustment and recovery.

During initiation, cultures meet and adapt to the presence of each other. Fascination is the phase in which individuals find the new environment exciting and see the benefits of using a new technology in order to improve their job or their organization. Disenchantment is the difference between where the organization began and where the organization is now which may lead to some annoyance and resistance. Mental isolation happens when individuals wish that they could return to the old ways of operating. The final phase is adjustment and recovery where individuals alter their expectations, accept the new environment, and become comfortable in their new setting (Pan, 2008). In order to succeed with the adoption of new technology an organization must:

- Select a strong and visionary leader whose vision and experience are crucial for achieving successful change.
- Develop a strong robust project plan, including a cultural adaptation strategy.
- Develop a systematic and effective change management process.

- Ensure effective communication between senior managers and employees.
- Instill a strong sense of ownership in both project and work process and promote training.
- Initiate a stress management program to relive the pressure of changes in expectations.
- Cultivate a culture of innovation within the organization. (Pan, 2008)

Trust and transparency must be developed if employees are to commit to a project. Managing change is challenging and the earlier that employees are made aware of change and the benefits that come with it then the more successful an organization will be able to be when integrating new technologies.

Successful deployment of emerging technologies into an organization requires "continuing support from senior management, separation of the new venture from continuing activities, organizational and strategic flexibility, and willingness to take risks and learn from experiments" (Day, 2004). It helps to have and support diversity of viewpoints that can challenge dominant mind-sets and mislead precedents.

Dale Carnegie Training makes some general recommendations to organizations that are trying to incorporate new technology into the corporate lifestyle. First, they recommend that organizations communicate effectively between managers and staff to improve performance. Second, they note that training sessions are critical to the success of a technology deployment. Finally, they suggest that organizations can make the switch to the new technology fun by giving employees options, which allows them to feel more involved and part of the team (Dugan, 2007).

When introducing new technology it is important to provide as much warning as possible. Humans are naturally resistant to change, so as soon as you are sure that technology change is in your organization's future, announce the news to your staff. This will give them time to adapt to the upcoming change. Then, it is important to call on a few ambitious, interested, or tech-savvy employees to act as project leaders. These employees can convey new processes to other employees (Managing). The next step is to begin system training and boost your team's confidence and encourage them to ask questions. Organizations need to be prepared that there may be snags and roadblocks during the first few weeks of using a new technology. Contingency plans should be in place that teams can fall back on if something goes wrong. After technologies are introduced to an organization it is important that technology committees keep meeting on a regular basis to discuss concerns, issues, or suggestions for upgrades (Managing).

When organizations are trying to determine what technologies are most appropriate for their needs they often follow a road mapping process. Technology road mapping is "a powerful planning tool to solve this issue by helping organizations to identify alternative technologies that should be developed by certain time frames to satisfy future market goals" (Chang, 2009). This process starts by identifying the technologies that have been done well in the past but no longer meet present day needs. Then one needs to identify the technologies used by the leading organizations in their industry. The primary benefit of road mapping is by identifying the technology gaps that must be filled to meet future market performance targets. The process can also serve as a communications tool that encourages coordinative research (Chang, 2009).

Conclusion

Managing change in an organization is never easy as it requires a lot of communication, a lot of research, and a lot of practice. But, when the right technology is properly introduced to a company the results can be wonderful. Organizations see greater levels of profitability, they gain the ability to enter new markets, win over more customers, or improve overall employee satisfaction and morale. Organizations need to be aware of the technologies that are available to them and what the benefits of those technologies are in order to be able to make the right decisions. Organizations should not be afraid of change but instead should be constantly searching for new technologies that would help their organization. Introducing technology is challenging yet highly rewarding. Hopefully, this chapter helped clarify some of today's emerging technologies and helped explain the process of introducing technologies successful to get the highest level of return.

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Chapter 11: The Semantic Web

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Learning Objectives

- Understand the evolution of Web 1.0
- Understand that current limitations of Web 1.0
- Understand how Semantics is the search for meaning
- Comprehend how Semantics is applied and operates in an IT environment
- Identify the benefits of utilizing Semantic technologies
- Understand the relationship between Semantics and Master Data Management

Introduction

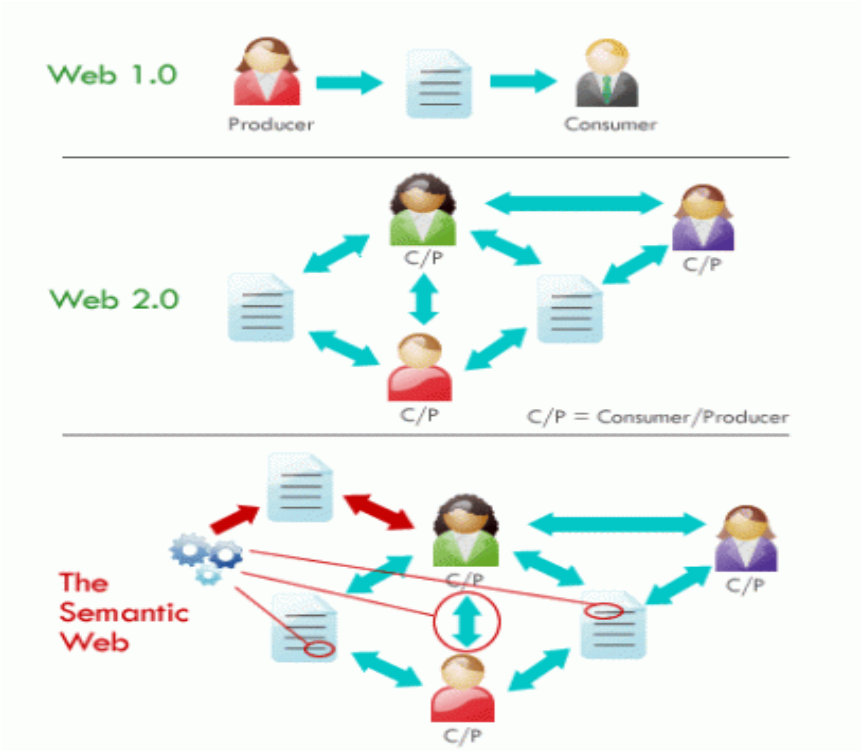
The World Wide Web today continues to be an evolving and increasingly complex environment of disconnected data. Web pages, documents, spreadsheets, and millions of other slices of data are stored, accessed, modified, and deleted every minute. This data exists in isolated environments and these "silos" mean very little to each other in way of relevance. How do we make sense of all data of this even if we wanted to? Tom Tague of the Open Calais Initiative (Calais 2009), a Semantic Web enterprise community, recently noted that, "We are content rich, and information poor, which has led to a deficient web experience." The primary goal that Semantics seeks to accomplish is to derive *meaning* from the web.

The hunt for meaning often means that *context* must be rightly considered. For example, how does one access and query all relevant information that pertains to "Fishing in the Rocky Mountains"? A search-engine today will likely give results ranging from fishing magazines to topographical maps and everything in between. More precisely, let us suppose you want to know "when, where, and how to fish in the Rocky Mountains in the month of July". The meaning of the search is more complex and will likely yield less relevant search results in a Web 1.0 environment. A fully applied and integrated Semantic web environment may be able to identify the context of your search and get you the information you want more efficiently. Tim-Berners Lee, the man credited for the invention of the World Wide Web, described the Semantic Web as an "*extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation (Berners-Lee 2001)*." Invariably, the Semantic Web will help countless users utilize seemingly endless amounts of online information—bypassing that which is irrelevant and capturing what you need and how you need it.

What is Web 1.0 vs. Web 2.0 vs. the Semantic Web?

The initial stages of the World Wide Web can be described as individually constructed web pages or documents that were intended to be viewed by an internet consumer. The producer was the only active agent in this relationship and the consumer was merely passive (see Figure below), absorbing whatever information the web page or document provided them. As you can assume, the consumer had little impact or influence over what content was displayed on the internet.

Web 2.0 (previously discussed in Chapter 10) operated under similar circumstances, but has revolutionized the role of the internet consumer. No longer does a producer dictate the content, but is an active consumer themselves. Within this second generation environment, consumers are enabled to collaborate and share information online with ease and efficiency. Web 2.0 puts a strong emphasis on web applications, instead of mere HTML, which improves communication and sharing functionality. Popular manifestations of this environment include blogs, social networking sites, wikis, and other web services. Web 2.0 does not significantly depart from Web 1.0 from a technical point of view, but simply a represents a culmination of new software applied to the same framework.



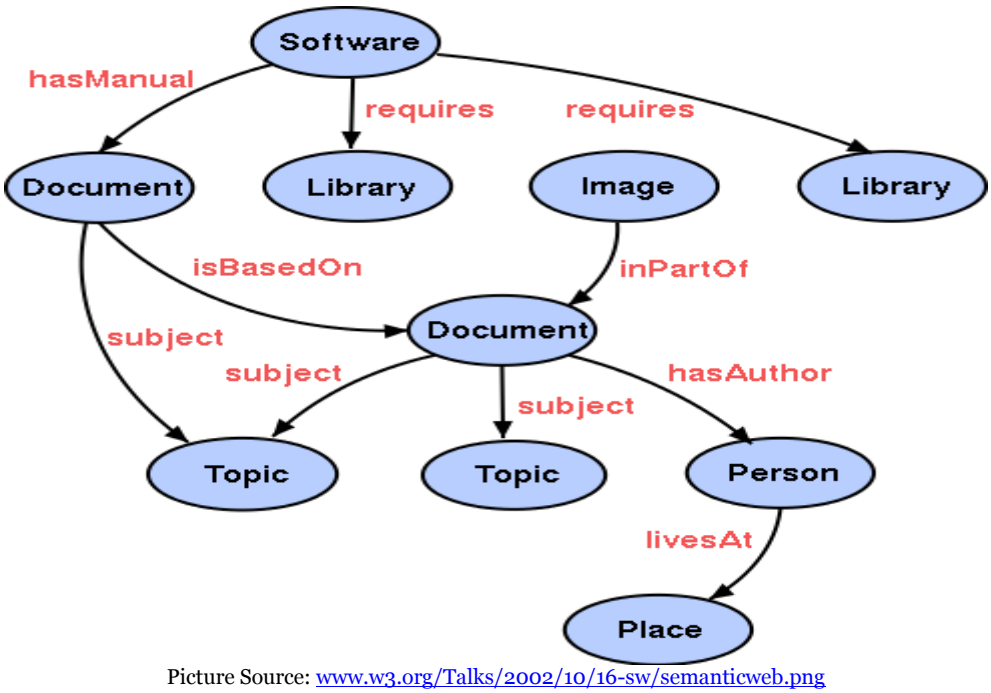
The Semantic Web, or sometimes referred to as Web 3.0, takes most of the valuable foundations from the previous two generations and employs a specific "tag" for each piece of web information and identifies the relationship of that data to other data. Notice how the Semantic Web can simultaneously reference multiple pieces of information and understand their relationship in order to benefit all users.

The key advantage of Semantic technology is the storage of the relationship (meaning) of two objects (data) in addition to the object itself, which allows the processing and interpretation of these relationships by both humans and IT systems. The goal of developing these semantic meanings is interoperability, allowing for flexible business rules and operations that are governed by those rules. Once this "interconnected metadata" is available, the organization or individual will have the opportunity to make use of it.

One of the large assumptions of Semantic data draws upon some of the key questions of Western philosophy—does the universe and all of its data (things) make sense, or do humans simply make sense of the world? How would computers handle the multiple degrees of ambiguity that exist in our world of data? Would the Semantic Web, despite our best intentions, be rendered useless because of this ambiguity? Critics would tend to say so. However, without venturing fully into a Semantic approach, the promises of Semantics will go unrealized and undetermined.

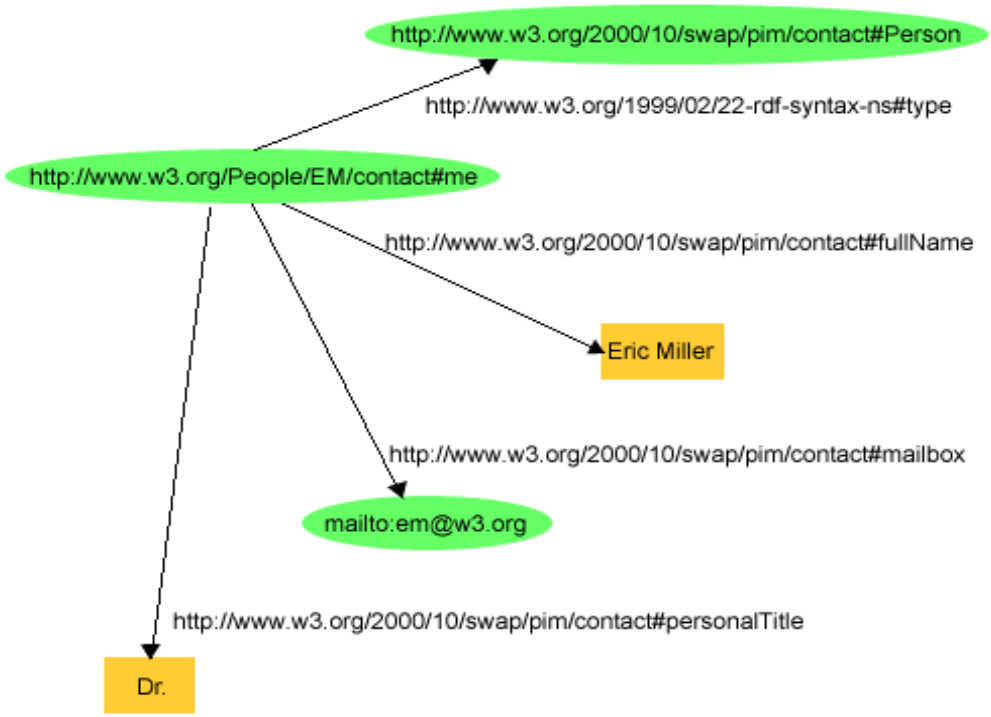
How Semantic Data is Expressed?

Semantic data storage is contained in a *subject-object-predicate* structure that is often found in most written/spoken languages. Examples include "The grass (subject) had the color (predicate) green (object)", or "George (subject) likes to play (predicate) baseball (object)". This structure in Semantics is called the RDF (Resource Description Framework) Triple and operates as the key to linking disparate data in the web and within organizations (W3C 1998). The "Triple" denotes the three parts that make up the subject-object-predicate statement. This approach eliminates traditional approaches of classifying and identifying data in terms of relational-database modeling techniques, which often requires columns and rows of data to have unique names or attributes, but does not store the *relationship* between them. Notice how the top bubble of the figure below, labeled "Software", is linked to a series of other objects. When taken as a whole, each bubble begins to make sense as part of a larger whole. In essence, no object exists without reference to something else.

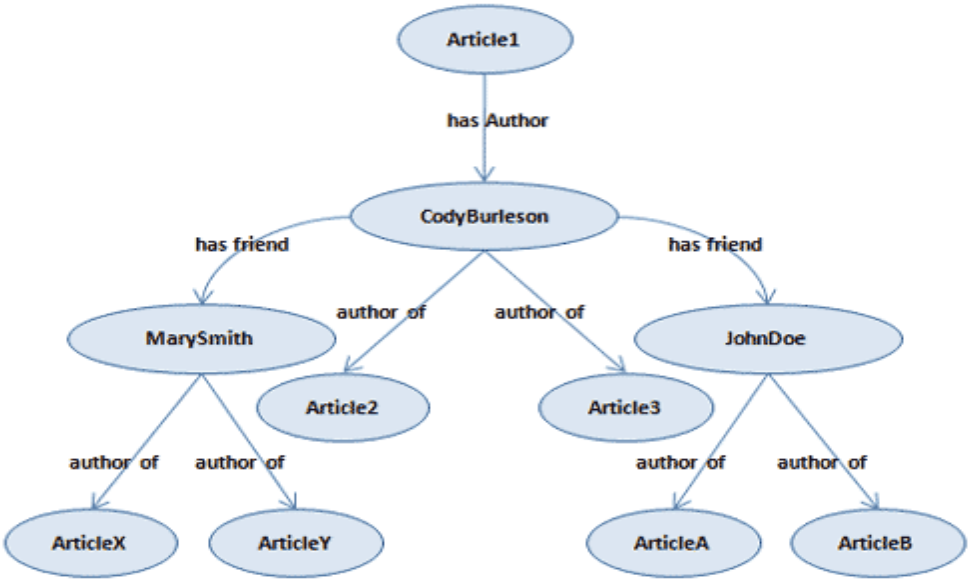


Picture Source: www.w3.org/Talks/2002/10/16-sw/semanticweb.png

As one RDF statement is constructed, it can naturally extend to other RDF statements to derive meaning, and so build the beginnings of an ontology, which will be discussed later in the chapter. One example from the www.w3.org website describes the fact that "There is a person identified by the this website, whose name is Eric Miller, whose email address is em@w3.org , and who has a title of Dr." Graphically, these statements would look something like this (Miller 2004):



The RDF Triple approach is a metadata data modeling approach. Metadata is information about the data itself. As demonstrated above, data stored in RDF statements is capable of cascading into exponential amounts of data. Data almost always makes more sense when connected to other data. While this idea is not new to users of the web, Semantics allows the user to build relationships from these links that would otherwise be very difficult, if not impossible. In the graphical example below, let us assume that the web user only knows the name of Article 1 positioned at the top. A web search today would likely yield the article and likely the name of the author. However, a search engine would be hard pressed to make the connection between Article 1 and the fact that the author of Article 1 has friends that have other Articles that may be related.



Semantic Ontologies

The "data model" in a semantic system is stored in a framework called an "Ontology," which represents the collection of multiple RDF statements, within an environment that has an agreed way of describing "things" (McComb 2009). Ontologies can be thought of as mere databases, but their reach and significance is larger than that. Ontologies normally share a common set of knowledge, for example, a collection of biomedical information, a collection of news media, a collection of library documents, or a collection of financial data. Since it is often difficult to categorize massive amounts of data into one "subject", ontologies are a way of segmenting in reasonable portions with data that has a common nature.

Since the data stored in ontologies normally has something in common, relationships can be clearly established within an ontology itself. Often ontologies are merged to form a library which can multiply the information available and the relationships that can be made. Currently, there are thousands of public ontologies that can be searched and mined for semantic data searches. Examples of public ontologies include CYC, Friend of a Friend, and the IDEAS Group . One popular source to find ontologies is Swoogle, an ontology search engine.

Within the ontology, RDF statements are stored in a classic text manner than can be queried using several structured query languages, such as SPARQL (SPARQL Protocol and RDF Query Language), which was universally adopted by the W3C Consortium, a Semantic professional work group, as a key semantic querying standard. SPARQL allows you to query RDF Triples and identify relationships and patterns within Linked Data (Berners-Lee 2001). The RDF statement that would be searched would like something like the following:

rdf:about="http://morpheus.cs.umbc.edu/aks1/ontosem.owl#automotive-repair-service-corporation">
<rdfs:subClassOf

rdf:resource="http://morpheus.cs.umbc.edu/aks1/ontosem.owl#repair-service-corporation"/>
<rdfs:label> "a service corporation that repairs and does maintenance on cars"

Notice the RDF statement classifies where the data is sourced and the label it is referencing, in this case, "a service corporation that repairs and does maintenance on cars." While this statement likely means very little on its own, put together with hundreds of thousands, or millions, of other RDF statements of a similar subject, the appropriate query could yield impressive results.

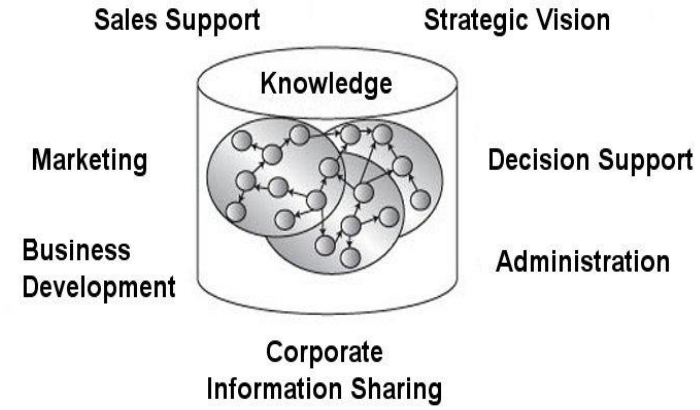
The Business Case for the Semantic Web

Since some of the concepts and technologies of the Semantic Web are in the early stages, many businesses are wary of making a full investment into them. Without practical applications and a clear assessment of the value of Semantic technology, the approach will continue to be a hard sell. Questions like, "How can we make use of the Semantic Web?", "What will it do for us?", "Is with worth our financial investment and time?". All are worthy questions that deserve a good answer.

It is often said that the organization that has the best data, knows how to use it, and applies its wisdom to make better decisions will be successful. Is this sense, the true competitive advantage is knowledge management. As the

size of an organization grows, so does its scope and the data it creates. In that event, it is not uncommon for some departments to have very little idea what another departments are working on, which permits the company to waste resources by duplicating efforts. The Semantic Web can help bring structure to this chaotic growth of data and information.

The standards-based architecture that Semantics is built on lends itself to integrating disparate data within an organization (DevX 2007). While many organizations have some form of reporting on what each department is doing, most of the valuable detail of these reports is lost in translation as it goes up the executive hierarchy. If this detail was annotated with metadata in a machine-readable format, employees could search not only what current projects are being worked on, but what knowledge has been created in the past. This is particularly important as it pertains to long-time employees who leave with years of experience and knowledge on the job. Such knowledge could include not only personal contributions, but employee documents, emails, and meeting minutes. The knowledge that be extracted from *within* the organization itself can often be staggering.



Imagine a scenario where a sales person of financial services firm has a meeting with a bank client. The client is very interested in new form of investment vehicle that is not available on the market currently. With the help of Semantic technologies, the sales person, who does not have inside knowledge into the product development department, searches for the concept that the bank client is interested in. The sales person learns within seconds that the company is in the User Acceptance Testing (UAT) phase of a nearly identical product. The sales person sets up a meeting between the bank client and product developer to talk more specifics and a new sale could be made.

Another key advantage to a Semantic data infrastructure is the flexibility and scalability it provides an organization. In traditional database design, a pre-conceived schema is required in order properly organize the input and its corresponding tables (Zaino 2010a). Once the tables and underlying relationships are established, it can be difficult to change them.

This poses a significant problem when companies merge. While they may be in the same line of business, rarely do they have the same quality of data and IT infrastructure. When and if all of their data was in RDF Triple formats, this data could easily and quickly be merged, and reduce costs and years of work from the transition. Furthermore, the more quickly the data is merged and available to use, the quicker the company has to take advantage of what the data is saying.

A Business Manager at the drug company Pfizer Inc. applied Semantics in a way specific to demands of the company (Zaino 2010b). Vijay Bulusu was faced with two challenges. The first was the need to calculate the purity of their drug compounds for internal scientists and regulatory agencies. In order to this, he needed to evaluate these calculations in one system by pulling raw data from another system. Since regulators and auditors not only want to see the final results of the purity tests, but the actual raw data that those calculations were derived from , Vijay had to manually match and validate the raw data and ensure that it was connected to the correct final result. Such a process was time-consuming and left a good deal of room for error.

The second challenge Vijay faced was conducting a drug stability analysis, a process where the company randomly takes one of their drugs in order to test it for intactness, potency, and other safety parameters. These tests must then be compared to prior tests to evaluate any changes that may need to happen. Vijay's question was whether or not there was a way for him to have a system that lists all the drug compounds used in their products, what compounds were used in what drugs, and how stable those drugs have been over different increments of time. The core problem was a topic that was broached earlier in the chapter—the problem of disparate data. In this case, multiple data sources needed to be accessed in order to accomplish one task.

While solutions to similar problems have been tried through Master Data Management and optimized relational database design (discussed later in the chapter), many required that the company simply create another unique schema that was unique to one application that was unique to one function. One of the most powerful attributes of a Semantic architecture is that there is no underlying schema. In addition, the amounts of data and sources of data continue to grow as the organization grows. With an RDF Triple based ontology, an organization can keep adding more and more triples without pre-defined plans or applications to use the data. The advantage of not needing to foresee every possible change or use of your data is an incredible advantage.
In addition to the business topics discussed above, the adoption of Semantic technology could prove valuable in the following areas:

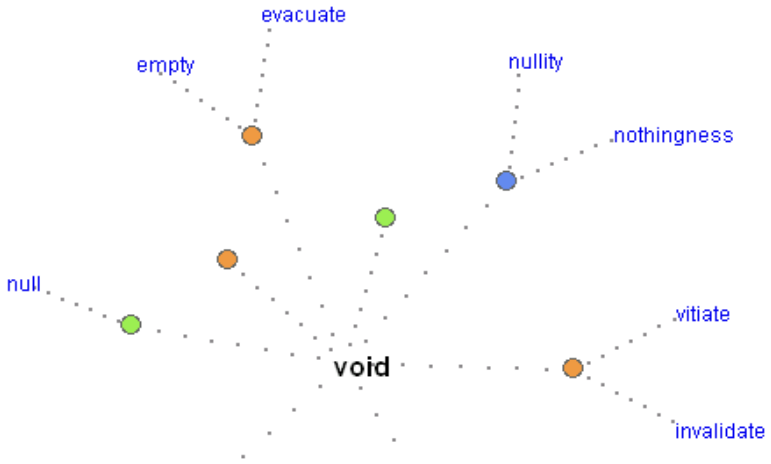
- Coordinated access and views to external systems (across companies)
- Passively cataloguing RDF statements from existing legacy systems for future IT transition
- Universal approach to business expansion and consumer growth
- Modifying systems to local demands—for example, for changes in financial markets or legal regulations
- Managing multiple sources of data simultaneously
- Tailoring company content to fit evolving media, changing audiences, and different languages

Semantics Being Used Today

As the use of Semantics continues to evolve and be applied in various commercial areas, there have been several examples that demonstrate what is being done today.

- Citigroup is leading an initiative that uses semantic technologies that correlates disparate financial data to help identify new capital-market investment opportunities (Rowland-Campbell 2008).
- Oracle is working with multiple state and national governments to develop interoperability between legacy databases in order to improve efficiency in government spending and the ability to find relevant information when searching for it (Rowland-Campbell 2008).
- Hewlett Packard helped to develop an open source framework for building Semantic Web applications called Jena. This tool provides developers an RDF API, memory/storage, and a SPARQL rule-based query engine to create and operate their own applications (Jena 2010).
- Microsoft owns a tool called PowerSet, which enables a Semantic search on Wikipedia data, allowing the user to express their search in keywords, phrases, and even simple questions (i.e. Who was the eighth president of the United States?) (Powerset 2010).
- Harvard University and Massachusetts General Hospital are working on a project that catalogues clinical data using Semantic tools, in order to leverage the collective data in future research (W3C 2009).
- The government of Finland is developing a massive projected called FinnOTTO, which according to Tim Berners-Lee, "lays a foundation for national metadata, ontology, and ontology service framework in Finland, and demonstrates its usefulness in practical applications. In our vision, a conceptual semantic infrastructure is needed for the semantic web in the same way as roads are needed for traffic and transportation, power plants and electrical networks are needed for energy supply, or GSM standards are needed for mobile phones and wireless communication." (SeCo 2010)
- A New York based company called Peer39 is bringing semantic technology to the market advertising space by using existing data to target a relevant audience. This is achieved by focusing on consumer sentiment, product meaning, and matching the most relevant ad to the web page (Peer39 2010).

- Princeton University developed a project called WordNet, (Princeton University 2010) which is a large lexical database of English words, using semantics to conceptualize and develop lexical relationships. Much like a thesaurus, this program will build a meaningful network of related words based on your word search and visualize the relationships. An example of the word "void" is shown below (Princeton 2010).



Semantics and Master Data Management (MDM)

Due to the fact that many legacy systems fail to communicate with each other, many businesses face a growing challenge of integrating their data in order to make sense of the big picture. A company that has data which exists in "silos" or "stovepipes" fails to leverage the competitive advantage of its own data. But the reality continues to be that several systems house different types of business data and exist on disjointed and disconnected platforms. R

Rarely can the Accounting Department, the Finance Department, and the Human Resources Department rely on the same facts, since they do not have one single place to go to for the same facts (Putman 2008a). Therefore, initiatives often labeled Master Data Management (MDM) or Customer Data Integration (CDI) have been popular to fix this problem (discussed further in the MDM Chapter). Most of these initiatives involve connecting multiple "legacy" systems to a singular master data warehouse from which the data requests will be queried from. Others involve fully developed business intelligence suites which promise to standardize all the enterprise data through a variety of means. Examples of this are Oracle's Customer Data Hub, IBM's Information Server, and SAP's Enterprise Information Suite. According to the Stephen Putnam from TDAN.com, these solutions may be attractive but suffer from a number of fundamental flaws (Putman 2008b):

- In many ways, they are "just another system," with the additional expense in both implementation and maintenance.
- The products (naturally) work best in a homogenous (single-vendor) environment, ignoring the reality of assorted computing environments in most organizations. The advertized "plug and play" solutions rarely deliver on the promised simplicity or effectiveness.
- The vendors' case studies and "customer success stories" present a false picture of the effectiveness of the products since the scope of the projects described is typically small compared to the large scale CDI and MDM projects at large organizations.
- The server infrastructure and license fees for these solutions are quite large, often totaling millions of dollars, with tens of thousands of dollars in yearly maintenance fees.
- Many of these systems showcase some of the newest technologies that are revolutionizing the IT industry, such as web services and service-oriented architectures (SOAs), however, it may only augment the IT complexity which many organizations are trying to simplify. If the solution does not help the business make better decisions faster, it will likely not serve its intended purpose.
- The new technologies virtually guarantee that an organization's existing staff will not have the skills required to implement and maintain the system. This means increased expense from a budgetary standpoint.

Since many of these shortcomings may be enough to avoid such a solution altogether, another approach may be needed. Semantic data systems and an applied Semantic methodology may be beneficial for a number of reasons. As discussed earlier in the chapter, Semantics is not in the business of creating "new" data, but making sense of existing data by establishing relationships between the data which give meaning to the end user. A system could be built that would "passively catalogue" existing (and future) company enterprise data, generating a company

"ontology". This ontology would then serve as the enterprise hub where key business decisions are driven and governed. The technologies to create and utilize this type of ontology are still in the early stages of development. However, there are several reasons why such an approach may be superior to the CDI/MDM approach (Putman 2008):

- It allows the system designers from not anticipating and mapping all possible data sources and relationship combinations before a Semantic system is implemented.
- The system likely would not have a high expense, either in infrastructure or support.
- The system would be free to vendor-specific commitments, since it would not require a host of supporting systems to achieve peak functionality.
- The system could be maintained by existing IT technical resources. There would be less of a requirement for more specific skills such as Java or Microsoft.Net.

The key objectives of any integration is to simplify (and master) the storage, indexing, and retrieval of enterprise business data. Without meeting all of these objectives, an organization is typically no better off than they were before.

Preparing for a Semantic Transition

While applications that employ a full semantic solution have yet to be developed (many experts predict that this is 5-10 years out), there are several steps that an organization can take in order to prepare for this advantage once it becomes commercially available. Surprisingly, many of these changes have little to do with technology, but rather the general mindset of the IT organization (Putman 2008).

- Train staff to think in terms of interconnected metadata, not data that is compartmentalized or has no relationship with other data in the organization. Part of this process is finding common definitions for business terms and that the relationships that exist between them. Such a mindset will foster the beginnings of a business ontology.
- Encourage data mining mentalities rather than simple data collection. The inter-relatedness of data will become the predominant outlook in a Semantic environment.
- Make the IT systems and tools transparent to the whole organization. The concept of how one system makes up one portion of a larger organizational fabric is important.
- Document all processes and relationships between objects at all levels of detail. This recommendation would benefit most IT organizations regardless of their pursuits. This process will increase knowledge across functions and will likely eliminate duplicative or low-performing processes. While this can be difficult under taking, it will allow the transition and deployment of Semantic technologies much easier.

What the Semantic Web Is Not

With a growing glossary of terms and explanations for the Semantic Web, it is not always easy to separate fact from near-fiction. It is also easy to exaggerate the capabilities of the Semantic Web, but equally easy to understate its potential. With that in mind, Tim Berners-Lee wrote a paper describing his version of what the Semantic Web is not in order to reduce confusion (Berners-Lee 1998).

He states that the concept of machine-readable documents is not a whimsical form of artificial intelligence that suddenly can comprehend human thoughts. In reality, humans will have to make the extra effort in order to make well-defined data which allows to machines to solve a well-defined problem with well-defined operations. Since the RDF Triple format is readable with natural-language processing, it is capable of evolving and adapting to needs depending on how humans apply it.

dditionally, Lee claims that the Semantic Web is not the re-creation of a previously failed experiment. In the past, Knowledge Representation systems fell into similar categories by uniformly representing the nature of data with accompanying schema for machine use. The critical distinction was the inability of Knowledge Representation systems to merge two or merge "trees" of knowledge.

RDF was created with this gap in mind and is scalable across ontologies of data. In other words, individual concepts that are represented with an RDF statement can be reasoned through due to the structure of the RDF itself (Berners-Lee 1998).

Relational-database design, the leading practice in the industry today, is intensely connected to the Semantic Web data model. Both have similar pieces of data, but organize and express them differently. A relational database consists of tables, columns, rows, and records with corresponding values. These elements map almost directly to the body of an RDF statement. The record is called the RDF node; a column is the RDF property type; and the record value is the same value. In this sense, the RDF is not simply another new data model, but specifically designed to accommodate the linking of data from many different models, including the Web itself.

It is sometimes assumed that since data in the Semantic world is represented uniformly and with the same syntax, that no inconsistencies should occur when performing searches or running queries. As with the all data models, that has proven to be an unreasonable expectation, and it is no different for Semantics. If my public records say my social security number is one thing and the government says it is another, one source has to be wrong. This requires that the user test the reliability of their data sources, as is required of us today when searching the web. An RDF statement is uniquely positioned to help users identify the source of the information by tagging it within the statement itself. In this event, certain sources can be isolated for consideration (or elimination) when performing queries.

Current Challenges of Semantics

With the advent of social media and Web 2.0, user-created content has grown exponentially. Such a reality leaves the question—what data quality can we expect out of the web today? If the web is full of unreliable data, how can Semantics drawn meaning for something that may be inherently meaningless? The answer to that question is that ontologies provide the same standardization and quality metrics that the reputable web requires today. While it is true that junk data will always exist on the web, there may be ways to avoiding it enough to suffice for commercial and consumer use.

Another challenge that Semantics faces is whether or not the markup language (RDF) can adequately represent the complexity that many commercial transactions/products provide. It may be straight-forward to link a relationship from consumer to product, but correctly linking that onto shipping details, local taxes, receipts, regulations, policies, terms of use, warranties, and a host of other details may be a daunting task.

The last challenge is common among all emerging technologies—funding. Up to this point, some investors have been weary of devoting too much of their resources to Semantics due to its complexity and early stage of development. However, such a state forces entrepreneurs to make the strongest possible business case for Semantics and thereby improve its outcome and overall usefulness.

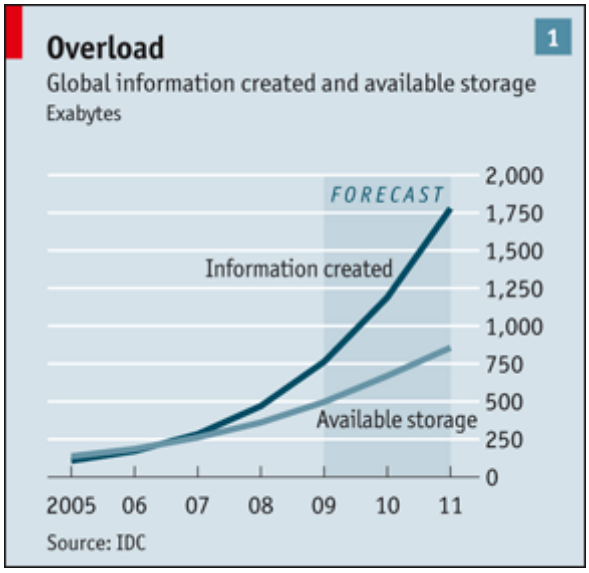
Data Superabundance

It is often noted that our ability to create data has far surpassed our ability to manage it, or least to make sense of it. *The Economist* (The Economist 2010) recently stated that information "has gone from scarce to superabundant". To give a perspective of exactly how much data is being produced, examine the Overload graph (in Exabytes) with Data Inflation graph below. As one could imagine, this reality brings a great deal of promise as well as many challenges.

Data inflation

Unit	Size	What it means
Bit (b)	1 or 0	Short for "binar computers use t
Byte (B)	8 bits	Enough informa in computer cod
Kilobyte (KB)	1,000, or 2^{10}, bytes	From "thousand
Megabyte (MB)	1,000KB; 2^{20} bytes	From "large" in A typical pop so
Gigabyte (GB)	1,000MB; 2^{30} bytes	From "giant" in
Terabyte (TB)	1,000GB; 2^{40} bytes	From "monster" in America's Lib
Petabyte (PB)	1,000TB; 2^{50} bytes	All letters delive to around 5PB.
Exabyte (EB)	1,000PB; 2^{60} bytes	Equivalent to 1
Zettabyte (ZB)	1,000EB; 2^{70} bytes	The total amour this year is fore
Yottabyte (YB)	1,000ZB; 2^{80} bytes	Currently too bi

The prefixes are set by an intergovernme
Source: *The Economist* Yotta and Zetta were adde



The tools available to the market to help utilize a Semantic approach are still in their nascent stages. Many believe however, that Semantics remains the best potential solution to make use of this data overload. The immediate and real commercial opportunities for Semantic technologies appear to fall into on three different categories according to Mark Greaves from the Vulcan Inc (Zaino 2010):

1) **Enterprise Business Intelligence-** Businesses can apply Semantic approaches not only to standardize the way they manage their data, but to link this data simultaneously to data on the web that can give them a competitive advantage. Imagine a company wants to know how many phones they have sold in cities with less 10,000 people? By leveraging evolving US Census data with proprietary-company data, the queries that they will be to execute will continue to grow in complexity and value. This trend may even push companies to publish and make public non-proprietary data, which companies may agree to for cost savings purposes—knowing that they both companies need certain data to operate in their industry but neither company has unique claim over it.

2) **Marketing-** Currently, the code embedded in HTML is what drives most search-based marketing. If Semantic coding techniques are adopted, marketing firms and search engines will have an even closer partnership. The beginnings of such linkages are exemplified in the Ellerdale Project (Ellerdale 2010), which uses semantic technology on text and web pages to create an index of topics (such as Politics, Sports, etc) that operates in real-time. The data feeds that generate these topics are endless and represent a unique barometer on what data is driving decisions, opinions, and trends throughout a market. Such projects will be a natural extension of marketing associating/affinity analyses that try to match consumer purchases with products they "may also like" (i.e. Amazon.com).

3) **Web 3.0 Businesses-** The creation of extensive knowledge-based ontologies provides a unique opportunity for those web businesses looking for rich, inter-connected data, which can be leveraged to serve a market, product group, or existing consumer base. By synthesizing and indexing high quality web data, ontologies can turn into profitable stores of knowledge that can be very attractive to a business in need of good data. One example of such a source is FreeBase (FreeBase 2010), offering structured free content for users to exploit and query at their discretion. The data stored here can be integrated into one's own site for business purposes

Conclusion

The need for the Semantic Web was born out of the limitations and challenges of the Web 1.0 environment, which was limited to disconnected web pages and isolated documents that had very little meaning in reference to each other. Overtime, the web became a parsed and "silo" environment and the web user had difficulty navigating the endless pages of data. Web 2.0 has enhanced the user-experience tremendously and is rightly praised as the next phase in the web revolution. Though Web 2.0 still falls short of the vision of Tim Berners-Lee, who stated: "*The Web was designed as an information space, with the goal that it should be useful not only for human-human communication, but also that machines would be able to participate and help. One of the major obstacles to this has been the fact that most information on the Web is designed for human consumption, and even if it was derived from a database with well defined meanings (in at least some terms) for its columns, that the structure of the data is not evident to a robot browsing the Web... the Semantic Web approach instead develops languages for expressing information in a machine process-able form."(Berners-Lee 1998)*

In this chapter, we have evaluated how the Semantic Web is envisaged and how it may be applied in an IT environment. We have discussed how Semantics is essentially the work of finding meaning. The commercial and business of applications of this technology range from managing data, enterprise business intelligence, marketing, and web content. Such are the beginnings of the Semantic Web and its foundation is only now taking formidable shape for a promising future.

Chapter Questions

1) Explain the difference between Web 1.0, Web 2.0, and the Semantic Web.
2) What is an RDF statement and why is it relevant to the Semantic Web?
3) What is an Ontology and why are they necessary?
4) Describe three ways that Semantic technologies are being applied in businesses today?
5) Explain how Semantic technologies can help solve the problems of Master Data Management.

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Chapter 12: Master Data Management

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Learning Objectives:

- Understand what MDM is and what it is used for.
- Understand the basic phases of a project
- Understand the approach to an MDM solution.
- Understand MDM within an organization.
- Discover the implementation issues of MDM.
- Making the business case for MDM

Introduction

Master Data Management (MDM) is, in essence, a series of processes or software tools that seek to collect data within an organization and streamline the classifications and definitions of this data throughout the different departments. Throughout large corporations you will find that the data issues are found with the quality of data, consistent classification and identification of data, and the reconciliation of the bad data or duplication of data (Wikipedia, 5/20/2010). In order to manage corporate data a series of "Master Data" must be created.

Now Master Data is used by multiple applications, therefore, if an error occurs in the master data then the error occurs in all the applications that use it. If a customers' address is incorrect in the customer master data then that could mean that product orders, bills and marketing material are being sent to the wrong address. An incorrect price on an Item Master can be a marketing disaster or an incorrect account number on an Account Master can lead to huge fines or worse.

"Here is a typical master-data horror story: A credit-card customer moves from 2847 North 9th St. to 1001 11th St. North. The customer changed his billing address immediately, but did not receive a bill for several months. One day, the customer received a threatening phone call from the credit-card billing department, asking why the bill has not been paid. The customer verifies that they have the new address, and the billing department verifies that the address on file is 1001 11th St. N. The customer asks for a copy of the bill, to settle the account. After two more weeks without a bill, the customer calls back and finds the account has been turned over to a collection agency. This time, they find out that even though the address in the file was 1001 11th St. N, the billing address is 101 11th St. N. After a bunch of phone calls and letters between lawyers, the bill finally gets resolved and the credit-card company has lost a customer for life. In this case, the master copy of the data was accurate, but another copy of it was flawed." (Wolter & Haselden, 2009)

Master Data must be in singular form, corrected and updated. It needs to be managed continuously for the business process to flow smoothly. However, the most criticism about MDM comes from the value and current approaches, due to the large cost and perceived low return on investment.

Master Data

Before we get into MDM and where the concept came from, first we must briefly look at Master Data. Master Data is often the key asset of a company and companies can be acquired solely for their Customer Master data. There are many definition of what Master Data is; however, many define Master Data by an item list that is most commonly agreed upon, such as: Product, Customer, Employee, and location.

There are 5 primary types of data within a corporation:

Unstructured—This is data found in e-mail, white papers, magazine articles, corporate intranet portals, product specifications, marketing collateral, and PDF files.

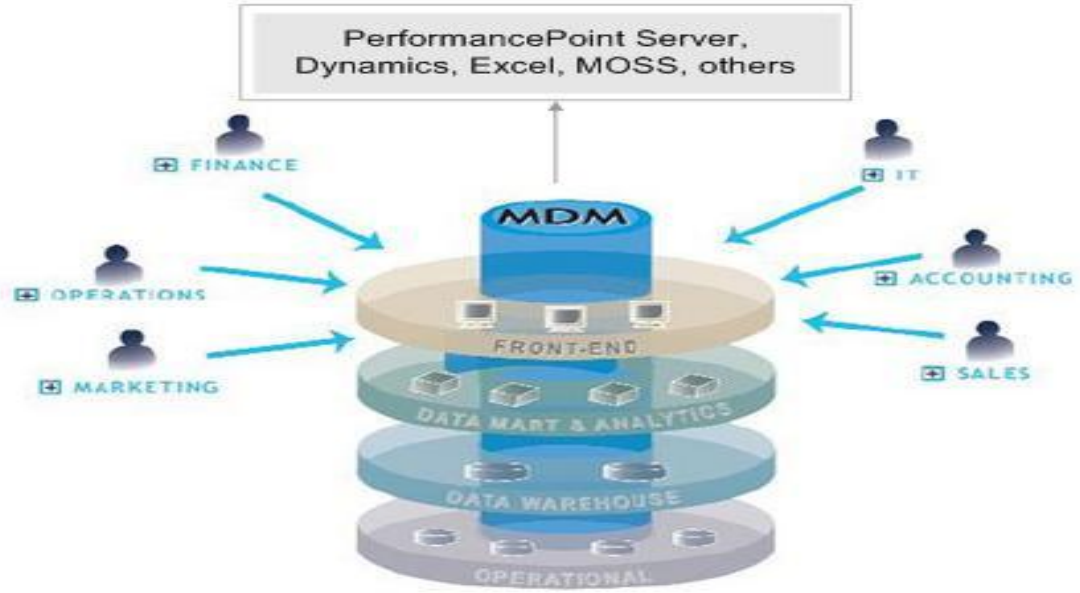
1. **Transactional**—This is data related to sales, deliveries, invoices, trouble tickets, claims, and other monetary and non-monetary interactions.
2. **Metadata**—This is data about other data and may reside in a formal repository or in various other forms such as XML documents, report definitions, column descriptions in a database, log files, connections, and configuration files.
3. **Hierarchical**—Hierarchical data stores the relationships between other data. It may be stored as part of an accounting system or separately as descriptions of real-world relationships, such as company organizational structures or product lines.
4. **Master**—Master data are the critical nouns of a business and fall generally into four groupings: people, things, places, and concepts. Further categorizations within those groupings are called subject areas, domain areas, or entity types. For example, within people, there are customer, employee, and salesperson. Within things, there are product, part, store, and asset. Within concepts, there are things like contract, warranty, and licenses. Finally, within places, there are office locations and geographic divisions, for example, some of these domain areas may be further divided.

(Wolter & Haselden, 2009)

Identifying what is and is not Master Data is pretty straight forward; however, not all data that fit the Master Data criteria should be managed as such. Part of the MDM solution is sorting out relevant data to be used across the board.

MDM

As was mentioned above, MDM is defined as a technology with tools and processes to help gather, identify and classify relevant data to be used as Master Data throughout an entire corporation. The image below can help you visualize how the clean control of data an MDM system can help provide to a corporation.



(Norm's PerformancePoint Server Blog, 2008)

However, MDM is not just a technical issue. In order to maintain clean master data the stagnant business processes will have to change. This is, in turn, creates issues within the corporate political arena that can be far harder to solve than any technical issue. Secondly, creating and maintaining master data takes a huge investment of time, money and man power. If the MDM solution does not include the proper tools and processes to keep the master data clean and consistent in a world of ever expanding and updating data, then the project will be a complete waste.

MDM Phases

While MDM is very effective, trying to justify the risk and expense to a CEO and CIO can be extremely difficult. An MDM project can be influenced by a number of factors: requirements, priorities, resource availability, time frame, and the size of the problem. (Wolter & Haselden, 2009) Most MDM projects include at least these phases: Laying out the phases of the MDM solution can be complicated but it's not impossible. Most MDM projects will

begin with at least these phases:
Identify sources of master data. This step is one of the more time consuming phases as there can be a surplus of data that must be gone through that no one knew even existed

1. **Identify the producers and consumers of the master data.** Which applications produce the master and which applications use it.

2. **Collect and analyze metadata about your master data.** What are the entities and attributes of the Master data, and what do they mean? Some examples include data type, constraints, default values, ownership of the definitions and who handles the maintenance of the data.

3. **Appoint data stewards.** People within the company with knowledge of current data and its sources for the master data format.

4. **Implement a data-governance program and data-governance council.** The council must have the knowledge and ability to make decisions and changes to how the master data is managed. With so many decisions needed to be made through the project, without a governing body to do so, the project will fail due to internal politics.

5. **Develop the master-data model.** This step will evolve decided what data attributes and values are allowed. This will also include the mapping of the master data to the data sources. This is normally both the most important and most difficult step in the process. You cannot make everybody happy by including all possible data attributes (e.g. should weight be represented in pounds or kilograms or BOTH). The master data will become too complicated to maintain and be useful. This is where the data-governance council will be very useful in making those executive decisions.

6. **Choose a toolset.** You will need tools to clean, transform, and merge the data sources to create your master data list. You can build these on your own if you have the technical expertise at your disposal or you can buy from vendors. Some choose to use one vendor source for their MDM tools; however, it might be best to pool the best tools from a variety of vendors. Not many tools will cover all MDM requirements and some vendors are more adept at various aspects of the process than others.

7. **Design the infrastructure.** Once your master data is configured, you will need to expose it to your applications and provide processes to manage and maintain it. You will have a number of applications that will depend on the infrastructure being available.

8. **Generate and test the master data.** This step is where you merge your source data into your master-data list. There will be a lot of back-and-forth over which rules will need to be modified in order to make sure all the requirements are met.

9. **Modify the producing and consuming systems.** If your master data is using a data warehouse as a separate source system then no modifications may need to be made. However; if the source system has to use the master data then you may have to modify the system to synchronize with the master data. This will provide the source system with an updated clean copy of the master data to use. The source system that generates the new records should be modified to double check against the current master data files to insure that no duplicated or out dated records are created.

10. **Implement the maintenance processes.** The data steward has the business knowledge and the data knowledge to recognize incorrect data and the authority to correct it. The steward will want to review matches such as two different customer numbers residing at the same address. The steward must review the data history to see if previous changes were made by the MDM system and to isolate any errors and undo incorrect changes. The maintenance should also include a distribution process for all newly cleaned and updated data.

> MDM is a complex, time consuming process. A successful MDM project is implemented incrementally to allow for the business to adjust and settle in with the new system and processes and realizes the short term benefits while the overall MDM project continues. (Wolter & Haselden, 2009)

Approach to MDM

The single dimension approach to an MDM project solution can be used when master data issues revolve around distinct dimensions or "pain points". The characteristics of the points are:
Single dimension, the single most significant business driver, is affected

- Low resistance to a new system of entry for this dimension
- Minimal additional stakeholders required for complete implementation
- Central data management

Tyler Graham in his article "Implementing a Phased Approach to Master Data Management" discussed the following example of the process. "For this example, let us discuss a fictitious company called Fabrikam, Inc. This

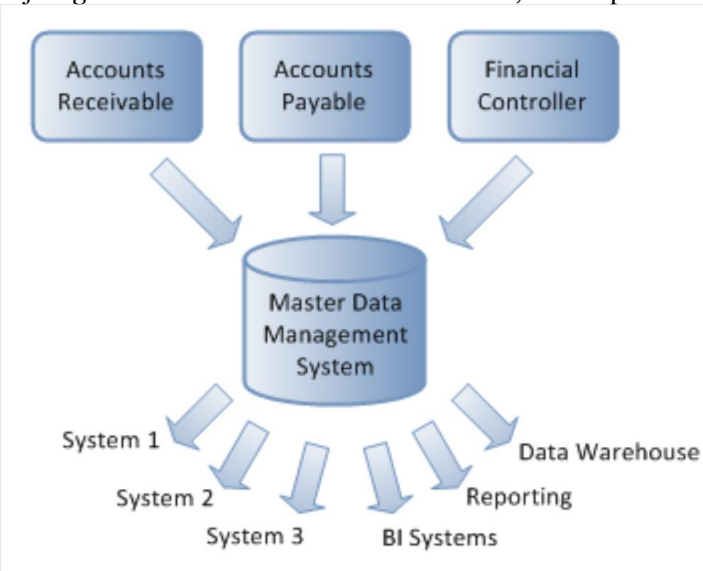
company spends at least 20 hours per month reconciling changes between seven systems that rely on account-related information. New accounts are created by three different groups. The Accounts Payable group creates a new account for each new supplier. Accounts Receivable creates a new account for each new customer. All other account changes are handled by the financial controller. These changes and all the corresponding attributes must be propagated to all seven systems. Difficulties arise because many of these accounts are created a few months before a balance is shown in them. If a system is not in sync at that time, reports will not balance and it is difficult to determine where the error is coming from.

Figure 1: Phased Approach - Before

After reviewing their options, the finance and IT departments agree that this problem is a commonly recurring issue with the master data within the organization. The IT department is able to identify at least six places within the organization where critical company master data must be synchronized. While the time and monetary resources are not available to implement an enterprise-wide master data management solution in the next quarter, it is determined that the solution should have the ability to scale across the organization.

Three months later, the initial implementation is a success. All three account creators are using the master data management solution to create new accounts. All of the account structures are being propagated to the seven internal systems. The company spends less than one hour per month reconciling issues between any of the financial systems. After seeing the initial success of the finance department's implementation, the sales organization is preparing a project to leverage the master data management system to manage its active customers. The accounting group will be able to leverage this data when creating the accounts receivable data as well.

Leveraging the early success, this project is prepared to grow organically throughout the organization, each group taking advantage of the efficiencies learned in early phases of the master data management implementation. As the project grows into other areas of the business, it is imperative that clear ownership is determined."



Architectural Styles

Centralization

Service Oriented Architecture (SOA) is growing and as it grows more and more corporations are looking to centralize their trusted data sources with master data management systems. If you look at the more hectic times for companies, like during mergers and acquisitions, MDM is very important and useful in tying together separate operational systems that use the same data. As time passes, SOA capabilities are maturing and are starting to centralize the decentralized environments. Combined with a MDM system the merger processes, from a data stand point, can run much smoother.

"Being able to do that with their MDM is as critical today as ever, given the large volumes of data that are available to anyone," said Greg Todd, executive director of information management services at consulting and IT services company Accenture. "Having that centralized architecture for MDM – having the ability to harmonize that batch to all the applications that need that master data using your SOA architecture – leads to more of a globalization of you master data management." (Rob Barry, 2010)

Centralized data can be very important AFTER the merger or acquisition. The company must discover where all the repositories are and what key data needs to be integrated into the master data list and maintained for the future. System integration is a huge challenge as combining of data, like customer information and the like, need to be matched and translated when going from one system to another.

Consolidation

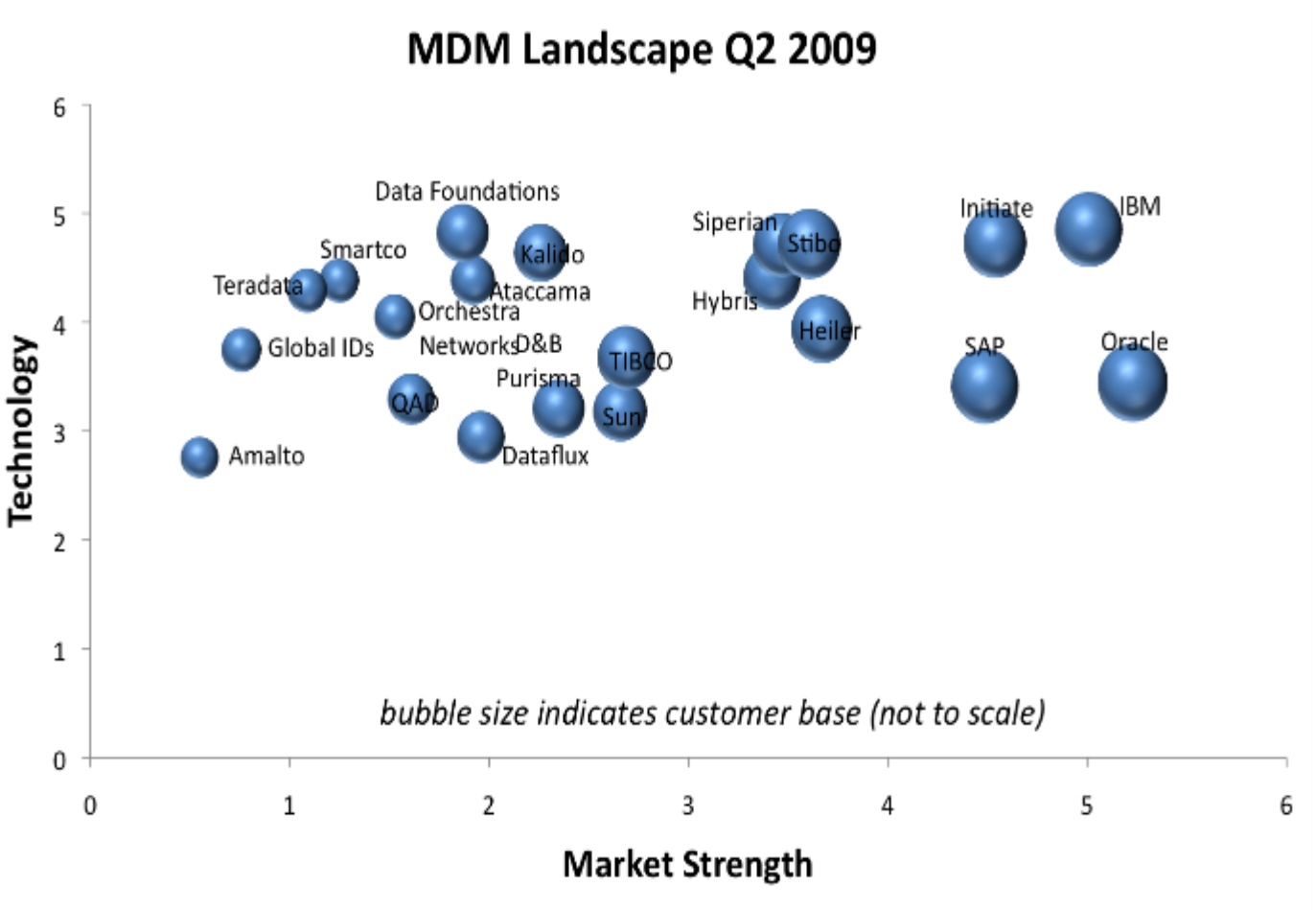
Master-data consolidation means matching, normalizing, cleansing, and storing master data imported from client systems. The principal activities of master-data consolidation are identifying identical or similar objects spread across local systems, building consolidated master data, and providing ID mapping for uni_ed, company-wide analytics and reporting. (SAP AG, 2008)

Harmonization

Master-data harmonization ensures that master data is synchronized across heterogeneous system landscapes. Extending the scope of master-data consolidation, harmonization encompasses the distribution of consolidated, globally relevant information and the enrichment of client application systems with locally relevant information. (SAP AG, 2008)

Landscape

"Master Data Management (MDM) deals with the life-cycle of data that is shared across computer systems, such as customer, product, asset and location. It encompasses the business processes associated with the management of that data (data governance) as well as technology. The Information Difference MDM Landscape is a high level assessment of the main vendors in the MDM market at a particular point in time." (Dave Waddington 2010)



Three different dimensions are represented in the graph above: the technology axis, the market strength axis and the bubble size. The technology score was created based off a customer satisfaction survey, the impression the technology made on industry analysts, maturity of the technology during its time in the market and the breadth the technology covers as compared to functionality models. Market strength scores are a combination of MDM revenue, growth, financial strength, size of partner ecosystem and geographic coverage. Finally we look at the size of the bubbles representing the top MDM vendors. The size represents the number of corporations that the vendor has sold its MDM products to (the customer base).
(Dave Waddington 2010)

Agile Data Management

We are going to look at a specific vendor, Agile Data, and the difficulties in streamlining MDM through a corporation. For the most part, we have looked at MDM as a way to improve the quality and consistence of data resources throughout the corporation. This can be a long and expensive process, depending on the size and scope of the project, and company executives want to see an improvement in the overall return on their IT investment. Agile software development strategies offer significant value to the realm of MDM. Collaborative approaches, business value focus and evolutionary developments are the core objectives to Agile Data strategy.

The difference between Agile MDM and what is considered "traditional MDM" is their approach. Agile Data looks at the work that needs to be done, how to do the work and who the work needs to be done with. Their key focus is promoting the common data definitions, minimizing the data inconsistencies and maximizing the return on IT investment. Although Agile Data may take a slightly different stance on the approach to MDM they still follow these basic MDM activities and work to make those activities more efficient and effective:

- Classify data elements (data classification)
- Consider data access (data security)
- Identify pertinent master data elements (MDEs) such as entity types, data elements, associations, and so on.

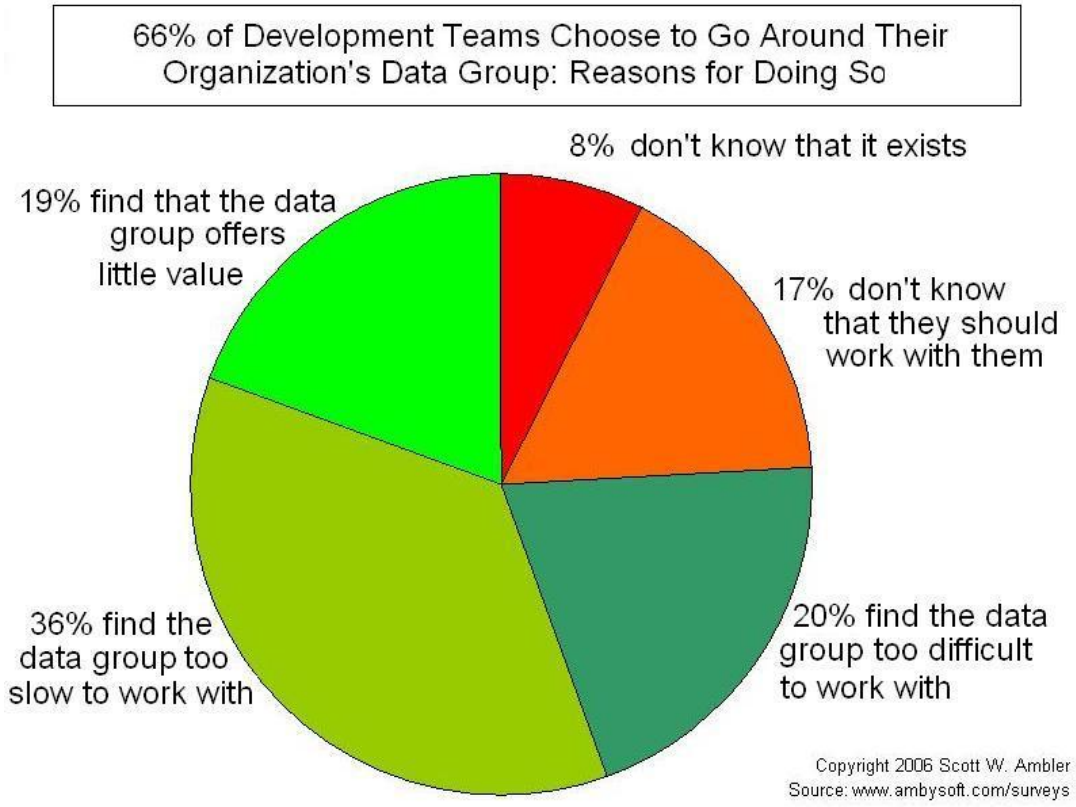
- Define and manage metadata pertaining to MDEs, including:
    - Primary source(s) of record for MDEs
    - How systems access MDEs (identifying producers and consumers)
    - Volatility of MDEs
    - Lifecycles of MDEs
    - Value to your organization of individual MDEs
    - Owners and/or data stewards of MDEs
- Adopt tools, including modeling tools and repositories, to manage MDM metadata

(Scott W. Ambler, 2010)

Agile Data believes the best way to deliver results is through collaborative efforts. Working closely with all the development teams as well as the company stakeholders helps ensure the focus of the project does not veer off course. "With a collaborative approach to MDM:

- The enterprise administrators and enterprise architects involved with working with the teams to support and enhance the MDM efforts.
- They make it as easy as possible for the development teams to do the right thing by collaborating with them to do so.
- They do a lot of the "MDM grunt work" which the teams would have otherwise avoided.
- You work together in face-to-face collaborative working sessions. These prove to be far more effective than traditional approaches such as formalized meetings, reviews, or functionally distributed teams (where the data specialists work on their own in parallel to the development teams)." (Scott W. Ambler, 2010)

Data management doesn't have the best track record when it comes to working together and effectively with development teams and providing a collaborative approach can prove to be much more difficult when fight against a negative reputation. The chart below summarizes the result of a survey that ask if development teams found the need to go around the organizations data group and if so, why?



As you can see, 25% of the problem was educating the developers on who to work with and when to do it. 75% of the problem was directed at the data group and how development teams found them too difficult to work with or didn't see the value that the data team offered. In order to reach a successful level of collaborative team work, a cultural change must be made to allow the data group to make inroads into the support teams for the overall MDM effort.

(Ambler, S. 2010).

Implementation

Earlier we spoke of the different phases of an MDM project. Before implementation can even begin, senior management will want to know how much the MDM project will cost to develop and deploy. You will want an end-state vision that crosses all IT departments and domains. This vision should cover how the current project will have to be modified and aligned with the MDM project. Another challenge is defining the MDM projects' success criteria. MDM should follow a road map that defines the implementation and deployment strategy. This road map should focus on both the long and short term success criteria and should be approved by all stakeholders.

A feasible timeline must be created and documented, showing the content and deliverables from phase to phase, while coinciding with the success criteria. A multiphase approach is a good strategy as long each release falls within a six to eight month timeline. Tangible benefits must be seen at this point as the credibility of the project is on the line. If a single release takes long than a year and no practical changes have been made.

Let's take a look at an implementation example. Let's say that one of the MDM goals is to have a Customer Transaction Hub developed to support data access transactions for customers. Before it can be implemented, a Customer Data Hub must be implemented. This Data Hub should continuously evolve as the data attributes, of which this hub serves as the master, increase and broaden. As the scope of these attributes, and the Data Hub as a whole, grows so does the value that the hub provides to the company. These evolutions within the Hubs should all be organized and released in their own implementation phases. Using this example as a rough guide, it is suggested that the categorization of Data Hubs should be more aligned with the phase implementation shown below, as discussed by Berson and Dubov:

Phase 1: Hub "Slave"	Phase 2: Hub "Slave" enhanced	Phase 3: Hub "Master"
Data governance • Reference data • Data cleansing in source • Data cleansing during Transformations Buy vs build and client hub vendor selection • Data-model-specific • Data-model-agnostic Customer identification (matching) & data quality vendor selection • Deterministic match • Probabilistic match Key generation cross-reference loading and synchronizing the hub Visibility & security at the record level limited to view only	Additional attributes, LOBs and systems Attribute level visibility & security solution All account types, party types, domestic vs international Enhanced customer identification capabilities based on improved data quality and stewardship Comprehensive reference data translations Visibility & security at the attribute level Legacy system/functionality phase out road map	Direct updates against the hub Inverse data flows to support hub master scenario for selected fields Customer identification enhanced by end-user input • Merge • Split • Data enrichment Comprehensive visibility & security implementation Legacy system/functionality phase-out Comprehensive transactional semantics Comprehensive visibility & security solution including support for direct data changes in the hub

Business process analysis (current state).

1. Requirements for business process improvement and re-engineering (desired target state of the business processes).
2. Incremental business process changes by release.
3. Incremental benefits by business function and line of business.
4. State of the solution architecture by release.
5. Conceptual and logical data model of the integrated solution and how it ties back to the business processes.

6. Scope and priority definitions in terms of data attributes, products/account types, and lines of business.
7. Solution architecture and the architecture road map indicating how the architecture evolves with the implementation releases.
8. Vendor product evaluation criteria, buy vs. build decision, and tool recommendation/selection for the key areas of CDI Data Hub functionality.

(Berson & Dubov, 2007)

"The following list is for an organized phased approach, showing the work and resources of interconnected and interdependent work streams. The list is a typical representation of the work that needs to be planned and executed for phased implementations:

- Customer identification
- Customer/account groups and relationships
- Data governance, standards, quality, and compliance
- Data architecture
- Metadata and related services including record locator and attribute locator metadata and services
- Initial data load
- Inbound data processing (batch and real-time)
- Outbound data processing (batch and real-time)
- Changes to legacy systems and applications
- Visibility and security
- Exception processing
- Infrastructure
- Data Hub applications
- Reporting requirements of a stratified user community
- Testing
- Release management
- Deployment
- Training
- Project management

This list is just a guide to help build the project plan. Each of these bullet points needs to have a detailed and well defined deliverables that aligned at the "entire project" level in order to produce a truly comprehensive solution." (Berson & Dubov, 2007)

Challenges

Many of the challenges and barriers that affect an MDM project are not technical at all. Let's take a look at 3 of the human elements behind some of these challenges. As discussed by Jane Griffin in her article "Overcoming Challenge to Master Data Management Implementation" the first, lies in showing the value behind an MDM initiative. "The business has run for years without this kind of effort, so what is the benefit?" or "The benefits of this are really intangible. How do you make a business case for it? Where's the ROI?" are just a couple of question that are initially thrown on the table. These can usually be countered by clearly defining the expectations of the project up front. MDM's value is in the ability to provide timely, accurate and consistent information.

The second challenge follows the concern that the manpower and structure required to provide ongoing data governance for the master data be too complex, costly and ineffective. First of all, yes proper data governance will have its costs, but ineffective data governance will cost more. Data, in all its forms, is a valuable asset for any corporation and it must be management like any other corporate asset and managed effectively.

The third challenge is corporate inertia. There is a perceived bureaucracy that MDM creates during implementation and many companies are reluctant to get involved. The complexity of trying to rationalize all the redundant data at a reasonable cost also causes hesitation. The best way to deal with issues of this particular category is to practice good project management skills. Along with any other obstacles that may be thrown in your way, the best way to handle them is to have clear and concise goals and benefits laid out. (Griffin, J. April 2006)

Justifications

Today's Chief Information and Technology Officers (CIO's/CTO's) are not only faced with increasingly sophisticated executive teams, boards of directors, chief financial officers, treasury boards, and business manager throughout their respective companies or government agencies. They're also faced with the challenge of managing data, specifically Master Data Management (MDM). MDM, as you have learned, is a technique used to define key business objects, such as vendors, products and customers, consistently and accurately. Governments and businesses alike are required to make tough decisions on where to invest their cash, assign resources, while more and more worthwhile investment opportunities compete for tight financial and human resources. For MDM efforts, simply doing benchmarking and the associated analyses of costs are no longer good enough to justify how these types of Information Technology (IT) expenditures should be made. Smart IT executives must present compelling and credible business cases with measurable benefits of MDM to defend worthwhile initiatives that clearly spell out project costs, benefits, risks, and scalability to get the funds and business support needed for proposed projects. A successful business case must be a living document, enabling the organization to review and reassess whether MDM has met the expectations of the organization as well as monitor, track and record anticipated benefits; return on investment, total cost of operating new solution, return on assets and even the rate of return.
A successful business case for investing in MDM is one that convinces management that the business needs it. Today most CIO/CTOs are as adapt with technology as they are with the operation and financial management of their respective organizations. What they lack may surprise you – the ability to assess and measure the quality of the master data they are responsible for! In most Fortune 100 companies, corporate executive and senior managers understand that IT is a strategic asset and does not just support the IT organization, but protects it as well. This protection always comes under fire when there is an alleged data quality issue. The CIO/CTO is encouraged to spend time on determining what has caused the quality issue by participating in the visioning and strategic discussion of how their companies are using MDM. In most cases, executives of companies view IT and the CIO/CTO role as complacent when it comes to data quality . And all too often, the senior executives don't seem to have much time for IT, much less the benefit / value data quality can have on the company strategically.
For the latter group, this is where the business case for MDM efforts is not only needed, it is required. Business cases for MDM can help the CIO/CTO formulate a good communication process that can help support the IT vision and strategy, establish and overall data governance program, and lastly, for managing the quality data. Provide a metric and measurement criteria on how and what investment are being made and what the expectation or results that can be achieved.

How to Create the Business Case for MDM

As a manager or leader in an IT organization, chances are that you will find yourself in the position sooner or later when you are asked to produce a business case for MDM. The process of creating a business case can be unique not only to an organization but to the CIO/CTOs , their managers, or outside consultants that are creating the document. Most business cases usually begin by determining what's driving the need for change (where is the problem) and then creating a business case to communicate and justify the change. Within the business case is the financial, operational or competitive advantage/improvement on how an investment in MDM can / will benefit the company. Though IT professionals can gain an understanding of the fundamentals of business finance and operation impacts by creating business cases, it is often suggested that the business cases for IT efforts be led and sponsored by the business/operation leadership. They are the most impacted by poor MDM. IT is meant to support and enable business success. By having the business executive sponsor and drive the business case development, IT creates a partnership within the business community. IT professional understand the pain of poor quality data and can empathize with the businesses users of information. This provides an understanding of what the needs are for both IT and business operations as well as a fully vetted benefit and value analysis. It is then and only then that the business cases of various other project ideas for both IT and the business operation can be compared in an apples-to-apples fashion.

Conclusion

To sum up, data is the life blood of any corporation. The world has become smaller with globalization but with the expansion of the internet and online businesses, data is increasing tenfold. Managing this data is crucial to the core of your business and MDM could be a solution. Enhanced revenue opportunities, operational efficiencies and insight into business operations are just a few of the initial benefits that MDM offers. The preventative benefits include avoiding fines and customer role over due to data errors are huge benefits of MDM. By focusing on Master Data Management you can almost always increase your business value.

For information on Semantics and Master Data Management, please refer to Chapter 11.

Discussion Questions:

- What is Mater Data and what is its purpose?
- How can MDM save a corporation time and money?
- What are the primary departments where MDM can be most beneficial?
- Describe some of the phases of MDM implementation.
- Describe the challenges that face MDM projects.
- How do you overcome these challenges?
- How can YOU use MDM to improve business operations?

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