CREATING A VALUE PROPOSITION FOR COLLABORATIVE ENGINEERING SYSTEMS WITHIN AN APPLICATION SERVICE PROVIDER MODEL

By

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Bachelor of Science in Civil and Environmental Engineering
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Submitted to the Department of Civil and Environmental Engineering
In Partial Fulfillment of the Requirements for the Degree of

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ABSTRACT

Globalization has spawned an increasing number of geographically dispersed teams, the success of which is dictated by the ability to effectively communicate and share information. Meanwhile, the rapidly changing Internet economy places unparalleled importance on faster time-to-market development cycles for products and services. Providing organizations with new ways to improve communications, collaborative engineering systems increase productivity, while reducing project costs and duration. The ability to allow employees to share information across organizational boundaries is a significant step in producing effective teams. Additionally, information sharing between collaborative teams may be ideally supported by an application service provider (ASP) model. ASPs provide common information and centralized application services for collaborative engineering systems.

The objective of this investigation is to create business value for collaborative engineering systems. Bringing business value through strategic, organizational, and technological issues, collaborative engineering systems may spread across educational, financial, industrial, as well as business sectors. Businesses must perform strategic, organizational, and technological analysis to achieve successful distributed collaboration.

A business plan, featuring a marketing report and an abstraction of a collaborative engineering system, will highlight the thesis. The business plan will also reveal the business model and strategies of the company ieCollab (intelligent electronic collaboration) Partners, a team of graduate engineers in the Department of Civil and Environmental Engineering at the Massachusetts Institute of Technology.

Thesis Supervisor: Feniosky Pena-Mora
Title: Associate Professor of Civil and Environmental Engineering

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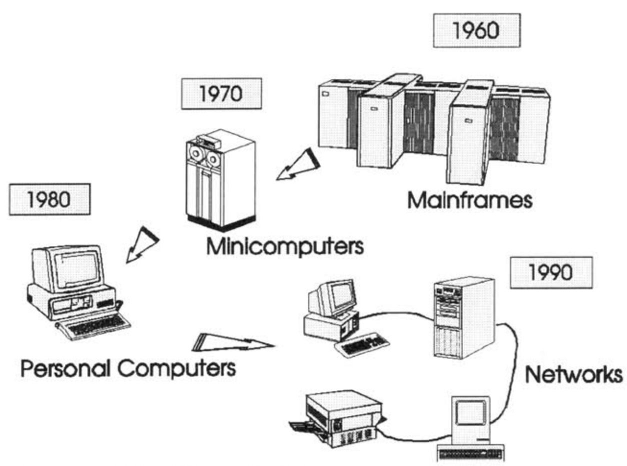
1.1 Background

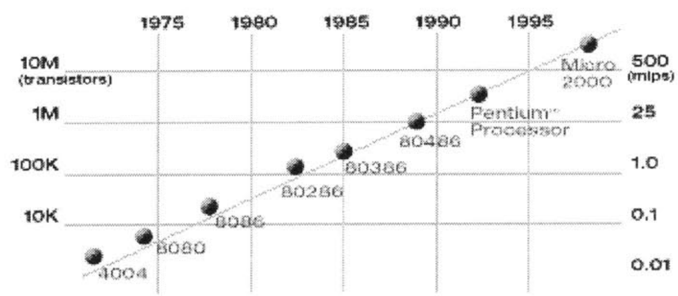


Reference: IBM Corp., 1994.

Figure 1.1 *Evolution of Computers*

Tremendous advancements in hardware and software technologies of the 1990s originally trace back to the introduction of data processing systems on traditional mainframe platforms in the 1960s (Figure 1.1). The powerful computing capability of the mainframe widened its acceptance within organizations. Now known as legacy systems, these types of systems still exist in many corporate information technology (IT) infrastructures. Soon after the widespread proliferation of mainframes, appearance of business software tools, such as word processors, shared filing, and electronic mail, significantly increased the productivity of the office staff. Adding to office productivity, the arrival of the personal computer (PC) in the early 1980s revolutionized the office worker's ability in productivity by providing business software and office automation tools to the masses.

In addition, the developments in microchip processing capacity has almost doubled nearly every 18 months as exhibited by Figure 1.2. This trend, called Moore's Law, estimates that the pace of microchip technology change is such that the amount of data storage that a microchip can hold doubles every year or at least every 18 months. Jim Gray (1999) of Microsoft Research estimates that today's storage capacity equals the sum of all previous storage capacity.

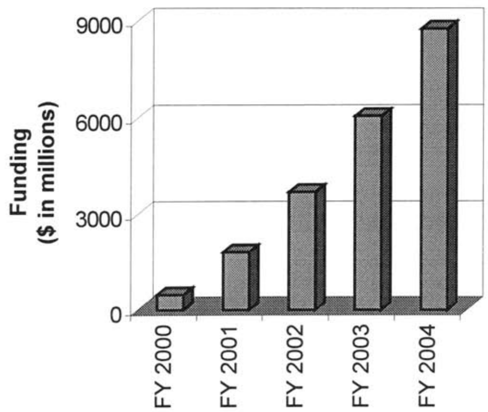


Reference: Intel Corp., 2000.

Figure 1.2 *Observation of Moore's Law*

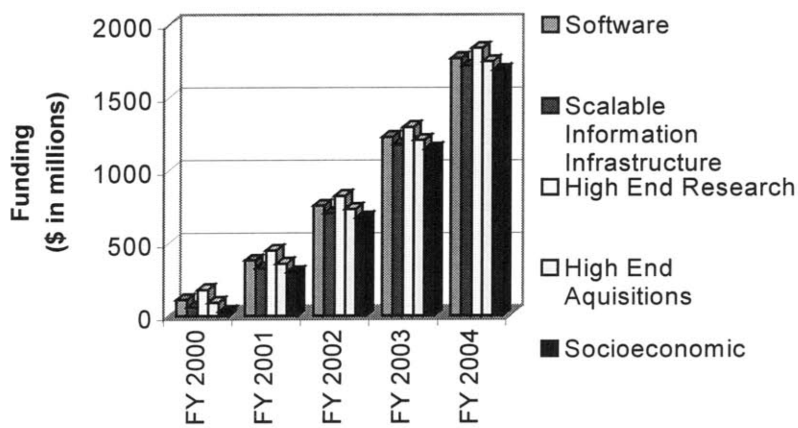
Accompanying the increase in processing power is decreasing computing costs. With lower computing costs and high potential for business process optimization, organizations naturally adopted the PC as a fundamental tool in business operations.

To fuel the advances in computing and communications technology, the President's Information Technology Advisory Committee (PITAC) Report to the President (2000) recommends the Federal government should increase its support for information technology research and development. PITAC suggests an increase of $9 billion in annual funding over the five period, from fiscal year 2000 to fiscal year 2004, as displayed in Figure 1.3. Furthermore, PITAC provides a detailed recommended budget for costs of specific research programs and activities (Figure 1.4) needed to sustain the economic boom in information technology, address important societal problems, and protect us form catastrophic failures of complex systems.



Reference: PITAC, 2000.

Figure 1.3 *Recommended Total Funding for IT Federal R&D*



Reference: PITAC, 2000.

Figure 1.4 *Detailed Funding for IT Federal R&D*

"Computing and information technology will be one of the key factors driving progress in the 21st century – it will transform the way we live, learn, work, and play... Information technology will make the workplace more rewarding, improve the quality of healthcare, and make government more responsive and accessible to the needs of our citizens. Vigorous information technology and development is essential for achieving America's 21st century aspirations."

– President's Information Technology Advisory Committee (2000)

Now recognized as a significant Federal research investment, organizations have also established PCs as an essential business tool. Over 90% of all business PCs have implemented network technology, according to Bates (1996). And with rapid innovation of Internet technologies, access to the World Wide Web (WWW) has become ubiquitous. "Many years ago people had trouble understanding what drove political issues," says Cisco CEO John Chambers. "It was the economy, stupid. Today people are asking what is driving the economy. Well, it's the network effect, stupid." As more PCs and devices link to the Internet, costs of data transmission is dropping faster than Moore's Law is increasing processor speed. The PC evolution, along with a dramatic shift in the business environment, is priming companies for the next stage in business development involving information technology and computers.

1.2 Motivation

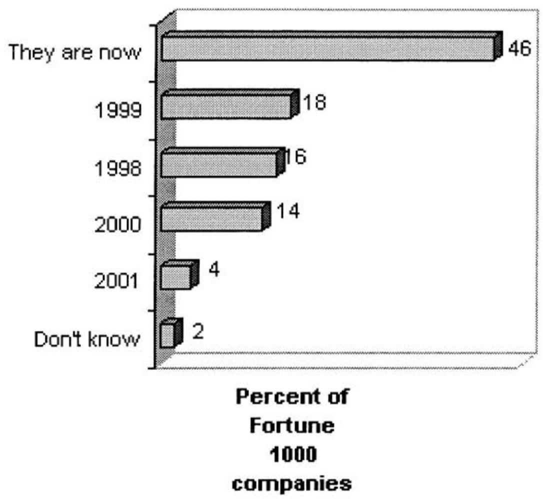
With the advent of modern technology, customers now demand high quality, low cost, and rapid design and development. Organizations must now rely on cross-function teams that are distributed across organizational and geographical boundaries. These teams often consist of project managers, designers, engineers, production personnel, and clients. Modern business practices require the ability to share documents between these fellow collaborators. Collaborative systems aid in the development of worker designs and provide a median for sharing between team members. The emergence of distributed collaboration has stressed greater importance on effective communication between team members.

The need for collaborative systems is also influenced by the fact that face-to-face interaction is limited by the cost and time associated with travel. Thus, the inability to share information, make decisions, and implement solutions has forced companies to budget excessive travel and relocation expenses. Travel, relocation, and conference calls expenditures can cost corporations more than $10 billion annually (National Institute of Standards and Technology, 1999). Additionally, problems in collaboration threaten both project duration and quality. The current practices of emailing or faxing documents back and forth limit synchronous communication and collaboration, as well. Hence, the necessity of real-time collaboration and document sharing is evident and the tools that are presently available do not suffice. Real-time, collaborative systems are critical in the quest for more efficient business processes.

The incorporated communication tools, available in collaborative systems, enrich the document sharing experience. Chat, side-talks, audio, and video allow users to share ideas and make decisions over a simple Internet connection. According to Forrester Research (1999), seventy percent of Fortune 1,000 IT executives expect to use Internet conferencing by 2001. Additionally, users will have their choice of meeting protocols, which provide a structured environment in which meetings finish on time, with the desired goals accomplished. Also, by providing a median for document sharing that allows multiple parties to view and edit that same document simultaneously, independent of geography, distributed collaboration can transpire into effective collaboration.

The collaborative solution gives organizations enormous flexibility. Organizations that can improve and maintain this flexibility will succeed. As a new software distribution model, the application server provider (ASP) model allows organizations to further improve their flexibility. Organizations can try innovative new software packages, such as collaborative systems, on pilot projects, without the risk of purchasing the applications. Additionally, partnerships can be formed on a per-project basis, and easily dismantled if deemed unproductive. These relationships can be formed with companies located anywhere in the world, providing the best possible product, at the lowest cost, in the desired amount of time. The flexibility provided by ASPs permit organizations to explore avenues that were previously deemed impossible, as access to commonly used tools specific to their industry becomes widely available. ASPs help businesses gain a competitive advantage through increased flexibility and uncomplicated access to business optimization and productivity tools.

As software application life cycles continue to decrease, ASPs will become the standard application purchasing model. The ASP solution serves short-term user needs, better technical and support resources, and competitively priced packages. As a catalyst for server and storage consolidation and server clustering, ASPs have been implemented in many organizations and will continue to exist as definite strategic plans (Figure 1.5).



Reference: Forrester Research, 1998.

Figure 1.5 *When will ASPs become strategic to your company*

1.3 Methodology

Companies are definitely ready to incorporate collaborative systems into their IT systems. The following chapters will discuss the different implementation issues of a collaborative engineering system, as well as an abstraction of a collaborative software product.

Section I discusses the framework of analysis for determining the strategic, organizational, and technological issues in a collaborative system. This section also examines case studies in different industry sectors using the proposed framework. Chapters 2 and 3 are included in Section I. Chapter 2 is organized into strategic, organizational, and technological issues driving the need for a collaborative system. Issues that organizations must address are also considered. A detailed examination of strategic issues, highlighted by a Porter Five Forces analysis, is the focus. Chapter 3 explores three case studies utilizing a collaborative engineering system. Each case study represents a different industry: consumer products, aerospace manufacturing, and software development. Successful levels varied, and the reasons will be discussed.

Section II, also identified as Chapter 4, is an ieCollab business plan analyzing the market, competitors, product, business concept, and risks. The original design of the business plan has been reformatted for the purposes of this thesis.

Finally, in Section III, Chapter 5 concludes with a value creation section noting the quantifiable benefits and reduced costs. The summary section concludes the thesis with findings and recommendations.

SECTION I

CHAPTER TWO

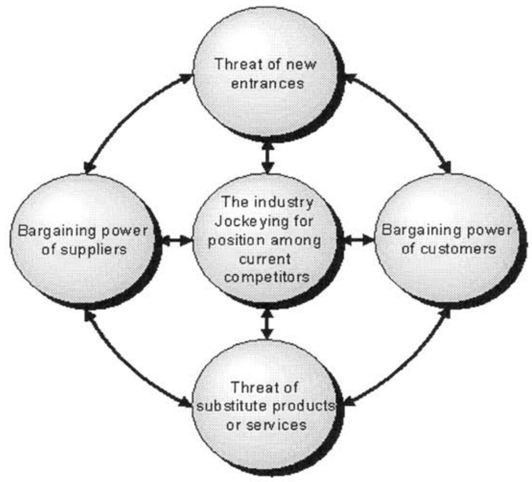
2. Strategic, Organizational, and Technological Issues

2.1 Overview

Strategic, organizational, and technological issues drive the movement to collaborative engineering systems. Moreover, as companies search for creative methods to reduce their operating costs, collaborative systems will be discovered as the necessary solution. The economic push to minimize inefficiencies has created the need for more streamlined business operations within many companies.

The following sections analyze the collaborative system industry using a traditional strategic assessment model. By using traditional models to analyze strategic issues, companies can then understand the landscape of their specific industry. Competitive strategy analysis is an essential tool for businesses, and with this knowledge, companies adjust their company plans accordingly. Organizational issues also arise in this analysis. Companies must align their organizational structure to match the optimal business framework. The primary cause of most information technology systems is the lack of organizational consideration. Nonetheless, the key driver in much of the late 20^{th} century economic boom is technology. As information proliferates throughout the world, organizations must be ready to capture and send information. Aligning technological issues within companies to correlate with the marketplace will be essential for successful executive management.

2.2 Strategic



Reference: Porter, 1980.

Figure 2.1 *Porter Five Forces Model*

According to Porter (1980), the state of competition in an industry depends on five basic forces, exhibited in Figure 2.1. The collective strength of these forces determines the ultimate profit potential of an industry, where each particular industry has a different set of forces and underlying causes.

Table 2.1 provides a description of factors to consider for each of Porter's Five Forces. We will analyze the strategic issues involved for the collaboration software industry, while recognizing some of the considerations listed in the Table 2.1. The considered strategic forces also function as industry drivers, which form an attractive or unattractive market. Preliminary investigation concludes an attractive market exists for real-time, Web-based collaboration.

Table 2.1 *Overview of Porter Five Forces*

Porter Five Forces	Factors to Consider
Rivalry/Competition	▪ Numerous competitors ▪ Slow industry growth ▪ Product/service lacks differentiation or switching costs ▪ Fixed cost are high ▪ Capacity is augmented in large increments ▪ High exit barriers caused by specialized assets or owner pride
Power of Buyers	▪ Buyers are concentrated or purchase in large volumes ▪ Purchased products are standardized ▪ The product forms a large cost component for the buyer ▪ The buyers earns low profits ▪ Threat of backward integration
Power of Suppliers	▪ Supply is dominated by a few companies ▪ Supplied product is unique ▪ Significant switching costs ▪ Suppliers can integrate forward ▪ The industry is not an important customer
Substitutes	▪ The availability of substitute products will limit the profitability of an industry ▪ High profits in an industry may encourage development of substitutes
Barriers to Entry	▪ Economies of scale ▪ Product differentiation ▪ Capital requirements ▪ Access to distribution channels and raw materials ▪ Government policy ▪ Proprietary technology

Reference: Porter, 1980.

Rivalry/Competition. The new economy creates fierce global competition. New entrants into the economy have introduced faster development cycles and enhanced products. The necessity for rapid cycle times in product development and distribution will continue to be a key competitive differentiation in the future. A product development cycle, which improves inefficiencies resulting in lost sales and reduced customer satisfaction, will increase their revenues and market share. Thus, organizations, using new methods to dramatically reduce their product's time-to-market, will succeed.

Power of Buyer. Currently, customers are equipped with mature hardware technology, but need new techniques to empower themselves with the ability to share information. The information becomes useless unless it can be shared and collaborated upon. An organization that utilizes effective collaboration techniques gains a considerable competitive advantage. Also, customers want customizable solutions to their unique problems, so the producers of the technology have significant producing power over the bargaining power of the buyer. In addition, the demand for newer, effective collaboration methods generates a very attractive market for collaborative software makers.

Power of Supplier. The suppliers, mainly program developers, to this industry are limited. The low number of capable software developers creates an expensive and powerful supplier force. The resources needed to attract and retain talented workers requires substantial investment and the demand for IT workers grows even higher. Information Technology Association of America (ITAA, 2000) predicts that 1.6 million new information technology jobs need to be filled by next year, 2001, and growing at a 35% rate per year in some areas of the United States.

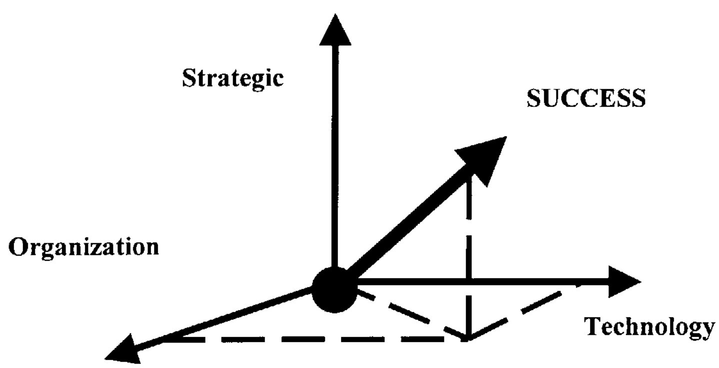
Substitutes. Web-based collaboration does not seem to be threatened by other potential substitutes. The traditional costs of telephone, email, and fax are virtually none, but do not offer effective means of collaboration. In addition, lower costs of travel is not likely in the immediate future. Mobile, browser-less collaboration may soon substitute for Web-based interaction, but does not offer robust functionalities available through high-end PC systems. "However, these traditional technologies provide a mechanism to participate in a collaborative environment with some trade-offs... None of these technologies can be completely excluded, but can be included partially, as these capabilities are inevitably needed." (Pena-Mora, 2000)

Barrier to Entry. A robust product/service differentiates itself from the competitors by offering multiple options to customers, who choose only the services they need. Having the product within an ASP facilitates this service. Technical advantages, such as propriety software and enterprise-level hardware, build barriers to entry that are difficult to penetrate.

Analysis of the industry using Porter Five Forces reveals an attractive market. Customers are willing to purchase these services to employ value for their organization. Furthermore, organizations now realize that their company structure and culture must also change to meet the business demands of the future.

2.3 Organizational

"It has become increasingly clear that the identification of strategic applications alone do not result in success for an organization. In fact, a careful and delicate interplay between choice of strategic applications, appropriate technology, and appropriate organizational responses must be made to attain success," according to Madnick (1988). Figure 2.2, also known as a Strategic Applications, Technology, and Organizational Research Initiative (SATORI), depicts a spatial representation for identification of success in deploying information technology systems.



Reference: Madnick, 1988.

Figure 2.2 *SATORI*

One appropriate organizational response is the recognition that empowered teams of individuals working collectively to achieve common business objectives is significantly more productive than employees working in isolation. The traditional practice of relocating designers, developers and project mangers to a central location does not utilize the technology of the 21st century. The technologies available today in telecommunications, fax, and email, enable collaboration among geographically distributed teams, but they are not very effective nor efficient. As these problems compound, corporations increasingly realize that organizational and infra-structural issues related to collaboration play a much larger role than strategic or technological issues.

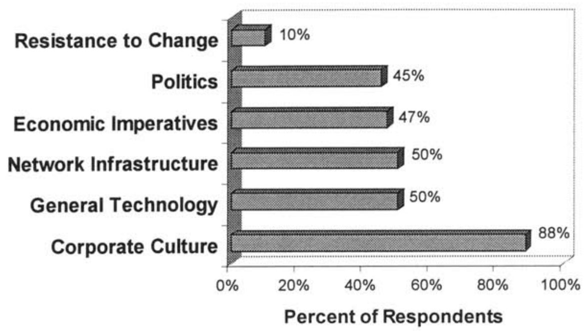
Globalization has spawned an increasing number of geographically dispersed teams, the success of which is dictated by the ability to effectively communicate and share information. A collaborative system needs to provide the framework for individuals to work effectively as a team, by effectively leveraging off-site expertise or improving the knowledge management design. The appropriate framework inherently contribute to the following enhancements:

- Reduction in Project Duration
- Assurance of Quality
- Improvement in Productivity
- Rise in Flexibility
- Overall Higher Success Rate of Distributed Teams

Initially, the new organizational model will be confusing to functionally organized corporations competing in clearly defined markets. However, industry leaders will have to catch teams and flexible organizations that practice successful communication, across the organizational boundaries and among industry partners.

However, alliances can become messy. Nevertheless, they are especially essential in the high-technology industry and growing in all sectors. Even "partial strategies like joint ventures and partnerships are certainly going to become more prevalent," says Excite At Home President, George Bell (1999). Such events cause more decentralization among its workers. The need for collaborative engineering systems becomes obvious as well.

An important aspect in implementing collaborative system within organizations is transforming the company culture to adopt the system. According to a study by Coleman (1996), many electronic collaborative technologies are not greeted with favor. Figure 2.3 highlights a few other impediments in implementing a system.



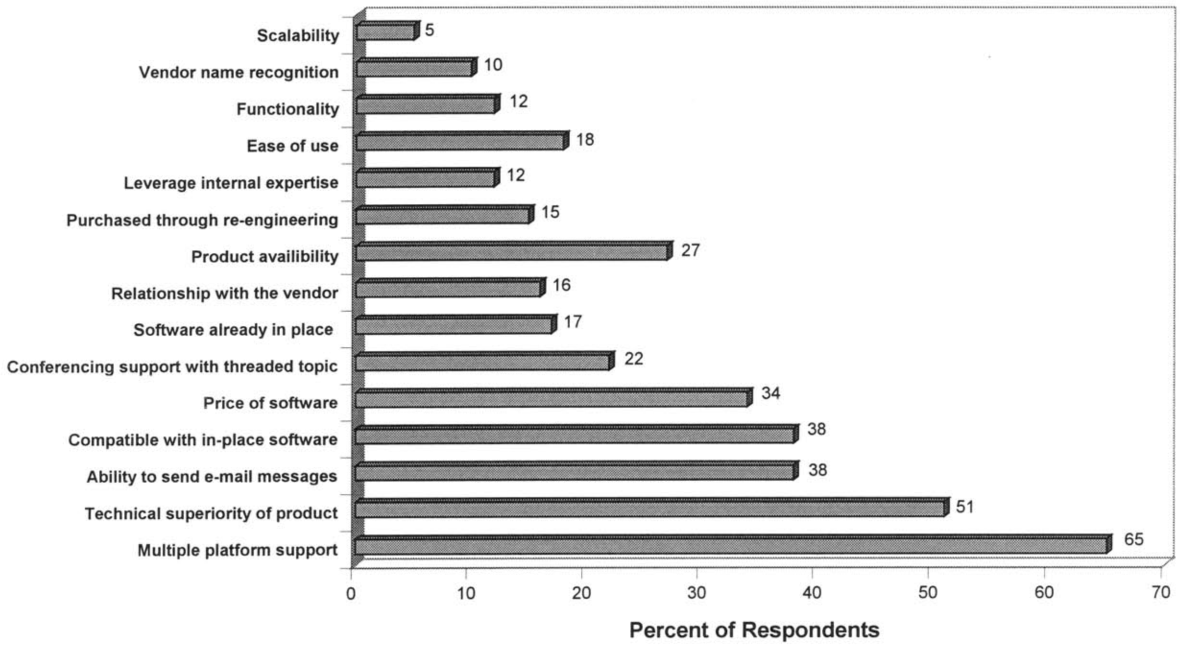
Reference: Coleman, 1997.

Figure 2.3 *Impediments in Implementation*

2.4 Technological

As stated by Venkatraman, "information technology changes the way we do business." The Internet is fundamentally changing the way businesses operate. The Internet creates rapid metrics on performance and acceptability. Rapid metrics drive next-stage development cycles sooner. Quicker intervals between the development cycles compel the development teams for faster time-to-market product development cycles in order to respond to customer's needs. The new economy is growing at Internet-speed, and organizations become pressured by adapting to the pace.

The general movement towards client-server architectures and opting for open systems platforms, is a consequence of the Internet network revolution. This architecture is ideal for collaborative engineering systems within an ASP model. The demand for these technologies is growing at a rapid rate. Currently, the technical infrastructure necessary to implement these systems is mature, and readily available at affordable prices. So, the division between the demand and availability of the technologies required to implement the system is growing smaller. A collaborative system's aim is to fulfill the companies' purchasing decision criteria. A purchasing criteria study was conducted by Collaborative Strategies (Figure 2.4).



Reference: Collaborative Strategies, 1995.

Figure 2.4 *Criteria Used in Purchasing Decision*

2.5 Summary

The previously analyzed marketplace drivers will likely determine the outcome of the industry. By tracking certain metrics and adjusting their business practices to the marketplace, organizations can benefit from a productive collaborative system. The next section will study various experiences and results with collaborative systems. Successful organizations must realize the strategic, organizational, and technological issues involved. Organizations, which perform these analyses before implementation, are more likely to observe successful distributed collaboration; on the other hand, organizations with no planning and analysis are likely to experience failure.

CHAPTER THREE

3. Case Studies

3.1 Consumer Products Case Study – UNILEVER

Company Description. Unilever is one of the largest consumer businesses in the world, producing over 1,000 successful product brands worldwide and employing more than 300,000 people. Hard discounts and strong competitors, such as Procter & Gamble, Johnson & Johnson, and Colgate, create a competitive consumer products. Unilever's competitive advantage in this industry has been to produce high quality products and reduce lead times. With the advent of company growth from globalization, Unilever products are developed by cross-functional and transnational teams through a process of continuous exchange between members dispersed all over the world. This requires a global innovation funnel to help the project development process.

The innovation funnel is a strategic tool developed by Professor Kim Clark and his colleagues from Harvard University, which offers a structured means of managing innovation, from conceptual design to product launch. The funnel establishes a framework for systematic development, including the generation and review of alternatives, the sequence of critical decisions, and the structure of the main decision-making processes. This case study on Unilever was extracted from research by Ciborra (1996).

Technology. At Unilever, the funnel methodology has been combined with an information system based on Lotus Notes, which supports co-operative work and global coordination. The main purpose of the Lotus Notes system was to inform approximately 1000 users worldwide about project progress, in real-time.

The technical performance of the platform was generally recognized as sufficient. Technical problems had been resolved through gradual implementation, based on user comments. The system appeared robust, and breakdowns in the system were not very frequent.

Results. At Unilever, distributed collaboration problems seem to reside in the shift from a group culture to a community culture, one that is required by the strategy of globalization. A lack of strategy in organizational transformation is typical of large business organizations. Below is a summary of the problems faced in distributed collaboration:

- Dynamics surrounding the shift from a local strategy to a global one and the spanning of the boundaries of the organizational network.
- Instances of resistance to the tool by users.
- Institutional properties of the pre-existing organization creates barriers to the adoption of new tools.

The effectiveness of existing interactive computer systems is fundamentally based on robustness. The system must provide extensive language structure and cognitive resources whereby people make sense of events within the network. Understanding the information requires knowledge-based activities utilizing the contribution of everyone. New information systems based on transparency, which guarantees open access to knowledge and supports collaborative work, may be the solution.

Observations. Unilever's strategic and technological analysis partially led to its general acceptance of the collaborative system. Unilever recognized the importance of analyzing its competitors, the marketplace, and its customers. Thus, they were able to formulate global coordination strategies and design the appropriate technological architecture for a collaborative system. However, Unilever's failure to recognize organizational barriers may have caused the limited success. As stated earlier, globalization transformed the organizational culture, and Unilever did not plan for this shift. Large businesses often lack planning in organizational transformation. It is recommended that organizations acknowledge the strategic, organizational, and technological aspects in creating a successful collaborative system.

3.2 Manufacturing Case Study – BOEING COMPANY

Company Description. In 1996, Boeing merged with Rockwell North America and McDonnell Douglas in 1997. The merges led to a rapid growth in geographically distributed teamwork. After the mergers, only 40% of 235,000 employees were located in the greater Seattle area, compared to 80% before the mergers. Travel cost and time restrictions made finding new methods of collaboration within the organization a priority. Thus, Steven Poltrock (1999) of Boeing observed that "effective virtual collaboration became a necessity [within Boeing]." This case study used research from Poltrock, et al (1999) and Mark, et al (1999).

Technology. By combining forces country-wide for designing aerospace products, a virtual best-practice team was formed. The team was comprised of 20 managers that primarily used Microsoft NetMeeting. NetMeeting featured a multiuser whiteboard, chat, file-transfer, and audio/video, as well as a scheduling and hosting server. Use of the technology operated smoothly, but was limited by the amount of interaction for creating new documents. Also, Mark, et al (1999) discovered that the technology ran into some adoption obstacles.

Results. The goal of connecting remote team members is hard to achieve. The absence of on-site consultation about technology, relative lack of importance in remote teams in the eyes of mangers and participants, and local discouragement contribute to impediments in adoption. Common difficulties in collaboration include the following:

- Team participation was voluntary and part-time, so reduced commitment to the project was frequent. The ability to multi-task often distracted participants during the meetings.
- Heterogeneous computing equipment, software, and support organizations, and slow response to user needs diminished organizational support.
- Internal organizational discouragement created obstacles. One member reported that others at his site discouraged him from using NetMeeting by saying that a lot of time would be wasted getting it synchronized. "Also, the leader believed his team members were resistant to NetMeeting as they had been to other unfamiliar applications in the past. He felt that peer pressure was needed to influence adoption. In a virtually collocated team, peer pressure and other influence must work from a distance." (Mark, 1999)
- Teams found difficulty in associating names, faces, and speakers together.

Members found that application sharing contributed more to efficacy than live video. "Thus for distributed team meetings, application sharing provides a real advantage. It enables smooth coordination when changing document views. The shared cursor directs all members' attention to the same point, particularly useful with detailed diagrams. We find that a shared reference also markedly improved the efficiency of virtually collocated team meetings." (Mark, 1999) Some possible solutions to Boeing's collaboration problems include the following:

- Development of new roles that governed speaking turns, identified speakers, coordinated interaction, and directed questions and comments accordingly.
- Facilitator enhancement of display information for remote participants by gesturing with the cursor and zooming.
- Attendance and participation monitoring.
- Application sharing feature, which alone is sufficient for distant participation in meetings.
- Informal interaction combined with formal meetings to aid continuous, seamless team communication.

Observations. Boeing apparently failed to analyze the technological tools and organizational obstacles in implementing a collaborative engineering system. Boeing's heterogeneous computing equipment and software was a basis for its poor distributed collaboration. Furthermore, inadequate examination of its technological capabilities and requirements partially contributed to disappointing collaborations. In addition, Boeing lacked any forethought of potential organizational impediments. The entire organization of Boeing basically rejected the system. Internal resistance and the need for face-to-face interactions led to its weak acceptance. As stated previous, organizations must thoroughly evaluate the strategic, technological, and organizational issues involved in a collaborative effort.

3.3 Software Case Study – IECOLLAB

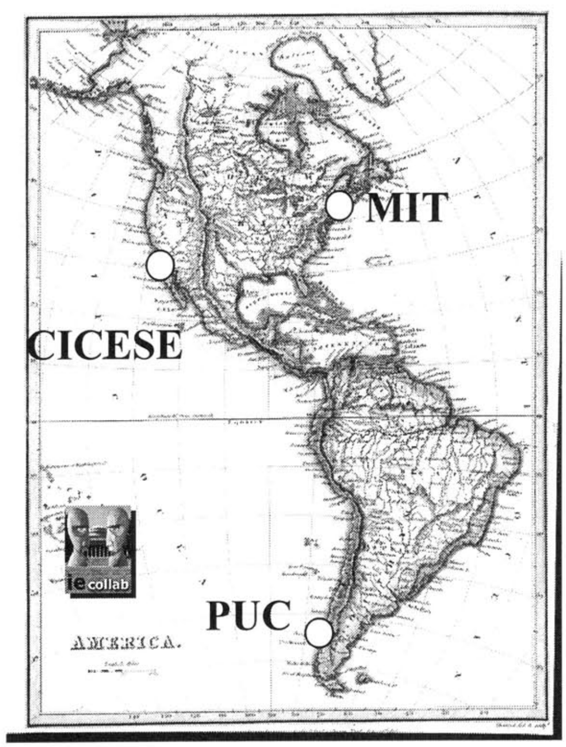


Figure 3.1 *ieCollab's Distributed Locations*

Company Description. ieCollab is a team comprised of 32 information technology graduate students from Massachusetts Institute of Technology (MIT), Centro de Investigacion Cientifica y de Educacion Superior de Ensenada (CICESE), and Pontificia Universidad Catolica (PUC). The team worked together in a distributed environment (Figure 3.1), with members in United States (MIT), Mexico (CICESE), and Chile (PUC), to develop a collaborative software application. The project duration lasted over 8 months.

Technology. ieCollab used various communication tools to collaborate with distributed team members. The group primarily collaborated with chat tools (Mirabilis ICQ), videoconferencing (Microsoft NetMeeting), phoneconferencing (DSOF), electronic mail (ieCollab@yahoo.com), a Web repository (collaborate.mit.edu/1.120.html), a configuration management system (CVS), and a meeting system (CAIRO).

The team faced many problems in distributed collaboration, which occurred primarily from the lack of experience between team members. Among the problems confronted were as follows:

- Difficulty in communication and scheduling conflicts due to time differences between distributed team members (MIT, CISESE, and PUC).
- Lack of coordination and communication among various role assignments (Business Management, Requirement Analysts, Designers, Programmers, Testers, Quality Assurance, Configuration Management, and Knowledge Management).
- Ineffective distributed communication leading to loss of team members.
- Poor information management through comments, changes, and delays.
- Lack of specific technical knowledge and troubles in setting up NetMeeting.
- Lack of dedicated hardware.

The team members also discussed the situation amongst themselves, and agreed on the following recommendations for each of the problems, respectively:

- Get MIT, CISESE, and PUC involved earlier in the project by providing preliminary meeting information and agenda. The project requires clearer early specification and time schedules. ieCollab should also built trust among distributed teams through team-building exercises.
- Collaboration among role assignments is necessary to build clear and consistent analysis and documentation. Responsibilities may overlap between role assignments, thus necessitating a closer interaction requirement.
- Authority should be clearly defined, to produce more effective meetings. Members should establish time commitments, so project managers may then adjust accordingly.
- Differentiating submission of documents, reorganizing comments, and handling submitted documents to the web repository, may minimize inefficient document checking processes. Ensure quality and relevancy of comments through participant evaluation.
- Members who are not familiar with the technical tools should be provided the technical knowledge and trained before the project start date.
- Improve the technical facilities by upgrading the hardware and reevaluating the software.

These recommendations on project improvements, may mitigate ieCollab's troubles in the future. Especially problematic for ieCollab was its ability to leverage know-how from distributed locations. Software companies often tap expertise across teams. Defining programming and interface standards early involves some workflow, but including people outside of the management chain, no matter where they are located, is complicated. When developers propose a standard, all involved parties covering the proposal are notified automatically, so that they can comment or pose questions before it becomes policy. Synchronization among team members helps avoid unnecessary surprises. Figure 3.2 shows ieCollab's software development cycle. Synchronization and interaction between phases is essential for accurate transfer of requirements, designs, and specifications.

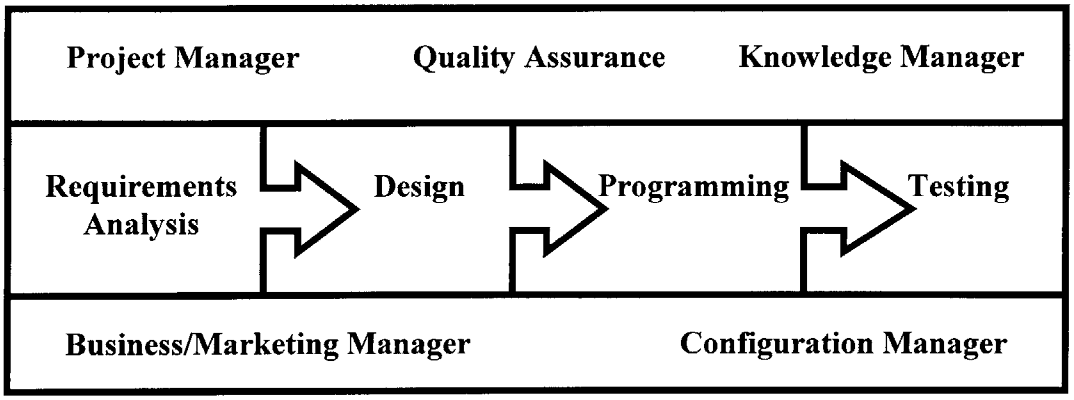
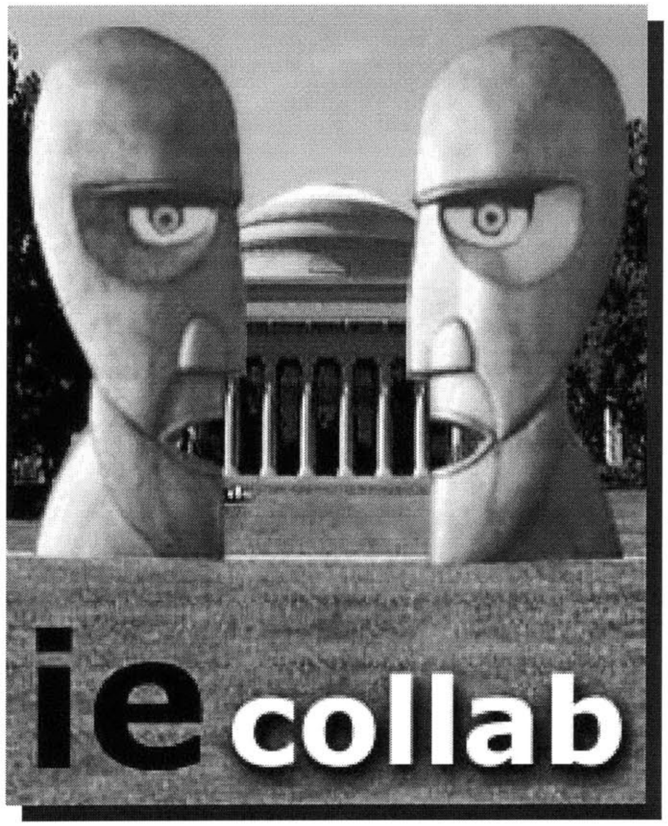


Figure 3.2 *ieCollab's Development Cycle*

Observations. ieCollab failed to examine all the strategic, organizational, and technological issues, thus resulting in unsuccessful distributed collaboration. The primary problem in ieCollab's collaboration was its absence of meeting goals. The team's strategic plans in collaboration lacked focus and direction. Teams did not prepare intended outcomes for meetings, nor were any outcomes achieved. Consequently, many of the meetings were destined to failure. In addition to this, the team's lack of camaraderie contributed to its organizational failure. The team's global inexperience resulted in cultural differences, which were difficult to overcome. Addressing these issues may have lessened some of the problems. The ironic technological failure of the IT team's collaborative system was the consequence of pre-existing strategic and organizational issues. It is difficult to compensate the deficiencies of strategic and organizational planning with strong technological systems. All aspects of strategic, organizational, and technological issues must be addressed for successful collaborative engineering systems.

In Section II, a business plan markets ieCollab's software product resulting from the distributed collaboration efforts. The business plan has been redesigned to fit within the thesis formatting requirements. An analysis of market segments that could use such a solution is presented with an overview of technologies available today. In addition, an abstraction of the product description and requirements substitute for a non-existent product. Otherwise, Section II incorporated the traditional architecture and content of a business plan.

SECTION II



intelligent electronic collaboration

CHAPTER FOUR

4. ieCollab Business Plan

4.1 Executive Summary

ieCollab is an application service provider (ASP) that provides meeting management tools and the ability to share and edit documents via the Internet. Globalization has spawned an increasing number of geographically dispersed teams, the success of which is dictated by the ability to communicate and share information. ieCollab provides organizations with new ways to improve communications, increase productivity, and reduce project costs and duration. ieCollab is entering the ASP and real-time collaboration markets, totaling over a projected $8 billion.

Business Concept. ieCollab's business concept is an application service provider (ASP) that provides meeting management tools and the ability to share and edit documents via the Internet. The technology utilizes a protocol-rich Java meeting environment, building upon over six years of patent-pending MIT research from projects with leading organizations in manufacturing, construction, and defense. Our solution to the collaboration problem offers the following features:

- Real-time Document Sharing/Editing
- Communication tools (Chat, Side-talks, Whiteboard, Audio, Video)
- Application Service Provider (ASP)

- Calendar Service
- Meeting Protocols
- Knowledge Management
- Security

The solution is a Web-based, meeting environment that can be accessed from anywhere, at any time, merely by launching a Web browser. Meeting participants will have access to a blend of traditional communication tools and customized industry specific applications.

Market Segment. According to Collaborative Strategies (1999), real-time collaboration is a $6.2 billion worldwide market in 1999. This market is divided into three segments: audio-conferencing ($2.3 billion), video-conferencing ($3.4 billion) and data-conferencing ($550 million). ieCollab is targeting the data-conferencing market, which is the fastest-growing segment, with an average growth rate in 1998 and 1999 of 111%. This segment is forecasted to be a $1.8 billion market by 2002.

In addition, Forrester Research (1999) predicts that the demand for ASPs will drive the market to more than $2 billion worldwide by 2002. The aforementioned, combined, bring the total expected market capitalization for ieCollab to be $8.2 billion by 2002.

4.2 Vision Statement

ieCollab, through the intelligent use of information technology, allows people and organizations to work together efficiently in real time, overcoming geographical and organizational boundaries, while leveraging innovation, teamwork, education, and communication.

4.3 Business Environment

Technology, politics, and numerous other factors have lead to globalization, creating a worldwide business environment. Efficient communication and the ability to share information dictate success in this global environment. The tools that are presently available - telephone, fax, or email - only scratch the surface of the solution.

With the advent of modern technology, customers now demand high quality, low cost, and rapid design and development. Organizations must now rely on cross-functional teams that are distributed across organizational and geographical boundaries. These teams often consist of project managers, designers, engineers, production personnel, and clients.

For instance, as manufacturing firms outsource more parts and services to focus on their own core competencies, they increasingly expect their suppliers to deliver innovative and quality products on time and at a competitive cost, according to a Sloan Management Review (Winter 1999) article. To achieve these needs, buyers are taking steps to help improve supplier performance. And in doing so, elements of the supply chain are becoming integrated, and sharing timely and sensitive information becomes critical.

Companies with the inability to share information, make decisions, and implement innovative solutions has forced them to budget excessive travel and relocation expenses. Travel or relocation and conference calls can cost corporations more than $10 billion annually. Additionally, problems in collaboration threaten both project duration and quality.

The Boeing 777 project is a perfect example of the challenges of collaboration. The $5 billion project has 10,000 Boeing personnel in over 230 teams collaborating with twice as many contractors and sub-contractors distributed in six countries on four continents. The wing trailing edge project alone had 10 different teams, with approximately 10-20 team members conducting design-build-test loops. Each one of these loops routinely generates over $7 million in costs for aerospace companies (National Institute of Standards and Technology, 1999).

The traditional practice of relocating designers, developers and project mangers to a central location does not utilize the technology of the 21st century. The technologies available today in telecommunications, fax, and email, enable collaboration among geographically distributed teams, but they are not very effective nor efficient. As these problems compound, corporations increasingly realize that organizational issues related to collaboration play a much larger role than just technology issues. Hence, the necessity of real-time collaboration and document sharing is evident and the traditional tools that are presently available do not suffice.

ieCollab can result in numerous benefits through improved communication, opening up a world of opportunities.

- Reduce Project Cost
- Reduce Project Duration
- Boost Productivity
- Ensure Product Quality by Leveraging Off-site Expertise
- Improve Knowledge Management
- Increase Flexibility
- Improve Success Rate of Distributed Teams

Furthermore, our collaborative solution gives organizations enormous flexibility. The ASP model allows organizations to try innovative new software packages on pilot projects, without the risk of purchasing the applications. Additionally, partnerships can be formed on a per-project basis, and easily dismantled if deemed unproductive. These relationships can be formed with companies located anywhere in the world, providing the best possible product, at the lowest cost, in the desired amount of time. The flexibility provided by ieCollab permits organizations to explore avenues that were previously deemed impossible.

4.4 Team

Business Development Team. ieCollab will pursue a management team.

Chief Executive Officer (CEO)

Responsible for securing venture capital funding, managing and strategically organizing the company. Setting future goals of the company and creating the vision. The candidate must have at least 15 years of experience in the high-tech industry.

Chief Financial Officer (CFO)

Responsible for balancing the company's financial objectives between growth, profits, and risk reduction. Manages the company's excess capital, reinvesting to create company value equity. The candidate must have at least 10 years of financial management experience.

Steven Kyauk – VP of Engineering

Mr. Kyauk brings over 3 years of information technology experience from organizations such as Merrill Lynch, U.S. Environmental Protection Agency, and Lawrence Berkeley National Laboratory. His role in the project involves execution of software designs and requirements from Research & Development, integration with existing and potential customer systems, and development of compatible application-sharing technology. Mr. Kyauk received his Bachelor of Science in Civil Engineering with a minor in Chemical Engineering from the University of California at Berkeley. He is currently pursuing a Master of Engineering degree in Information Technology at MIT.

Erik Abbott – VP of Operations

Mr. Abbott brings nearly 2 years of project and operations management experience and an additional 2 years of information technology experience to the company. Mr. Abbott's previous roles in global structural design firms such as Cowi Consulting in Denmark and Hershel Gill Consulting in Miami have trained him for the fast paced development cycles in the high-tech industry. His duties in the project include controlling operation-related costs, analyzing new technologies, creating system flexibility for server traffic expansion, and researching networking infrastructure suppliers. Mr. Abbott earned his Bachelor of Science in Civil Engineering from Florida State University. He is now pursing a Master of Engineering degree in Information Technology at MIT.

Alex Schroder – VP of Business Development

Mr. Schroder brings nearly 4 years of entrepreneurial venture experience. Additionally, his background in strategy, operations management, marketing, and finance brings solid business experience to the team. His main roles in the project involve development and implementation of business strategies, maintenance of organic growth within the company, and formulations of strategic partnerships with key industry players. Mr. Schroder is currently a candidate for Master of Business Administration, with an emphasis in Entrepreneurial Management, at the Harvard Business School.

Anthony Nichtawitz – VP of Sales and Marketing

Mr. Nichtawitz brings over 3 years of process engineering experience and nearly 2 years of consulting experience. He has worked and studied in the technology field for the past 10 years and has had valuable start-up experience, including positions at Applied Materials and Silikinetic Technology, an early stage venture in Silicon Valley. His project responsibilities include identifying new markets and customers, aligning customer needs with product features, creating new marketing strategies to position the service, and establish sales strategies to maintain and acquire new customers. Mr. Nichtawitz is currently studying for a Master of Business Administration in Strategic Management at the MIT Sloan School of Management.

Professor Feniosky Pena-Mora – Advisor

Prof. Pena-Mora will be advising the project and overseeing all phases in the software development process. Prof. Pena-Mora is an Associate Professor in the Department of Civil Engineering at MIT, specializing in Information Technology and Project Management.

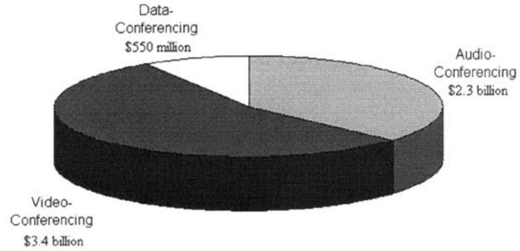
Software Development Team. The ieCollab development team has a combined experience of 25+ years in the nascent collaboration field and 15+ years in software design and development. The software development team is comprised of graduate students from MIT. The team currently has 2 project managers, 3 business/marketing managers, 2 requirement analysts, 2 program designers, 2 lead programmers, 3 quality assurance engineers, 2 configuration managers, 3 program testers, and 2 knowledge managers. Each of these students is pursuing degrees in Information Technology and Computer Science with undergraduate and professional backgrounds ranging from engineering to business. The members' various ethnic and academic backgrounds bring unique strength to the team. Because of this cultural diversity, we are more adept at formulating global strategies, eventually capitalizing on several global markets. All the team members have strong software project management and development skills, which will improve our design process leading to a more reliable stable and higher quality reusable application.

4.5 Market

Software Segments

ieCollab will target the Real-Time Collaboration (RTC) and Application Service Provider (ASP) markets. Each of these markets is discussed below.

Real-time Collaboration Market. The market for ieCollab's solution is very large and growing. According to Collaborative Strategies, LLC, the real time collaboration was a $6.2 billion worldwide market in 1999, divided into three segments (Figure 4.1):



Reference: Collaborative Strategies, 1999.

Figure 4.1 *RTC Market Segments*

ieCollab is specifically targeting the data-conferencing market, which is the fastest-growing segment with an average growth rate from 1998 to 1999 of 111%. (Collaborative Strategies, 1999) The data-conferencing segment is forecasted to reach $1.8 billion by 2000, with 12.9 million data-conferencing users located in 35,750 organizations (Collaborative Strategies, 1999). The data-conferencing market is a young market, experiencing tremendous growth.

Application Service Provider Market. The ASP Market is a strong, emerging market. Forrester Research predicts that the demand for ASPs will drive the market to more than $2 billion worldwide by 2002.

Overall

The aforementioned, combined, bring the total expected market capitalization for ieCollab to $8.2 billion by 2002. Overall, the potential market size is very large and growing rapidly.

Target Industries

The customers for ieCollab's ASP model are virtual teams in the automotive, aerospace, construction, defense, and high-tech industries. Typical buyers will be CIO's and functional vice presidents in charge of cross-functional teams, working across geographical, organizational, and cultural boundaries. The aforementioned are ultimately responsible for reducing project costs and thus will turn to ieCollab as a solution.

Beta testers have been identified and members from these organizations have been working with the core MIT research group in the development of the first version. ieCollab plans to leverage these relationships, retaining these beta testers as first customers. These customers include:

- **Kajima Corporation** - one of the world's largest design and construction firms
- **Visteon** - an enterprise of Ford Motor Company

- **Draper Laboratory** - a premier defense research center
- **Polaroid Corporation** - the leader in instant photography

One commonality among these industries is the need for an effective tool to solve complicated problems in distributed collaboration.

A number of drivers creating the need for ieCollab are prevalent across these five industries (Automotive, Aerospace, Defense, Construction, High Technology). The following tables identify industry drivers and transformation strategies in three functional areas:

- Product Development
- Planning, Forecasting and Replenishment
- Manufacturing

Table 4.1 *Product Development*

Industries	Drivers	Strategies
Automotive Aerospace Defense High Technology Construction	▪ Time to market pressures – Competitive environment demands rapid development ▪ Must simultaneously improve quality, reliability, cost, and customizability ▪ Complex Products - In some areas, products have become too complex for any one company to design and deliver the whole product. ▪ Total Solution requirements - Products and services must inter-operate with other products and services. Total solution must come together and work seamlessly.	▪ Collaborative new product requirements definition ▪ Collaboration with customers ▪ Utilize parallel design teams ▪ Close involvement between manufacturing and service organizations ▪ Real-time information sharing

Reference: Benchmarking Partners and IBM, 2000.

Table 4.2 *Planning, Forecasting, and Replenishment*

Industries	Drivers	Strategies
Automotive Aerospace Defense High Technology Construction	▪ Demand/Supply are either hard to predict or fluctuate ▪ Pressure to reduce inventory - Created by high carrying costs or danger of obsolescence ▪ Pressure to have items in stock- Not having an item in stock can be very costly	▪ Share plans ▪ Share forecasts ▪ Commitment to one forecast ▪ Share inventory and production data

Reference: Benchmarking Partners and IBM, 2000.

Table 4.3 *Build/Manufacture*

Industries	Drivers	Strategies
Automotive Aerospace Defense High Technology Construction	▪ Supplier performance is critical ▪ Cost, Quality, Schedule pressures ▪ Customization pressure ▪ High cost of downtime ▪ Need for optimization ▪ Regulatory Requirements	▪ Monitor supplier performance ▪ Collaborate with suppliers ▪ Collaborate on "design-for-manufacturability" or feasibility ▪ Outsource more services while maintaining visibility ▪ Remote testing

Reference: Benchmarking Partners and IBM, 2000.

The following observations were from the above tables (Table 4.1, 4.2, 4.3):

- Competition is supply chain versus supply chain, not company versus company.
- Customer pressure is forcing collaboration in all of these industries
- Efficient communication and the ability to share information across geographic and organizational barriers will dictate the success of projects

Further analysis on each of these industries will be discussed in isolation next.

I. Automotive Industry

Customer Pressure. In the midst of unprecedented prosperity, today's auto industry is facing significant challenges induced from customer pressure. Customers are becoming more demanding, refusing to compromise on vehicle purchases or wait for replacement parts.

Complex Supply. The automotive value chain includes a number of participants: marketers, original equipment manufacturers (OEMs), tier 1 and tier 2 component suppliers, assemblers, dealers, and after-market service providers.

Cost Savings. The slow propagation of inventory information to third and fourth tier suppliers costs the automotive industry approximately $1 billion annually, according to Manugistics, Inc.(1998).

Furthermore, the significant savings are possible in the development process. Estimates from Ford show that a mere 1 day reduction in a 4 year development cycle of a single $4 billion vehicle platform can save $1 million in development costs.

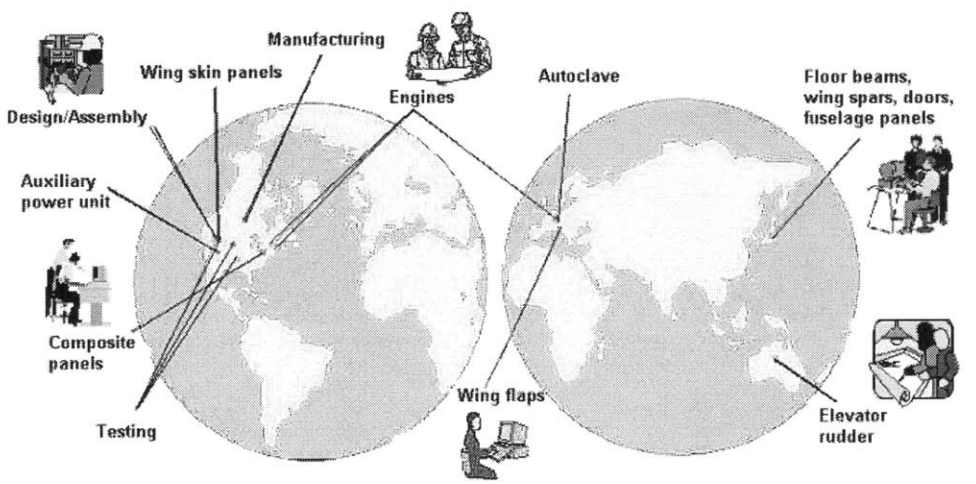
Mass Customization. In the near future, we may see consumers ordering the home delivery of a Ford Mustang equipped with a Toyota engine (Manugistics, 1998). Only through Internet-based collaboration will companies be able to simultaneously achieve customization and profitability.

Summary. The industry has to transform itself from manufacturing focused to customer focused. In doing so, delivery of information becomes critical. ieCollab facilitates the real-time information sharing and enhances customer relationships through increased interaction..

II. Aerospace Industry

Complex Products and Processes. Boeing estimates that the design of a modern jet engine takes roughly 200 design-build-test cycles, each costing about $10 million. Each test cycle that can be eliminated removes $10M from their bottom line.

Complex Relationships. The $5 billion project has about 10,000 Boeing personnel in over 230 teams collaborating with twice as many contractors and sub-contractors distributed in six countries on four continents (Figure 4.2). The wing trailing edge project alone had 10 different teams, with 10-20 team members conducting design-build-test loops. Each one of these loops routinely generates over $7 million in costs for aerospace companies (National Institute of Standards and Technology, 1999).



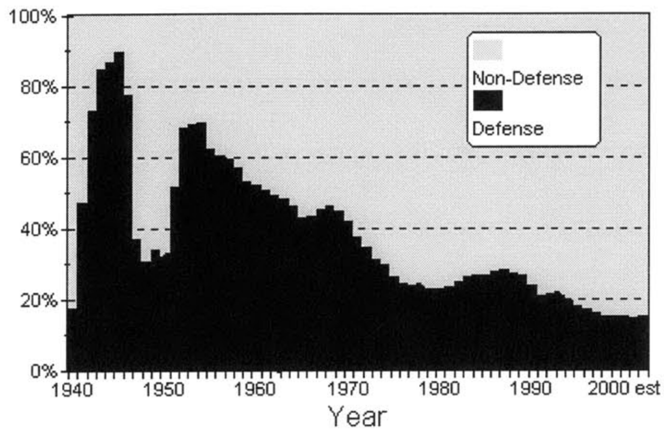
Reference: NIST,1999.

Figure 4.2 *The Boeing 777 Project*

Summary. The products are complex. The web of relationships extend from the component or systems supplier, to the sub-manufacturer, to the manufacturer, and finally to the customer. ieCollab provides the platform for sharing ideas and applications effectively, overcoming these obstacles and untangling this complex web of relationships.

III. Defense Industry

Need for Increased Efficiency. There has been a reduction in defense budgets around the world.



Reference: Brown, 2000.

Figure 4.3 *Defense vs. Non-Defense Spending*

As the chart in Figure 4.3 shows, there generally been a steady decline in defense spending since 1945. We are now at a level lower than the years prior to World War II.

This trend is not unique to the United States of America. Russia and many European countries, such as France, have also decreased spending. Every aerospace and defense company in the world must reinvent itself in order to survive (Donovan, 2000).

Summary. Defense spending is decreasing. Companies must do more with less. As a result, defense organizations are forming new relationship. Collaboration throughout the industry is already seen.

ieCollab can allow these organizations to leverage relationships and economies of scale, while minimizing relocation and travel costs.

IV. High-Tech Industry

Product Life-Cycle. The product life cycle of leading products in the high tech industry is shrinking rapidly. The industry's ability to hasten the pace of innovation, has led to rapid obsolescence of products.

Customer Pressure. Consumers simultaneously demand improved performance, lower prices, and customization.

Summary. New relationships are forming to combat these challenges. The advent of object oriented programming and componentized software has provided organizations with the opportunity to build software using teams located at different sites, and sometimes even in different countries. This drives the need to be able to simultaneously view and edit code from different locations, document projects in a collaborative fashion, and share ideas and information from dispersed locations. All of this functionality may be provide by ieCollab.

V. Construction Industry

Relationships. Joint ventures are evident more now than ever. Large projects are designed, managed, and built by organizations located around the world. Architects, Project Managers, Contractors, Sub-Contractors, Designers, and Customers are dispersed. Teams need to share critical ideas and share ideas and information on these large-scale projects in real-time. Collaborating to prepare a request for proposal (RFP) or checking design documents over the web, the need is in the exchange information and ideas in real-time. For example, the Central Artery project in Boston, Massachusetts has 109 separate construction contracts, consisting of 4,000 construction workers (Big Dig, 2000). Sharing information real-time and on-demand is critical to the successful completion of the project.

Summary. As the infrastructure of the United States ages, large-scale construction projects similar to this one will proliferate, as will obstacles in communication. By facilitating document editing, ieCollab aids in the exchange of information, provides the ability to present ideas, and creates the foundation for these large-scale construction projects.

4.6 Customer Acquisition

ieCollab's unique pioneering position, offering real-time collaboration market in an ASP model, will establish the company with a first mover advantage. The company has solid ties to major research universities (MIT, CICESE in Mexico, and PUC in Chile), corporate research centers (Draper, Kajima and Ford), corporate productions centers (Ford, Kajima, and Panasonic), and consulting firms (Booz Allen & Hamilton, McKinsey & Company, PricewaterhouseCoopers, and Andersen Consulting). ieCollab will leverage these relationships, bringing these organizations in as beta testers. The aforementioned will give the company a strong lead in the marketplace in terms of sales potential and endorsements.

In addition, ieCollab will leverage its unique position in the MIT-Harvard community, utilizing key area contacts from this influential community.

4.7 Product Description

Product Overview

ieCollab is an application service provider (ASP) that provides meeting management tools and the ability to share and edit documents via the Internet. The technology utilizes a protocol-rich Java meeting environment, building upon over six years of patent-pending MIT research from projects with leading organizations in manufacturing, construction, and defense.

Product Requirements

Based on initial customer surveys, ieCollab has identified the following product requirements.

- **Compatibility**. Many firms have heterogeneous desktop equipment. The software solution should be able to run on various operating systems with a similar look and feel.

- **Easy to Use**. The more intuitive the design, the easier it will be for users of all computer skill levels to quickly adapt to new software.

- **Availability.** Users need software to be available for everyone working together on a project, and to allow anytime/anyplace/anywhere meeting support. The ubiquity of the Internet browsers facilitates this requirement, while ieCollab's ASP model facilitates the availability of applications to all meeting members.

- **Data Management Tools**. Users have expressed interest in data management tools to manipulate the information collected, with the additional feature of exporting data into other common applications such as word processors, spreadsheets, and document management systems. This ability to attach or imbed files adds to team information sharing capabilities.

- **Scability/Flexibility**. The software must support the ability to run multiple conferences and groups concurrently. The product should be flexible, providing for scalability and opportunity for future enhancements. Furthermore, the system must accommodate multiple simultaneous users without degradation in performance.

- **Security**. The immense quantity of digital information stored and transmitted has lead to an increase in demand for privacy and security. Expressed as a necessity, appropriate security options that support distributed security is essential in Internet space. Secure methods of entry and a way for regional administrators to track security problems ensures the highest security. Secure, centralized databases, storing important files, is also crucial. Also, all these options must be completely transparent to gain user adoption.

- **Communication Tools**. Tools matching the meeting process and type of work to be done, such as brainstorming, surveys, voting, and prioritizing, and action plans, help simulate effective meeting procedures. Components, such as audio/video, whiteboards, chat tools, and file transfer, replicate the meeting environment.

- **Real-time Collaboration**. Real-time collaboration is essential for the success of distributed teams. Asynchronous communication limits the interactions with teammates while adding significant time to complete tasks. To ensure productivity in meetings, meeting protocols, such as editing limitations and speaking privileges, must be implemented as well.

Therefore, in order to meet our customer requirements, our solution to the collaboration problem offers the following features:

Requirements		Solution
Compatibility, Easy to Use	→	Web-based Application
Real-time Collaboration	→	Real-time Document Sharing/Editing
Scability/Flexibilty, Availability	→	Application Service Provider (ASP)
Security	→	Security and Encryption Tools
Communication Tools	→	Robust Set of Communication Tools, Meeting Protocols
Data Management Tools	→	Calendaring-Scheduling Engine, Knowledge Management

I. Web-based Application

Tim Berners-Lee stated that the Web "was developed to be a pool of human knowledge, which would allow collaborators in remote sites to share their ideas and all aspects of a common project." (Berners-Lee et al., 1994) The desire in enabling technologies for collaborative engineering systems lies in deployment and implementation of system prototypes in real work domains. Already prevalent in many businesses, Internet technologies, along with free, easy-to-implement software will remove many of the obstacles to collaboration within businesses. In this regard, the World Wide Web seems to offer vast potential as an enabling technology of collaborative systems.

- The ubiquity of the Internet supports anytime-anyplace access.
- Web client browsers are available for all popular computing platforms and operating systems
- The web and web browsers are easy to use.
- The web and web browsers are widely used. Users are already intimately familiar with this approachable working environment. The learning curve is fast and intuitive, avoiding time and money wasted on training.
- The consistent presentation of information can be maintained across multiple platforms
- The web is extensible. Additional tools and applications can be added through external helper applications and plug-ins.
- Browsers are already a part of the computing environment most organizations, thereby requiring no additional installation.
- Many organizations have installed their own Web servers as part of an Internet presence or a corporate intranet and have familiarity with server maintenance and, in many cases, server extension through programming the server application programming interface

Our solution is a Web-based, meeting environment that can be accessed from anywhere, at any time, merely by launching a Web browser.

II. Document Sharing

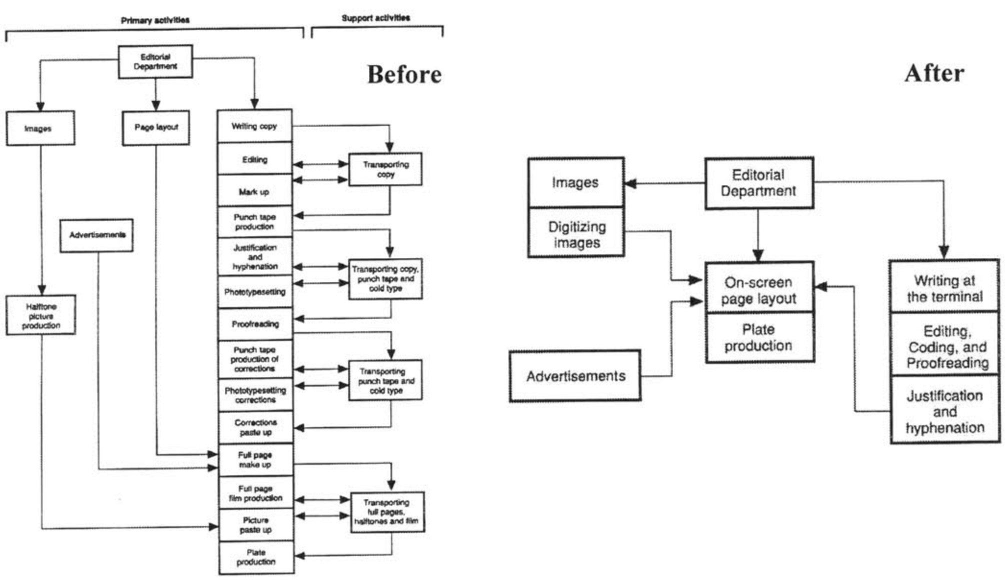
First and foremost, the ability to share documents is critical for real-time collaboration. The current practices of emailing or faxing documents back and forth limit true synchronous communication and collaboration. ieCollab provides a median for document sharing that allows multiple parties to view and edit the same document simultaneously, independent of geography.

Cooperative Authoring Process. Cooperative authoring is an example of a process that would be greatly enriched by such a medium. The cooperative operating process consists of multiple phases, with an asynchronous and synchronous combination. The cooperative authoring process is shown in Table 4.4.

Table 4.4 *Cooperative Authoring Process*

Phases	*Description*	*Mode*
Planning	Goals, organization, and distribution	Synchronous
Writing	Contribution and awareness	Asynchronous
Evaluation	Corrections, annotations, and comments	Asynchronous
Negotiation	Discussion, suggestions, and poll	Synchronous
Consolidation	Resolve, merge, review, correct, and polish	Synchronous

Reference: Rada, 1996.



Reference: Kyng, 1991.

Figure 4.4 *Reduction in the Editorial Process*

Simulating the cooperative authoring process, the ieCollab system provides a complete set of collaboration tools. In a specific example, a collaborative system can significantly reduce the number of steps in a newspaper editorial process (Figure 4.4).

Similar to the media industry, the construction industry includes, request for proposals (RFPs), change order requests, and contract statements, which may benefit from more efficient cooperative authoring processes. One contract manufacturer executive states, "we don't just want to pass documents back and forth. We want both companies to see materials at the same time, be able to change things at the same time, then work on them together." Organizations may necessitate distributed collaboration on virtually all types of documents and designs, including software code. The potential utilization of cooperative authoring is limitless.

A document sharing utility must fulfill design, role, and activity requirements for the system. The following requirements (Table 4.5) have been identified to maximize performance:

Table 4.5 *Document Sharing Requirements*

Design Requirements
• *Preserve collaborator identities* • *Support communication among collaborators with document annotations, synchronous interactions, and asynchronous messages* • *Provide a knowledge retention utility or system log*
Role Requirements
• *Explicit collaborator roles*
Activity Requirements
• *Support brainstorming, research, planning, writing, editing, and revision* • *Support transition between activities* • *Provide access to relevant information* • *Make process and outline plans explicit* • *Provide version control* • *Support concurrent and sequential document access* • *Support access to several documents* • *Support separate document segments* • *Support one or several writers* • *Support synchronous and asynchronous writing*

Reference: Posner, 1992.

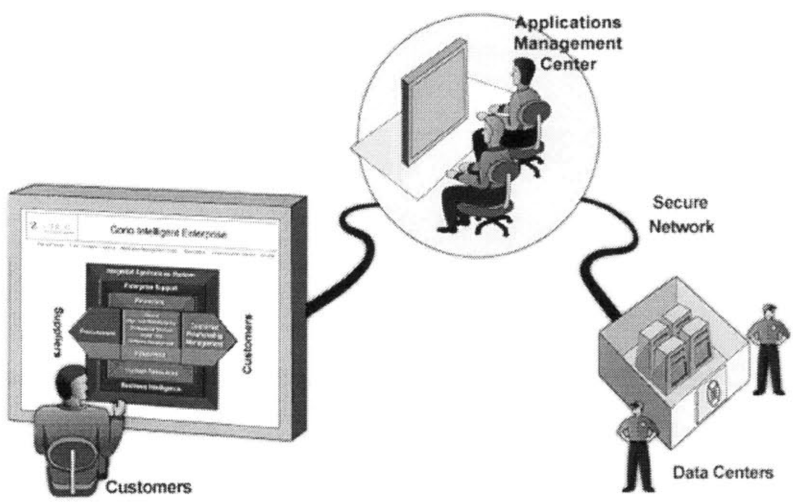
In addition, Table 4.6 lists the advantages and disadvantages of document sharing.

Table 4.6 *Advantages & Disadvantages of Document Sharing*

Advantages
• Encourages more integrated team work • Speeds up document and report production • Provides a means for comments to be attached during proof-reading
Disadvantages
• Requires extremely complex software • Write access leading to several amendments may cause confusion • Document may take longer to produce due to multiple editors

Reference: Bate, 1994.

III. Application Service Provider



Reference: Corio, Inc., 2000.

Figure 4.5 *Application Service Provider (ASP) Server model*

ieCollab provides offers collaborative design software in an application service provider (ASP) model. Similar to thin client-server architecture, ASPs manage client sessions, host business logic with an application management center, and connect back-end computing resources like data centers (Figure 4.5). The centralized computing environment offered is safe and scalable. According to Corbett (2000), application hosting will be driven by six forces (Table 4.7).

Table 4.7 *Top Six Drivers of Application Hosting*

Driver	Description
Speed	*Business solutions are available in days or weeks as opposed to months or years.*
Focus	*Today's executives know that anything that distracts their company from its subject matter expertise must be moved outside the organization.*
Flexibility	*Creates a true "plug-and-play" approach to acquiring advanced business capabilities.*
Connectivity	*Sourcing turns supply chains into fully integrated trading networks.*
Scalability	*The right solution can be put in place first and then easily grown as needed.*
Price	*Lower total cost of ownership and shorter time-to-benefit.*

Reference: Fortune, 2000.

The ASP model allows users to have access to commonly used tools specific to their industry. Organizations can quickly deploy applications without the associated cost and burden of owning, managing, or supporting the applications or underlying infrastructure. This offers enormous flexibility and cost savings. Custom applications once only available to few large companies are now available to small companies (Figure 4.6).

Evolution of ASP. Business applications have evolved from expensive customized programs, to packaged services available for companies of all sizes. Standard enterprise-wide ASP deployment occurs in days or weeks, and at one-third to one-half cost lower than common deployment approaches. The solution is one of the most important business revolutions yet to emerge from the dot-com world. Chairman of the ASP Industry Consortium, Traver Gruen-Kennedy (2000) believes, "ASPs are doing for software what the Internet has already done for data – making software applications universally available, affordable, and ubiquitous." Giving smaller firms the flexibility to acquire and upgrade new applications every couple of years without paying high costs, the concept helps bridge the gap between small to mid-tier organizations and high-performance business applications.

Reference: Fortune, 2000.

Figure 4.6 *Natural Evolution of ASP*

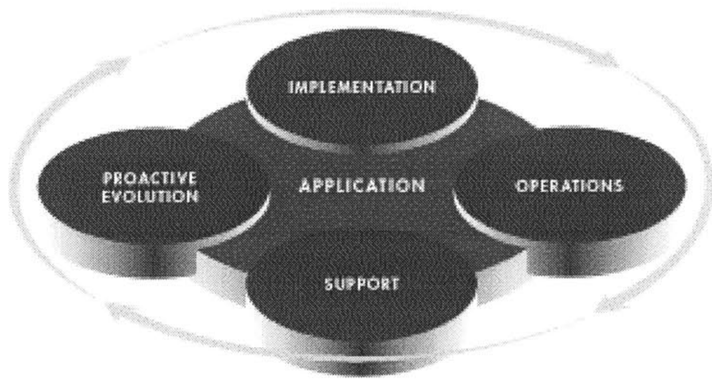
Key Characteristics of ASP. In order to meet the demands of distributed computing , ASPs will need to have the following five characteristics (Table 4.8).

Table 4.8 *Key Characteristics of ASP*

Characteristic	*Description*
Performance	Load balancing and server failover route Web users to the best available server. Thread pooling and object caching optimize server resources. A scalable transaction service ensures reliable database updates.
Connectivity	Application servers provide object request broker and connection services to packaged applications, middleware services, and databases. Database connections get pooled and cached for speed.
Application Management	Application management includes standard features like software updating and exception notification. But it also covers on-line performance tuning of individual code components in a complex, multi-server configuration.
Ease of Development	Application servers must support best-of-breed tools to address team development distributed debugging, and an array of in-house technical skills. The goal is blend hard-core coding with drag-and-drop simplicity.
Transactive Content Support	Application server vendors must provide a clear path to integrate with he content catalogs, personalization, and collaboration services that engender a self-service user experience.

Reference: Forrester Research, 1998.

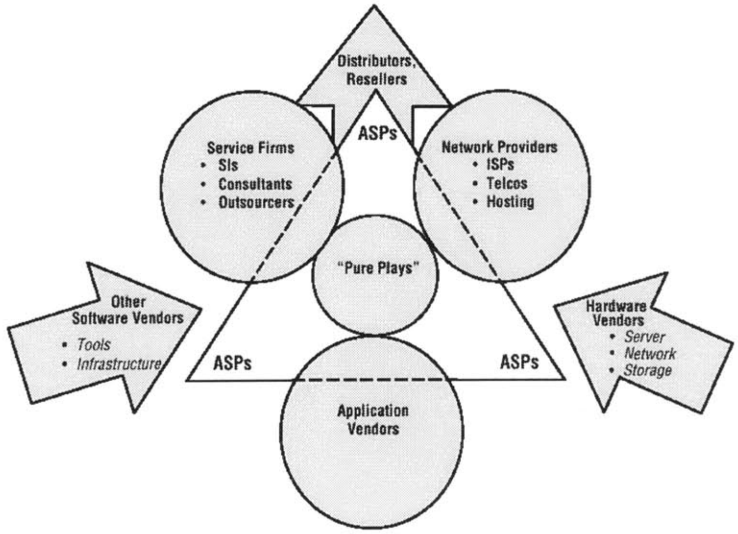
These business applications provided over the Internet offer organizations quick, cost-effective, and immediate use of strategic business solutions. A contractual service deploys, implements, customizes, hosts, manages, and rents access (based on some usage metric) to an application from a centrally managed facility. ASPs feature a full life cycle of application services as shown in Figure 4.7. Users then access applications via browser software on any network-enabled device, allowing network accessibility to applications hosted on powerful servers. ASPs are responsible for either directly or indirectly providing all the specific activities and expertise aimed at managing a software application or set of applications. Greater emphasis is placed on providing robust end-to-end performance monitoring and service management solutions.



Reference: Applicast, 2000.

Figure 4.7 *Full Life Cycle Service*

Involvement. Many industry players are involved in the success of the ASP model (Figure 4.8). Pressure on the computer hardware vendors, network providers, and software vendors will increase. ASPs will be a catalyst for storage consolidation and server clustering, which require hardware for physical or logical partitioning of server and storage resources. In addition, network providers will have to improve their networks so performance is par with reliability and customer service. Also, software vendors now face the difficult and complex economic decisions of licensing through an ASP or directly sell applications.

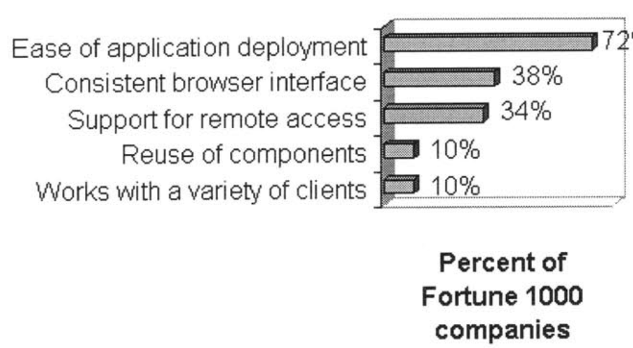


Reference: IDC, 1999.

Figure 4.8 *ASP Players*

Reasons for Implementation. Organizations are adopting ASPs for a number of reasons. A recent survey by Forrester Research suggests that ease of application deployment is the most common reason for using ASPs among Fortune 1,000 companies (Figure 4.9). Other companies are turning to ASPs for the following:

- Speed
- Focus
- Flexibility
- Connectivity
- Scalability
- Price



Reference: Forrester Research, 1998.

Figure 4.9 *Survey on Benefits of ASP*

IV. Security

Security and privacy of the system is essential to the acceptance of the system. Users want their privacy protected, since much of business information is sensitive. A collaborative system must protect users' information, while providing selected access to team members. For user adoption to occur, encryption techniques must also be transparent to the user. User are not obligated to understand the encryption process. Cypost Corporation (2000) recommends the following user requirements:

- One-step compression and encryption. The added feature of integrated compression reduces e-mail connection times and is much harder to decipher than uncompressed messages.
- Seamless integration with messaging applications and operating systems. Inside a well-designed privacy and security application, encryption processes are completely transparent.
- Easy to install and set-up, including quick start tutorials.
- Easy navigation using an intuitive graphical user interface.
- Support for current platform standards and future applications. Open component architecture applications will likely outlast those with closed architectures.

Encryption. 64-bit public key encryption (asymmetric) security, widely used in internet browsers, is the same level of security used in intranet networks, or a Lotus Notes system. This contradicts the perception that intranets are more secure than the Internet. The fact that most intranets reside inside a firewall, there is less chance of an attack from hackers. However, compared to asymmetric algorithms, symmetric algorithms are very fast, and thus are the preferred method when dealing large amounts of data. Common symmetric algorithms are RC2, RC4, and the Data Encryption Standard (DES).

64-bit encryption is sufficient, but a 128-bit encryption is recommended. The effort required to crack an encrypted key is directly proportional to the length of the key (in bits). Equation 4.1 below describes the relationship.

$$\text{Possible Key Combinations} = 2^{\text{length of key in bits}} \qquad \text{(Equation 4.1)}$$

The length of the key is a factor in preventing attacks, as the longer key requires more tries to find the right key. With a 64-bit key, there is a large, but definite limit to the number of keys you need to check (18 quintillion [18×10^{18}] possible combinations). Given the current power of computer, a 64-bit key is considered crackable. Some applications can test 200 million keys per second, and a specialized computer array that can break a 64-bit key encrypted message in a matter of hours. If the key is 128 bits long, the number of possible keys to check is 340 undecillion [340×10^{36}], which is 18,000,000,000,000,000,000 times more difficult than a 64-bit key.

E-mail. Letters, documents, and artwork, delivered via e-mail and attachments, can be susceptible to electronic eavesdropping. Encryption protects e-mail and attachments by rendering it impossible to read. The contents of a message can be encrypted using a conventional encryption scheme such as the data encryption standard (DES). The most difficult technical challenge for such schemes is the secure exchange of encryption keys between pairs of correspondents. The goal is to prevent anyone but the intended recipient from reading the message.

Another development that may help in messaging security is the adoption by e-mail vendors of the privacy enhanced mail (PEM) standard, which describes a common way of encapsulating encrypted messages and defines when software applications should decrypt a message. The standard, approved recently by the Internet Engineering Task Force, should help bring standard, secure e-mail to market more quickly.

Information sharing. Even in a total information sharing environment, there will always be some information that must remain of a personal and private nature. Users may be concerned that such information will lose its confidentiality during the transition to collaborative and ASP systems. However, encryption will minimize risk from unauthorized access.

Centralized Server. Sensitive files are protected by centralized security system. Information is on distributed and local hard drives must be protected. Centralization adds another level of security sophistication, as the intruder must break through multiple security barriers.

V. Application Tools

Meeting participants will have access to a blend of traditional communication tools and customized industry specific applications.

Interface to Electronic Mail. The asynchronous exchange of text messages and multimedia objects is facilitated by e-mail. Most systems include the ability to attach various documents, maintain address lists, and postal exchange services, such as forwarding and replying. Many consider e-mail a fundamental enabling technology. It is the basis upon which multimedia mail, data access, scheduling, and document sharing is supported. Below is a listing of e-mail advantages and disadvantages (Table 4.9).

Table 4.9 *Advantages & Disadvantages of Electronic Mail*

Advantages
• Enhanced communication throughout the organization • The ability to transmit documents and other files to colleagues • Support for remote workers who can keep in touch using e-mail • Provides the foundation for the adoption of work group computing
Disadvantages
• Can cause information overload – facility is used to extremes with the result that employees spend too much time reading mail messages • Security – the security of mail boxes and the fact that a document could inadvertently be sent to the wrong person or group of people

Reference: Bate, 1994.

The incorporated communication tools enrich the document sharing experience. E-mails may be used to inform team members, list meeting agenda, summarize objectives, or confirm meetings. Chat, side-talks, audio, and video allow users to share ideas and make decisions over a simple Internet connection. Additionally, users will have their choice of meeting protocols, providing a structured environment in which meetings finish on time, with the desired goals accomplished. Detailed in the following section is a further discussion on meeting protocols.

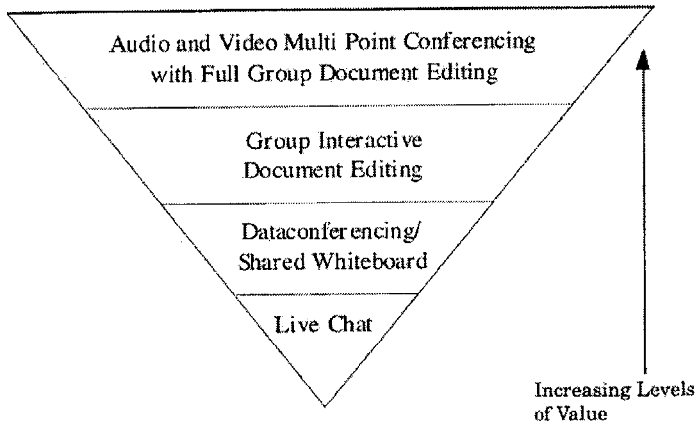
Audio/Video Conferencing. Full scale audio/video conferencing tools allow meetings to be conducted between geographically distributed participants. Multiple meeting participants can view images of each participant from a PC, while holding real-time conversations. The immediate tangible benefits are obvious. 1) Reduction in travel expenses by avoiding airfare, car rental, hotel, and meal costs. The time spent on transit also causes a drain on productivity. 2) Increased productivity by reducing time to complete a task, without sacrificing the objectives. The extra time is used for equally or more productive tasks. Below are the advantages and disadvantages of audio/video conferencing (Table 4.10).

Table 4.10 *Advantages & Disadvantages of Audio/Video Conferencing*

Advantages
• Save on travel time and costs • Establish closer relationships with customers and colleagues • Provides an enabler for telecommuting
Disadvantages
• Systems are currently expensive • Picture quality is generally poor • Limited group conferencing abilities

Reference: Bate, 1994.

Collaboration through real-time audio/video conferencing can speed the development of creative solutions to overcome critical situations. According the Coleman (2000), the highest level of value in real-time conferencing is multi-point audio/video conferencing with full group document editing as shown in Figure 4.10. Using the highest level of conferencing will produce teams who communicate more clearly and more creatively, while reducing cycle times.



Reference: Coleman, 1997.

Figure 4.10 *Four Levels for Conferencing*

Chat. Similar to e-mail, chat tools enable the user to communicate real-time with distributed members. Chat is a text writing tool for all team members to communicate synchronously. Problems may arise if teams become too large, and thus communication channels may diminish.

Whiteboard. The virtual whiteboard feature is similar to the traditional, representation media in a meeting room. The whiteboard becomes a simultaneous communication channel for members to capture ideas as they transpire. Whiteboards allow editing, copying, printing, and layering for users to express their ideas. Supporting innovation with technology, whiteboards allow users to create document the result of their thinking through sketches and formal diagrams. Teams immediately see the results, and increase their productivity. Also, by allowing a variety of presentation related capabilities, the whiteboard becomes a valuable business tool.

However, whiteboard discussions can be complex. Writing and talking are intricately bound when drawing on a whiteboard, and involves a standard process entailing presentation and acceptance. Also, users producing, recognizing, and responding to contributions fall within this space. Other problems surface from lack of sequentiality, anonymity, private editing, or unpredictable delay. Tailoring meeting protocols into the system lessen these complexities.

VI. Meeting Protocols

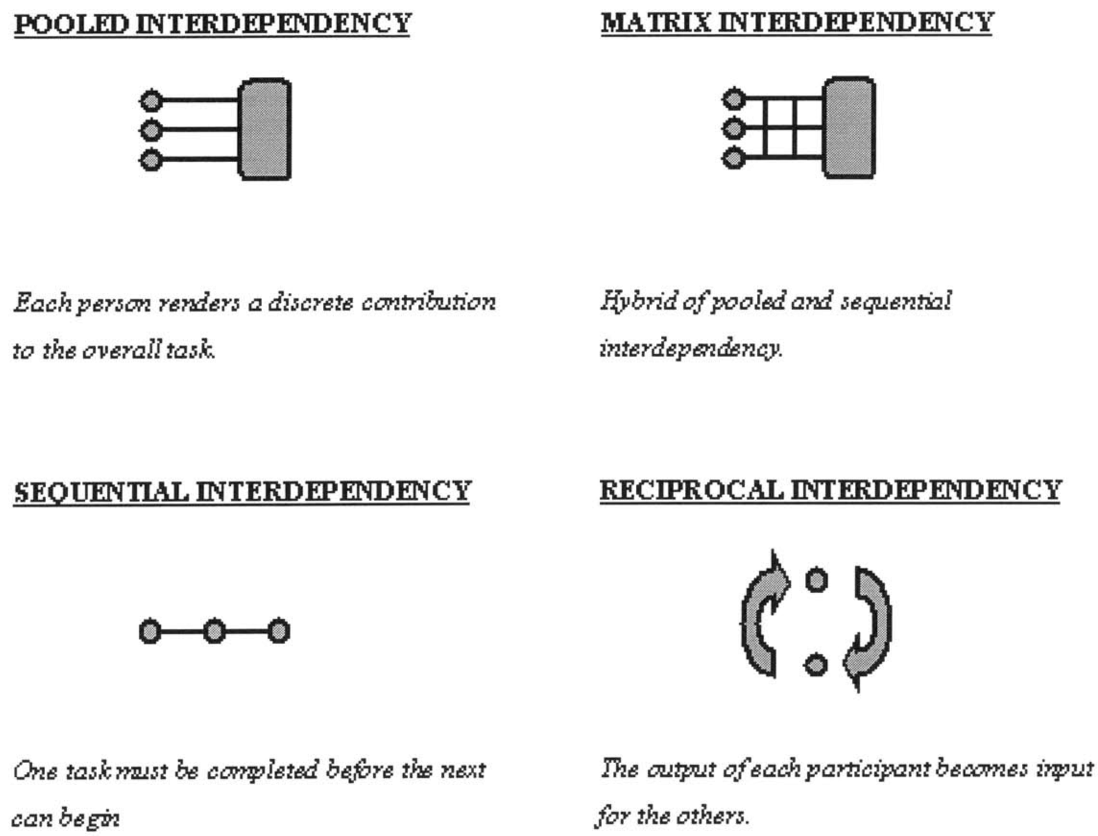
The problem of dynamic team interactions is solved by allowing collaborating users to set meeting protocols by custom tailoring the level of interaction allowed among users. A collection of constraints define team interactions. These constraint parameters are selected dynamically by team members, choosing ranges for each. The following below are a variety of scenarios showing flexibility in allowing users to define their meetings protocols in relation to semantic bindings.

Static bindings. Process binding occur at the earliest stage in product development. By completely binding the semantics of group interaction at program writing time, early binding is more efficient. Meeting protocols become standardized and static, as the semantics do not change dynamically. Thus, all collaborators are in meeting protocol synchronization. Early binding demands less of the users and is simpler to use.

Parameter bindings. Bind parameterized meeting protocols allow users to set values for their parameters at runtime. Thus, the range of collaboration semantics is bound at program writing time, but the exact semantics is not bound until the time of system use.

Process bindings. Process bindings are integrated tools for setting and defining collaboration protocols. Specific meeting protocols designed by the developers of the system is rare; instead, collaboration specialists, or the users themselves, must bind specific semantics at runtime. Collaborative work is situational, and difficult to design. Later binding increases flexibility for eventually evolving functions. Situational collaboration implies that some for some teams, one right choice for rules of group interaction will never exist.

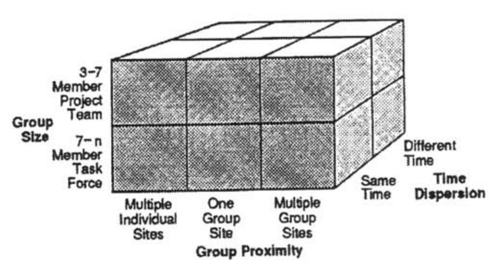
For effective meetings to occur, users must early or later bind meeting protocols. By appropriately defining meeting protocols, teams benefit from proficient collaboration. Meetings finish on schedule with the desired effect. Meeting protocols should facilitate team interdependency as well. The protocols should provide a structured framework that allows the following four types of task interdependency as shown in Figure 4.11:



Reference: Watson, 1994.

Figure 4.11 *Four Types of Task Interdependency*

All of these interdependent tasks are also geographically independent. Pooled, sequential, and matrix interdependent tasks can be accomplished in parallel, without the need for real-time collaboration. However, reciprocal task interdependency requires real-time collaboration, which is optimized by use of an ieCollab system. In addition, ieCollab helps reduce the complexities involved in electronic collaborative systems; since electronic meetings embrace a variety of meeting domains, as shown in Figure 4.12 below. An ieCollab system fuses the meeting realms into one unit by supporting the entire domain.



Reference: Nunamaker, 1991.

Figure 4.12 *Electronic Meeting Domain*

VII. Calendaring and Scheduling Engine

Not only is the resource of information exchange valuable to organizations, but the ability to electronically exchange calendars across workgroups brings a distinct competitive advantage to organizations. Group scheduling should be able to access the database of another system, and a project management program should be able to post times and tasks through a calendar and scheduling application programming interface (API).

The simplicity of calendaring and scheduling engine (CSE) compliments a collaborative system. CSE's ease of scheduling meetings with standardized protocol brings a sense of added time to users, by eliminating phone/email tag and saving time and energy arranging a meeting. A functional CSE serves as the primary tool in project management. Some additional characteristic of ieCollab's CSE include:

- Excellent personal productivity features
- Simple administration
- Scalability
- Real-time
- Web-based

Many calendaring and scheduling vendors allow its information to be accessed via the Internet using technologies such as common gateway interface (CGI). Other methods to deliver calendaring and scheduling information are through Java and ActiveX. ieCollab looks to partner with a calendar service, which will allow interactive scheduling of virtual meetings. This may include the ability to coordinate schedules with the project team, while making an appointment with a dentist. Server logs will keep track of meeting information while a centralized database allows users to access and organize files from a central location. The ability to integrate with 3rd party calendar services, such as Yahoo!Calendar and AnyDay, is contingent on ieCollab's CSE open architecture and compatibility. The list below (Table 4.11) are the advantages and disadvantages of a CSE.

Table 4.11 *Advantages & Disadvantages of Calendaring and Scheduling Engine*

Advantages
• Meetings scheduled more efficiently with fewer subsequent cancellations • Increased awareness of the location and plans of employees • Effective scheduling of group's tasks
Disadvantages
• Only operates if diaries are maintained by all involved • Not really appropriate for teams with members without mobile access

Reference: Bate, 1994.

VIII. Knowledge Management

The ieCollab solution will provide a substantial platform for knowledge management. As teams create and consume knowledge, organizations need to provide methods of sharing and distributing knowledge beyond distributed boundaries. The ability to access an indexed repository and locate experts on a subject brings the organization a great way to leverage their resources.

> *"Companies, like individuals, compete on their ability to create and utilize knowledge; therefore, managing knowledge is an important as managing finances. In other words, firms are knowledge, as well as financial institutions. They are repositories and wellsprings of knowledge. Expertise collects in employee's hands and is embodied in machines, software, and routine organizational processes. Some of this knowledge and know-how is essential simply to survive or to achieve parity with the competition. However, it is core or strategic capabilities that distinguish a firm competition. Management of these strategic knowledge assets determines the company's ability to survive, to adapt, to compete... The management of knowledge, therefore, is a skill. Like a financial acumen, and managers who understand and develop it will dominate competitively."*
>
> – Leonard-Barton, Harvard Business School, 1995

To capture business learning, such as product development, business strategy, and marketing sales, collaborative systems must incorporate knowledge management tools. The creation of knowledge must be preserved, so that organizations do not need to reinvent the wheel.

Overall Benefits

IT investments are usually perceived as costly, risky, and can potentially cause significant change to the organization. However, reducing the cost of quality and adding value to the value of the organization provides a powerful means of justifying an investment. ieCollab provides organizations with new ways to improve communications, increase productivity, and reduce project costs and duration. Collaborative systems bring great value to organizations, but can be difficult to measure quantitatively. Nonetheless, the overall benefits can be categorized into strategic, organizational, and technological benefits.

Strategic. Initially perceived as cost unit, a collaborative system can potentially contribute to the profitability of an organization. Improved productivity and reduced costs decrease the overall operating costs of the company. As an enabler for revolutionary changes, the collaborative system may also add to a company's competitive advantage as explained below.

A collaborative system simplifies the creation of a pooled negotiating power. Cost or quality benefits gained from purchasing scale can significantly reduce purchasing costs. Potential partners cooperate to form valuable relationships.

The introduction of a collaborative system extends the coordinated strategies of a company to a global scale. Collaborative systems allow better coordination with employees, clients, vendors, and strategic partners. A cost-effective central service creates a value-based performance culture that has low tolerance of unnecessary costs or weak performance, and yet is capable of investing when necessary.

The benefits from aligning the strategies of two or more businesses may result in vertical integration, formation of new ideas with follow-up, and potentially shorter product development life cycles. Formerly, important information from informal discussions may not get relayed to everyone. Information transfer in an electronic environment helps solve this problem. This system promotes innovation and creativity, generating new ideas and possibilities.

Organizational. The ability to share knowledge is essential to successful organizations. The benefits associated with sharing of knowledge and competencies are several. Collaborative systems help companies leverage expertise in functional areas, pool knowledge about specific geographical regions, share best practices in certain business processes, or enhance knowledge-transfer. By introducing the capability to transfer know-how about products, markets, marketing, manufacturing, and other functions from/to business units around the world, collaborative systems bring tremendous value to organizations. Additionally, the physical location of employees will be less of a constraint. The wisdom of an individual or group is made available to the whole company, so knowledge is built into every process and project, helping create an evolving, learning organization.

New organizational structures will be formed as well. Organizations will become more flexible, adaptable, and responsive to change. Teams and processes will be established on a need basis; thus are more responsive to changes in the market. In addition, fewer people need to maintain same level of productivity resulting in efficient work. ieCollab's system contributes to the increased autonomy of workers, allowing them to restructure their work procedures. The recognition that workers perform the same work faster and more cost effectively, but also with increased effectiveness by performing higher value work on processes is defined as work value analysis.

The effect of allowing multiple, and sometimes anonymous collaborators, is the addition of greater input. Collaborative systems enable more people to participate (through the flexibility to match schedules and time zones), collect broader perspectives, establish a level playing field (through anonymous contributions), and removes political overtones and presumptions. An equal opportunity for project participation geenrates team satisfaction. Workers then pass information quickly and easily, resulting in shorter, fewer, and more productive meetings. By reducing travel time and disruption to work flow before and after meeting, workers invest better time in more productive work.

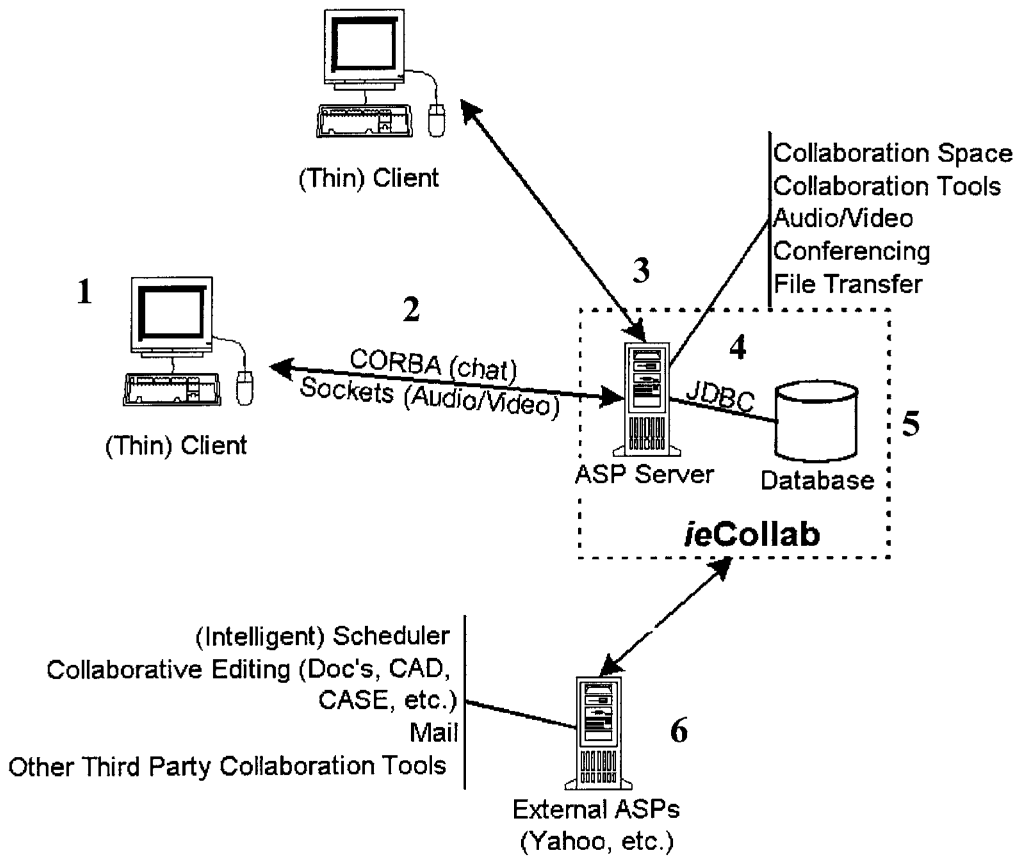
Technological. As stated before, the ASP model allows users to have access to commonly used tools specific to their industry. The ability to quickly deploy applications and support the underlying infrastructure brings flexibility to the organization. By using an ASP, organizations lessen the cost of owning, managing, or supporting the software.

The incorporated communication tools enrich the document sharing experience. Chat, side-talks, audio, and video allow users to share ideas and make decisions over a simple Internet connection. Additionally, users will have their choice of meeting protocols, providing a structured environment in which meetings finish on time, with the desired goals accomplished. The team may choose from a spectrum of structured or unstructured techniques to perform the project tasks

Product Prototype

I. ieCollab Architecture

The solution utilizes thin network clients. In this model, the client merely needs a web browser and a Java virtual machine, a processor that executes programs or applets written in the Java programming language. The Java virtual machine is included in the current Netscape and Microsoft browsers. By implementing the thin client architecture, costs are controlled by reducing the number of user-induced problem. The model offers simplicity and standardization.



Reference: El Solh & Tan, 2000.

Figure 4.13 *Application Service Provider (ASP) Server model*

The technology used by ieCollab, pictured in Figure 4.13 is an fundamental part of the softwares benefits:

1. **Client** – The ieCollab user interface is written in the Java programming language. Java is a pure object oriented language, offering the benefits of componentized software. These benefits include reusability of code and scalability, which helps with future upgrades to the system. In addition, Java is platform-independent, meaning that ieCollab can be executed from any operating system (Windows 95/98, Windows NT, Windows 2000, Sun's Solaris, Unix, Linux, Apple). The interface is web-based, supporting the need for anywhere-anytime communication..

2. **CORBA** – CORBA, or the Common Object Request Broker Archictecture, connects the client to the ieCollab database. The middlewhere allows distributed software objects communicate over a network, regardless of client and server operating systems and programming languages.

3. **ASP** – As an application service provider (ASP), our application server provides access to software packages located on our server.

4. **JDBC** – The Java Database Connectivity language (JDBC) was used for communciation between the client and database. JDBC allows portable object-oriented access to relational databases. Functions located on the server permit Standard Query Language (SQL) statements to be executed in the database and data returned.

5. **Database** – An Oracle relational database was used. The database stores client and workgroup profile information, as well as meeting logs.

6. **External ASPs –** The ieCollab software team plans to partner with external service providers for calendering. Possible third-party vendors could by Yahoo or AnyDay.com.

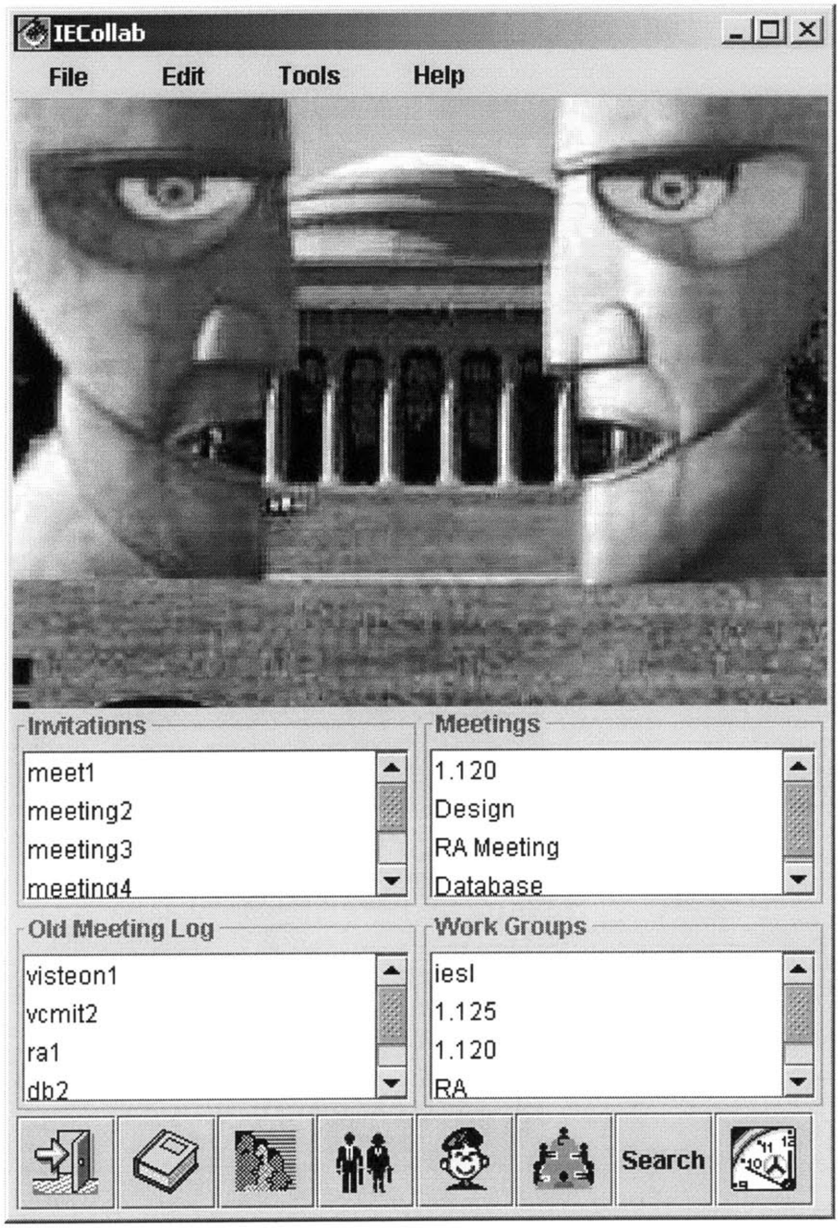
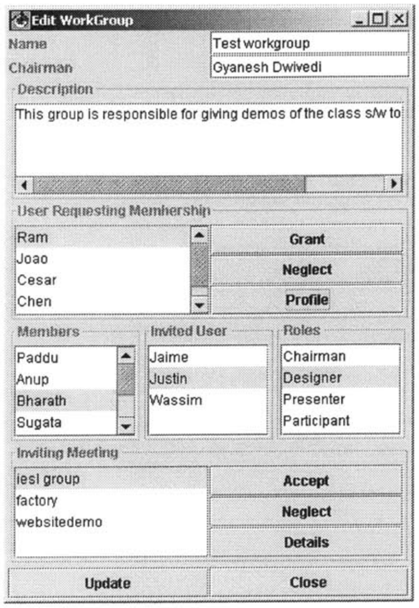
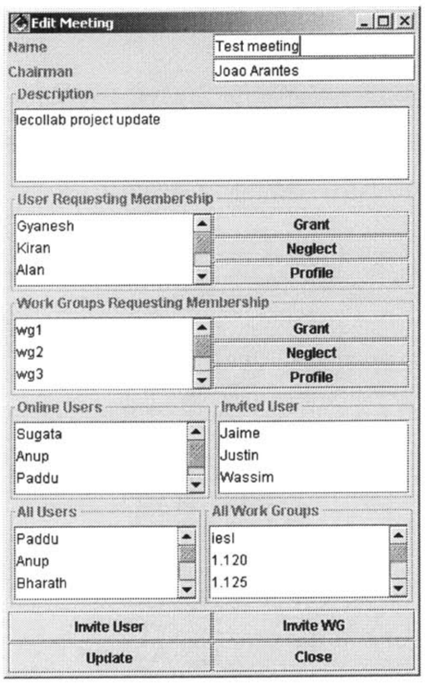


Figure 4.14 *ieCollab Application Window*



Name:	Name of the Workgroup
Chairman:	Leader of the Workgroup
Description	Description of the Workgroup
User Requesting Membership List:	List of users who have requested membership to join your Workgroup
Members List:	Users that are members of this Workgroup
Invited User List:	Users that have been invited to join the Workgroup
Role Lists:	Roles that can be assigned to each user
Inviting Meeting List:	Meetings that have invited this Workgroup to join

Figure 4.15 *ieCollab Edit Workgroup Window*



Name:	Name of the meeting
Chairman:	Chairman of a meeting is the leader of the meeting. A user is assigned the role of leader by scheduling a meeting. At all times, there should only be one leader of each meeting. The role does not persist across multiple meetings and every time a new meeting is called, the role of chairman is re-assigned.
Description:	Agenda or purpose of the meeting
Users Requesting Membership List:	List of User's that have requested to be admitted to your meeting.
Online Users List:	List of online users includes all members of ieCollab that are currently signed on to ieCollab.
Invited User List	List of user's that you have invited to your meeting
All Users List:	List representing all of the users of ieCollab and can be used to network and invite users to participate in a meeting.
All Workgroups List:	List representing all of Workgroups in ieCollab and can be used to network and invite new Workgroups to participate in a meeting.

Figure 4.16 *ieCollab Edit Meeting Window*

4.8 Competitive advantage

Competitor Analysis

ieCollab has identified four head-to-head competitors: Lotus Notes, Microsoft Netmeeting, White Pine's CU-SeeMe, and Webex. The following table provides a product feature comparison of these products and the ieCollab solution.

Table 4.12 *Competitor Comparison*

	Lotus Notes	MS Net Meeting	CU-SeeMe	Webex	Centra	Placeware	ieCollab
Communication							
Live Chat		✓		✓	✓	✓	✓
Audio		✓	✓	✓			✓
Video-conferencing		✓	✓	✓			✓
Data-conferencing		✓	✓	✓	✓	✓	✓
Whiteboard		✓	✓	✓	✓	✓	✓
Data							
File Transfer		✓	✓		✓	✓	✓
All Platforms	✓			✓			✓
Group Scheduling	✓						✓
Email	✓				✓	✓	✓
Calendar	✓			✓			✓
Document Sharing		✓	✓	✓	✓	✓	✓
Simultaneous Editing of Documents				✓	✓	✓	✓
Application							
Application Sharing		✓					✓
Application Service Provider							✓
Knowledge Management							✓
Wireless Features							✓

Reference: Multiple sources.

Two main competitors for ieCollab have been identified: Microsoft's Netmeeting and Webex.

NetMeeting offers audio, video, and chat over the web but does not enable document sharing or provide applications to its users. NetMeeting is widely used, although does not contain the functionality necessary for fully supporting distributed teams, which has been noted by Forrester Research.

Webex is an Web-based collaboration tool that offers various communication tools (chat, audio, and video) and enables document sharing. Their solution illustrates the potential for technology in assisting in real-time collaboration, although a few main differences separate ieCollab from Webex.

First, Webex does not allow users to edit the actual document. Users can make notes and draw on a transparent layer that lies on top of the document, but the changes do not affect the actual document itself. ieCollab, on the other hand, allows users to make substantial alterations to an unfinished document, with meeting protocols that assure the right people see and edit the actual document.

Secondly, ieCollab's centralized database and ASP model offer unique advantages. The ASP model allows users to access various applications, while the centralized databases support efficient file management. Without it, document and applications would be scattered across various workstations throughout the world.

ieCollab also intends to create partnerships with calendar-service websites, such as Yahoo!Calendar, AnyDay.com, or Excite-Calendar. Linking ieCollab's meeting creation service with these websites' meeting scheduling service, a critical mass of users will benefit from these enhanced, aggregated meeting services. By designing open data interfaces to external systems in the system architecture, ieCollab is already planning for this partnering strategy.

ieCollab's has a distinct technological advantage. The ASP model is similar to a thin client-server infrastructure, while allowing several users to share applications simultaneously from a single application server. ieCollab is built on this ASP model, which allows users to forfeit the high costs of new hardware or software to purchase, install, configure, and maintain. Users can simply access ieCollab's service from any standard Web browser. The program, written in Java, allows multi-platform access to the application, anytime and anywhere. In addition, the ASP model also provides centralized database access, superior application sharing, and tighter network security than standard Web-based collaboration tools.

Most Web-based meeting applications only supply basic communication tools, with little if any control. For instance, Microsoft's NetMeeting allows the meeting creator to grant higher permissions to other participants, but the control they gain merely lets them remove participants from the meeting. The software lacks meeting management issues such as creating side conversations, enabling document-editing permissions, silencing participants, and authorizing meeting access. These meeting protocol tools furnish the meetings with greater control and improved productivity. ieCollab builds on over 6 years of patent-pending MIT research in protocol-rich, meeting management tools, strengthening its sustainable advantage.

Competitive Advantage

Image the following scenario:

> *You are in the middle of the desert... alone... an integral part of a team that has been formed to complete a mission critical task. You are armed with a laptop computer and, miraculously, an Internet connection. To complete your tasks and help the team achieve its goals, you need two things.*

1. *Access to the right applications*
2. *Communication tools to communicate with your team members*

ieCollab is the only solution that can provide both of these tools in one package, as a total solution. Many people are finding themselves in situations, theoretically, very similar to this one.

ieCollab is differentiated from the pack for four, fundamental reasons:

- **Document Sharing** - The ability to simultaneously edit the same document from different locations
- **Application Sharing –** The ability to share applications with team members located anywhere, and at anytime.
- **An Application Service Provider –** Flexibility to implement software packages.
- **Wireless Features –** The ability to send text messages and pages, taking advantage of the new world of wireless communications

4.9 Risks Assessment

The likelihood of incurring problems or loss is defined as risk. Risk involves uncertainty and loss, and a risk management plan will be the tool used to quantify the uncertainty and the possible level of damage. The main objective of risk management is to develop a strategy to identify potential risks and develop a contingency plan. In this section, we will identify potential risks to the ieCollab project and propose mitigation solutions accordingly.

Risk Identification

We will use the framework proposed by ieCollab's project management plan (Abbott, et al, 2000) to identify the risks and estimate their impact on the project.

Product Size Risks. 1) Feature creep may emerge as a possible risk. The risk that the software's scope will be expanded may impact project duration and quality. 2) The current software size estimate may not fall within 5% of the final product size. 3) The small to medium amount of legacy software incorporated into the product may not properly integrate.

Business Impact Risks. 1) Late project delivery may be influenced by the inflexible academic calendar and other project demands. 2) Interoperability with a minimal number of systems may decrease market capitalization size. 3) Shrink in market size due to new competitors or substitutes. 4) Costs of business operations become too high. 5) Changing customer and technology trends will reduce the market.

Customer Related Risks. 1) The risk of not meeting customer expectations may reduce product revenue. 2) Customers may not be willing to participate in reviews and testing.

Development Process Risks. 1) The amount of product documentation seems to be large and information may be mishandled. 2) Developers may not adhere to Institute of Electrical and Electronics Engineers (IEEE) software standards. 3) The quality assurance team may not ensure all work conforms with IEEE software standards. 4) The configuration manager team may not assure consistency throughout the system. 5) Negligence of comments on technical reviews may be ignored. 6) The analyst and design teams, using Unified Model Language (UML) methods in development, may not design flexibility and scalability into the system. 7) The team has not totally mastered all the development tools. 8) The testing team may not thoroughly test and debug the prototype versions. 9) The knowledge manager team may not appropriately manage documentation, thus losing project and development information.

Development Environment Risks. 1) Lack of professional level development tools may hinder team effectiveness. 2) Software tools are not integrated with one another. 3) The development skills for team members in each team differ, thus inefficient and contrasting programming styles may occur. 4) Team resource allocation may produce ineffective members, as some team members are more familiar with project management tools, while others are more accustomed to using code development tools. 5) All team members will be involved with other course projects and thesis work, which will reduce the amount of time available for this project. 6) Attrition may occur during the project life cycle.

Technology Risk. 1) Many team members have no previous experience in this level of software development. 2) Previous source code may be corrupt. 3) Poor interfacing with potential partners and commercial software.

Table 4.13 *Summary of Project Life Cycle Risks*

Risks	Probability	Impact
Quality effected by schedule slippage	High	Catastrophic
Consistency among different systems	High	Catastrophic
Use of untested Cairo routines	High	Catastrophic
Problems with Cairo system	Medium	Catastrophic
Large number of systems with which product should be interoperable	Medium	Catastrophic
Project doesn't meet all requirements	Medium	Catastrophic
Team members involved with other course projects	High	Critical
Lack of quality or productivity metrics	High	Critical
Large amount of documentation	High	Critical
Small amount software reuse	Medium	Critical
Lacking of training on tools	Medium	Critical
Interface problems with another software	Medium	Critical
People leaving the project	Medium	Critical
Not using last year's documents effectively	Low	Critical
No previous experience on software development	Low	Critical
Confidence in software size estimate	High	Negligible
Lack of software tools to support testing process	High	Negligible
No testing tools available	High	Negligible
No configuration management tools available	High	Negligible
Software tools are not integrated	High	Negligible

Reference: Abbott, et al, 2000.

Risk Mitigation

The project management and quality assurance teams will pay close attention to the high priority risks and develop risk mitigation plans. Monitoring and control activities are necessary for quantifying the project status. Several checkpoints and milestones will gauge the development process (Table 4.13). Schedule tracking will help reduce schedule slippage, as the project manager team will request tracking reports to identify the status of current activities and checked against the scheduled dates. The knowledge management team will work closely with other teams to define report mechanisms as well. The following are strategies for mitigating risks associated with the project, categorized by probability and impact risk.

I. Strategy for Mitigation of High Probability and Catastrophic Impact Risk

Quality Effected By Schedule Slippage. Perform a critical analysis on the feasibility of the requirements. The requirements for beta versions should be realistic, taking into account the short project duration and various student commitments outside of the project. A small, reliable software package is better than a big, unreliable one. If a schedule slip must occur, reduce the requirements, but do not sacrifice quality.

Consistency Among Different Systems. Form a committee board with one member from each development team. This committee will meet every week or whenever necessary to manage the changes that could affect other parts of the project. If one team meeting deals with information that is pertinent to another team, one team member from the outside team should attend that meeting.

Use of Untested Cairo Routines. Assign a few team members to perform testing on Cairo programs. All Cairo code will be tested, regardless of previous testing.

II. Strategy for Mitigation of Medium Probability and Catastrophic Impact Risk

Problems with Cairo System. The risk that the Cairo system will not be fully understood or analyzed completely may prevent integration. Bugs and errors could result, so the project management team will meet with Cairo team members. The project management team will also assign the responsibility for analysis of the Cairo system to the quality assurance team.

Large Number of Systems with Which Product Should be Interoperable. The project management team will ask the advisors to organize a meeting with last year's Cairo team members. This will help familiarize the ieCollab team members with the Cairo System, acknowledging what code can be used and what must be fixed. The programming team leader will delegate the responsibility of exploring other systems that ieCollab will interact with (such as a calendar service).

Project Does Not Meet All Requirements. Review product specifications. An overoptimistic approach can create unrealistic goals. Identification of features that are indispensable or superfluous will require the input of all team members.

III. Strategy for Mitigation of High Probability and Critical Impact Risk

Team Members Are Involved with Other Course Projects. The team leaders should give each team member individualized responsibilities. The project manager plan contains the general responsibilities of each team. The leaders of each team are responsible for monitoring the efforts of their team member. Every week, the change control board will meet with the project management team to discuss any problems that their team members are facing with their academic schedule and other subjects. By so doing, the project manager team will be able to re-allocate resources to help teams complete tasks on schedule.

Lack of Quality or Productivity Metrics. Quality assurance, project management, and knowledge management teams must agree on the quality and productivity metrics at beginning of the project. The knowledge manager team must create the standard document in reporting quality and productivity.

Large Amount of Documentation. The knowledge management team must be active from the beginning of the development cycle. There is a natural tendency for all teams to put every file on the web repository. Unfortunately, this substantially increases the quality assurance team's workload. It would be more efficient to put the latest version of a given document on the web site, and store the previous versions somewhere else.

IV. Strategy for Mitigation of Medium Probability and Critical Impact Risk

Small Amount of Software Reuse. The project management team will make a member of the quality assurance team responsible for reusable code, whether from Cairo code or from other Web-based communication software or a database.

Lack of Training for Tools. Team members should inform the project manager team when insufficient knowledge of a given tool exists. The project manager team will contact an instructor and schedule a short course on the specific tool where need be.

Problems with the Interface of Another Software Package. This risk can be mitigated by the programmers if they place a member of their team in charge of 3rd party software. That person will locate and support documents related to the outside software that ieCollab will potentially perform integration.

People Leaving the Project. This risk can be avoided by splitting the leadership of the project between MIT and CICESE. A distributed leadership will sustain motivation and moral.

V. Strategy for Mitigation of Low Probability and Critical Impact Risk

Not Using Last Year's Documents Effectively. Using documents from last year's Cairo project will speed the creation of manuals and documents. The knowledge management group is responsible for making last year's documents available to all ieCollab members.

No Previous Experience on Software Development. This risk can be mitigated by placing an experienced team member in each team. Since most of the students are from Information Technology and Computer Science programs, this risk is relatively low.

VI. Strategy for Mitigation of High Probability and Negligible Impact Risk

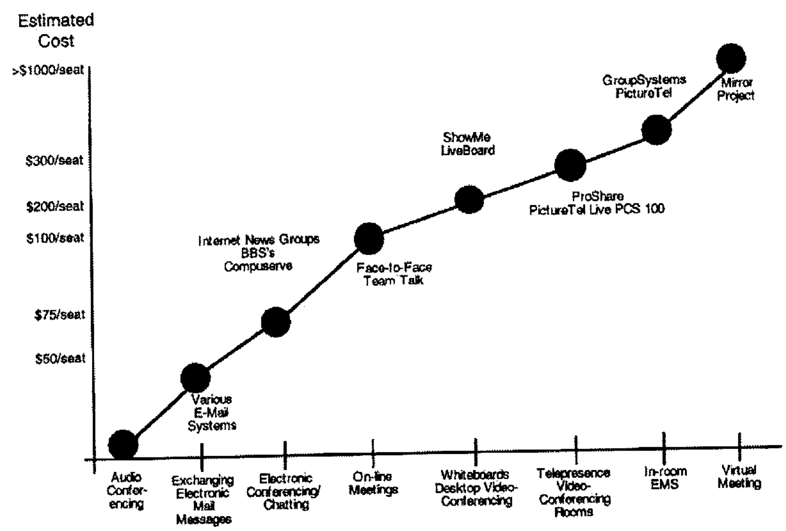
Confidence in Software Size Estimate. Common industry sizing estimates can be used to calculate a confident approximation. In addition, preliminary software size estimates should receive approval from experienced or advisory members.

No Configuration Management Tools Available. The Configuration Manager Team should determine the tools that can be used for managing software code. This is not thought to have a significant impact on the project.

4.10 Financials

ieCollab will have a prototype application developed in the second quarter of year 2000, and subsequently begin beta market testing. At that time, ieCollab will need $2 million to cover first-year operation expenses (salaries, travel, utilities, and marketing) and capital expenditures (office space, developer workstations, web servers, and application servers). With the initial funding, we will pursue industry expertise to compliment our existing team. Once under top-tier management, we will pursue additional funding to scale our application to an enterprise level. Initial funding will primarily be in the form of venture capital funding. From our break-even analysis, calculations show that the break-even point would occur after the second year in operation.

Our revenue model is based upon one pricing scheme for unlimited product use. According to marketing research by Collaborative Strategies, LLC, and simple comparative analysis of Figure 4.17, the cost for such a service is approximately $500 per user per year. Estimating 100 employees per company will register to use the product, companies will be charged $50,000 per year for unlimited access to ieCollab's services and resources. During the first year, we approximate 20 companies will purchase the ieCollab service. With an aggressive vertical and horizontal marketing strategy, the company expects second, third, fourth, and fifth year approximations to be 100, 200, 400 and 800 companies, respectively. Table 4.14 in the financial section details the projected 5-year financial statement of ieCollab.



Reference: Coleman, 1997.

Figure 4.17 *Comparable Costs of Collaboration Software*

The sales strategy will target specific teams within these large commercial organizations, establish successful vanguard pilot projects, use a horizontal spread approach for other divisions in the same organization, and finally adopt a vertical spread across the industry segment.

Table 4.14 *ieCollab 5-Year Financial Statement (in thousands)*

	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004
# of companies (units)	**20**	**100**	**200**	**400**	**800**
Revenue	1,000	5,000	10,000	20,000	40,000
Cost					
Engineering	840	840	840	1,000	1,000
Management	200	200	200	300	300
Capital Equip.	500	100	100	100	100
Office Space	30	30	30	30	30
Misc.	50	50	50	50	50
Profit	(620)	3,780	8,780	18,520	38,520

SECTION III

CHAPTER FIVE

5. Conclusion

5.1 Creating Value

> *"The cultural issues surrounding successful groupware deployment is growing in importance. Although these issues have been discussed in theory for the past few years, corporations are only now realizing the practical importance of: (a) matching the tools to the work process and; (b) addressing the human barriers to collaboration. In many cases, multiple solutions can coexist, but the fact that each solution addresses different organizational needs will provide the path to the highest ROI. For the CIO, it is important to recognize that standardization is no longer the Holy Grail, ROI is."*
>
> – Ian Campbell, International Data Corporation (1997).

Cost Reduction. Cost reduction focuses on the elimination of current business expenses through the use of distributed collaboration. Reduction in meeting time, efficient meeting scheduling, project productivity, and elimination of mistakes by increased presence of collaborators are very beneficial, but difficult to quantify.

However, we can quantify the costs associated in scheduling and attending meetings, then contrast costs with the distributed collaborative system. Using an analysis formulated by Knudson (1997), we will initially assume standard compensation of $30 per hour per employee. If we estimate the time duration to contact participants and resolving time conflicts to schedule a meeting is one hour, we can calculate the costs to schedule a meeting. Also, we can estimate one hour meetings. Assume two scheduled meetings and three attended meetings per week for 50 weeks out of the year:

- Traditional

  Cost to schedule meeting traditionally:

  ($30/hr)(1hr/meeting)(2meetings/week)(50weeks/year) = **$3,000/employee per year**

  Cost to attend a meeting traditionally:

  ($30/hr)(1hr/meeting)(3meetings/week)(50weeks/year) = **$4,500/employee per year**

We will use ieCollab's pricing of $500 per employee per year for a collaborative system. With a new system, scheduling meetings should occur in a matter of minutes. Increased productivity should decrease the time of a meeting by 25%.

- New System

  Cost to schedule meeting:

  ($30/hr)(0.1hr/meeting)(2meetings/week)(50weeks/year) = **$300/employee per year**

  Cost to attend a meeting traditionally:

  ($30/hr)(0.75hr/meeting)(3meetings/week)(50weeks/year) = **$2,250/employee per year**

  Cost to purchase system:

  $500/employee per year

- Comparison

  Traditional: $7,500/employee per year

  New System: $3,050/employee per year

  Cost Savings: $4,450/employee per year or **60% reduction in savings**

A collaborative system, such as ieCollab, expects to save organizations nearly 60% in cost reductions. The savings are from scheduling and meeting productivity tools alone. So, greater cost savings are expected from reduced travel expenses and application costs.

Value-added Benefits. Value-added benefits improve quality of decisions that are made by a team. New communication via collaborative systems prompt faster and better responses to emergencies and increased managerial control. Beyond cost-reduction, the most important benefits are designed at effectiveness, rather than efficiency. Value-added benefits are more attractive, but also difficult to measure and directly connect impacts. However, Table 5.1 exhibits the value matrix of collaboration for an effortless benefits assessment.

Table 5.1 *Collaboration-Value Matrix*

	Low Value	**High Value**
High Collaboration	• Video conferencing • Document editing	• Web-based conferencing
Low Collaboration	• Whiteboard only • Document sharing	• E-mail • On-line chat

Reference: Coleman, 1997.

5.2 Summary

Findings

Collaborative engineering systems within an ASP model bring great value to organizations. Organizations seeking cost savings through optimized business processes and value-added benefits will discover collaborative systems to be the solution. The new business environment has forced companies to eliminate cost inefficiencies through the use information technologies. Organizations primed for transition into globalization and high connectivity will succeed in the new economy, provided they streamline their business processes.

Today's business environment entails fast development cycles, more rapid customer metrics, and continuous realignment. Companies, which can keep pace with the new economy, will out-distance the competitors. Technologies that provide these companies the competitive advantage will be the winning solution. Collaborative engineering systems can provide companies the solution to succeed.

Recommendations

Implementing the technology is just one step in a series of steps. As observed in the case studies, companies must also analyze strategic, organizational, and technological issues to bring the full benefit of collaborative systems. Companies, which fail to assess the entire gamut of potential collaborative issues, will inevitably have unsatisfactory distributed collaboration as well.

Satisfactory systems stem from organizations that plan strategic goals for the collaborative system, in addition to the company's strategic plans. The ieCollab case study exemplifies failed distributed collaboration from the deficiency of strategic goals. Regardless of the technical superiority of the organization or the equipment, without strategic plans, the collaboration will fail.

Successful systems must also generate organizational acceptance. Users must shift to the global collaboration regime and accept the new business productivity tools. Organizations should facilitate this shift and acceptance. As the Unilever case study suggests, without organizational issues resolved, the system may not be utilized to its full potential. Systems need to appropriately integrate with the organizational structure and culture.

Also, a technological assessment of the system must be performed. Interfacing of heterogeneous hardware and software may cause setbacks in system concurrency. Existing technologies often cause legacy issues that must be resolved. Companies applying new technologies need to be aware of these issues. Technological analysis only partially resolves the entire set of issues contained within collaborative system.

Negligence in analyzing the strategic and organizational impediments prevents organizations from successfully deploying an effective collaborative system.

ieCollab is providing a technically superior and thoroughly robust product for collaborative systems. The ieCollab system is available within an ASP model, offering a cost-effective and reliable solution. Depending on the organizational structure, businesses can expect to save in costs, while adding value. An ieCollab system must also be scrutinized comprehensively, as in all collaborative systems. The overall success of a collaborative engineering system is ultimately determined by the organization. Organizations that can forecast and actualize the strategic, organizational, and technological value of a collaborative system will accomplish successful distributed collaboration.

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