STATUS OF E-BUSINESS IMPLEMENTATION IN THE CONSTRUCTION INDUSTRY

By

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TABLE OF CONTENTS

page

ACKNOWLEDGMENTS iii

LIST OF TABLES vi

LIST OF FIGURES vii

ABSTRACT viii

CHAPTER

1 INTRODUCTION TO THE STUDY 1

Introduction 1
Aims and Objectives 2

2 LITERATURE REVIEW 4

The Electronic-Business Phenomenon 4
Compatibility among e-Business Users 14
Customer Relationship Management (CRM): Customer Satisfaction 18
e-Business Applications 20
Case Studies 24
e-Business Strategy 25

3 METHODOLOGY 27

Scope of Work 27
Survey Methodology 28
Selection of Survey Participants 28

4 ANALYSIS OF SURVEY RESULTS 31

Results of the e-Business Assessment Survey 32
Respondent Profiles 32
Survey Findings 35

5 CONCLUSIONS AND RECOMMENDATIONS 53

APPENDIX E-BUSINESS ASSESSMENT SURVEY 57

LIST OF REFERENCES 64

BIOGRAPHICAL SKETCH 66

LIST OF TABLES

Table page

4-1 Survey respondent employee position.....33

4-2 Adopted e-Business application adoption in the construction industry 36

4-3 Respondent priorities.....45

LIST OF FIGURES

Figure page

4-1: Respondents job title distribution 33

4-2: Respondents employee size distribution 34

4-3: Respondents distribution by annual revenue 35

4-4: Distribution of adopted e-Business applications in 2000 and 2005 37

4-5: Connection with suppliers, partners, and customers 39

4-6: Company supplied computing devices 41

4-7: Electronic business initiatives in the construction industry 43

4-8: Construction industry's prioritized goals 46

4-9: Construction industry reasons for not implementing e-Business 48

4-10: Benefits realized by the construction industry with e-Business implementation 48

4-11: Impact on revenue 49

4-12: Construction industry's perceived benefits of e-Business implementation 50

4-13: Distribution of companies monitoring e-Business efforts 51

4-14: The construction industry's perceived ideas on future spending on e-Business implementation within their company 51

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This study is an update of a previous study completed in 2000 dealing with the implementation of e-Business in the construction industry. The main objective was to determine if and how e-Business strategies have changed in the construction industry and whether or not more of the top construction industries are using e-Business to their advantage compared to five years ago. This was completed by conducting an e-Business assessment survey. The survey was designed for the following purposes:

- Whether the construction industry has become more receptive to information technologies and e-Business practices.
- Why companies use e-Business in their work strategies and how it impacts their work process.
- What extent companies use these strategies, technologies, and applications.
- Whether companies plan to continue spending on e-Business applications

This survey examined previous use of e-Business strategies and applications in recent years, We also identified up-and-coming technologies needed for the successful advancement of internet technologies in construction industries. Tools such as wireless-technologies, more-advanced web-based project-management software, customer-relationship management, and bidding on the Internet are all becoming household phenomena in the construction industry.

The data collected from surveys sent out to construction industry leaders was analyzed. The information was compiled to determine how far the industry has come in previous years, and whether companies will continue to use e-Business. Although slow to embrace e-Business, the construction industry is taking an active role in e-Business implementation. Companies are making plans for future improvements in efforts to increase productivity and encourage cost savings.

CHAPTER 1
INTRODUCTION TO THE STUDY

A growing number of information technologies are entering the construction industry. Cell phones, palm organizers, laptops, wireless email, and other wireless technologies are all facilitating operations in the industry. Information Technology (IT) is essential in any business operation. IT is the most advanced way to communicate necessary information quickly, efficiently, and effectively. IT is driving the information revolution. The Internet has made communication easy for every company; and is vital for successful management, customer relationship management, and business-to-business exchange.

Introduction

The construction industry has been criticized for its inefficiencies and traditional, often outdated ways of conducting business operations. It is often difficult to convince individuals in this industry to change their thinking. They often feel that if something has worked for so long then why change it? Although the construction industry is beginning to embrace technology little by little, it is still a slow process.

Technology is changing communication for the construction industry and also for every industry, and individual. E-mail is essential in any workplace; it is difficult to find a successful business without an e-mail address. In the construction industry, Project Specific Web Sites (PSWS) are another technology enhancing business operations.

We conducted a survey to determine the construction industry's stance on e-business compared to previous years; and to determine the future role of e-Business in the

industry. Industry leaders from small and large firms alike were surveyed in an effort to get a broad range of opinions. The survey also aimed to determine construction leaders' intentions of using e-Business applications, whether for ease of communication, productivity, cost, or service. We also examined the impact of current e-business application on revenue. We also examined effect e-Business systems are having on productivity and profit to determine whether these systems will continue to thrive in the construction industry.

Aims and Objectives

Our study was designed to measure the construction industry's attitude toward Internet technologies and e-Business applications. Is the construction industry beginning to embrace the technology of tomorrow and use it to their advantage, or are they stuck in their old ways? How have companies attitudes toward e-Business changed in the past 5 years? Will these companies continue to evolve in their thinking?

One objective of our study was to determine if the general attitude of the construction industry toward e-Business is beginning to change in acceptance of technology, and how its acceptance of this technology can be used to the advantage of the industry. Furthermore, if the industry has accepted this new idea, how have they implemented e-Business applications into their current business operations?

Another objective was to measure the construction industry's e-Business against whether these goals have been reached or are within grasp. We compared the results of our survey with results from a previous survey to determine if e-Business attitudes have changed in the construction industry; and if so, to what degree. We did this in the hope of determining future acceptance and implementation of these e-Business applications.

Chapter 2 is comprised of the literature review which looks at and analyzes different e-Business strategies and applications that are currently in use. Chapter 3 focuses on the methodology of the survey as well as the aims and objectives of this study. The results that were obtained from the respondents to the survey are examined in Chapter 4. Finally, Chapter 5, presents final conclusions and recommendations for further research in this area of study.

CHAPTER 2
LITERATURE REVIEW

This chapter takes a look at e-Business on the Internet, where it has been in the past 5 years, and where it is headed in the construction industry. We analyzed e-business tools currently used in the construction industry for successful return on investment in terms of company productivity, and time and cost savings.

The Electronic-Business Phenomenon

Electronic-Business (e-Business) has become a world-wide phenomenon. It is no different than ordinary business. Internet technologies, intellectual property, and customer superiority are combined and integrated with business activities which alter the traditional business model of operations (Chang and Ping Li 2003). Companies large and small, public and private, from any industry are using e-Business to organize business communications and improve success rates. E-Business has become increasingly popular over the past 5 years, improve technology is making easier to adapt and use from any location.

Owners are more demanding and industry leaders want information available 24 hours a day, 7 days a week. More adaptable programs and collaboration are desired. Electronic marketplaces are emerging where the construction industry can go to find the most appropriate manufactured products and services are being developed and being made available to the construction industry. Lowering operating costs, increased productivity, and improved customer satisfaction are a few of the realities of e-Business strategies (Regan 2002). The improved productivity improvements offered by newly

developed e-Business services can reduce and often eliminate unnecessary mistakes, time, energy, and costs, all while keeping projects on track.

The construction industry has great potential in realizing the benefits of e-Business. Industry leaders need only to give up their old ways and turn to the computer for improved company success. There is a great deal of opportunity, especially in construction e-markets.

The Internet lets companies track projects, realize results faster, reduce risk, and hold parties accountable for their actions. In the past, the construction industry seemed to reject the Internet and its technologies because of the industry's deep roots in traditional thinking; but the Internet has the potential to rid the industry of inefficiency and cost. By sticking to the old methods of regular mail, couriers, and faxes the construction industry often gets a bad rap for finishing projects late and over budget. "The vast majority of people in the industry don't know what the hell these online services are. It's not a technical question, it's a cultural one. The highest level of IT in the construction industry is the fax machine" (Fisher 38).

Construction-industry leaders are leery of e-commerce because of the mere nature of the construction industry. It is an extremely people-oriented business. Relationships with suppliers and subcontractors have lasted for years: the option of using an unknown subcontractor found online is unappealing to most traditional thinking leaders. However, e-Business thrives on the people-oriented nature of construction; without human interface, the systems would not succeed at all. E-Business requires an integrated alignment of technology, operation, strategy, structure, and human interaction in a continuously expanding network (Chang and Ping Li 2003).

The benefits of e-Business are being realized by several businesses in various disciplines. Impacts realized by e-Business are not limited to reduced costs. Improved predictability, productivity, reliability, and scalability, ability to detect defects, improved levels of service, and extended market research are all pros that are attracting more companies as well as software applications that allow users to get more for their money (Issa et al. 2003). Swinerton & Walberg Builders(Fisher 2000) cut change order turn around time by more than half by using Bidcom.com, an online project management program.

Because the construction industry is a multibillion dollar industry, the idea of saving time and money on daily operations should be a real concern. The construction industry claims that 60 to 80% of the total cost of management operation, including capital, labor, materials and transportation, is directly attributable to information management (Geissler 2001). This information management pertains to everything from scheduling to ordering materials to designing and coordinating construction and shop drawings. More time is actually spent on the business side of construction with sharing information than is spent onsite actually constructing the structure.

E-Business Impacts. Companies are required to have well-structured business cultures in order to survive in this technologically advanced world. The culture a business takes on and makes their own has to be not just daily operations, but a complete mindset that is developed over time (Issa et al. 2003). E-Business should be just that: a mindset within a company's organization. It has reached that stage on a certain level. It is unlikely that you will find a successful company without e-mail and Internet use. However, to survive, e-Business should be adopted on a daily basis in order to keep up

with trends and stay a step ahead of competition. E-business has expanded the construction market while making the world smaller (Issa et al. 2003). Perhaps this is the reason more companies are setting up international offices, because it is easier to communicate and stay organized with e-Business adoption part of the company plan.

Business-to-Business (B2B) e-Business. The opportunity for construction to take advantage of business-to-business (B2B) ecommerce, or the exchange of services, information and/or products from one business to another, that produce positive affects for their company is significant (Webopedia 2005). B2B connects customer, supplier, and partner applications, as well as business processes across the Internet. Supply chain partners can use B2B for shared planning as well as synchronized manufacturing, and distribution management. The main purpose of B2B is to automate business operations and information.

Industries associated with construction, such as design, and facilities management or various infrastructures such as commercial buildings, manufacturing plants, roads, highways, public and private projects alike, together signify a worldwide market of more than $4 trillion a year (Cleveland 2001). However, construction companies are not using this B2B ecommerce to their full advantage. Such a huge industry as construction should take notice of the growing technological trends and invest time and efforts into becoming more technologically savvy in order to create greater successes for their companies. With such a large amount of money at stake in construction projects worldwide, companies could be using B2B ecommerce more to their advantage to streamline operations and increase company benefits.

The advantages B2B e-Business can offer in terms of speed and cost savings need to be realized by the construction industry. The construction process is much more complicated than most other industries because of the variety of projects and the fact that every project is unique from owner to designer to project manager. This fact can make most standardized practices for other industries a nightmare for the construction industry. Because there are so many people involved in any construction process it can be difficult to process business transactions.

It is through "straight-through processing" that streamline processes involved in construction can be achieved. This process involves entering the necessary information one time into a system and allowing the system to take it through the process with minimal human interface (Cleveland 2001). A Web-centric system, or an integrated network of computer devices and information appliances that manages, stores, and distributes information through WWW specifications, can support collaborative environments more readily through a combination of Internet technologies. Among these technologies are HTML-based Web pages with Java Applets, JaveScripts, CGI Scripts, Databases, FTP, peripheral devices, as well as other new data formats (Rojas and Songer 1999).

Although project web sites are extremely useful in regard to team collaboration and exchange of documents and information, it really does not have anything to do with B2B e-commerce and the selling and/or buying of construction items and materials for a certain project. It is merely the sharing of information for projects and nothing more. "Without components, we are forced to revert to the traditional – manual – methods for identifying and quantifying the materials we need to purchase and erect. We inject a

human right into the middle of our ecommerce transactions" (Cleveland 56). Dealing with components are what makes processes easier thus streamlining activities and speeding up processes.

Because the construction industry deals with a multitude of systems, coordinating these systems becomes a task in itself. Implementing e-Business has been an obvious obstacle that must be overcome. The complex nature of e-Business makes it difficult to implement and manage, especially when there are legacy systems and security issues that have to be implemented into the e-Business network as well (Perkowski 2003). E-Business requirements are evolving so rapidly that a traditional requirements definition based on the functionality desired is accommodating the ability to integrate future technologies (Aberdeen Group 2001). This is great news because there a so many systems that are faced with the problems of trying to integrate older programs causing headaches for users. The ideal type of application should allow one firm to function in an extremely adaptable network consisting of other companies, who coordinate both their internal and external transactions via a high level trust for a highly shared interest (Chang and Ping Li, 2003). Information passed from one system to another must be done accurately so the outcome remains the same as when it was first introduced into the system. It is difficult for each system in a project to understand all the different methods the other systems have used to deal with the same components (Cleveland, 2001).

There are always implementation challenges, whether it is implementing mainframe systems or implementing the latest web portal. (IT) is not the biggest challenge. There are still challenges in changing business processes, getting them to take

advantage of IT, training, roll-outs, and getting the skill sets you need. Top management has to be convinced that the investment is worth it (Gould 2003).

Currently in the construction industry, the extent of B2B ecommerce is that of project collaboration websites where companies can share information such as documents, drawings, schedules, RFI's, emails, among other project information. There are also websites that allow for the buying and selling of construction materials through electronic catalogs or through a process of reverse auction.

Reverse auctions. Auctions are familiar to most individuals. One person places a bid on an item they desire. If another individual comes along and decides that they too would like to purchase the item then they will have to place a higher bid on the item. Sellers and buyers watch the item's price and bid appropriately until a specified date and time have arrived. At this time the highest bidder will receive the desired item. Reverse Auctions are exactly what their name implies. The bids go down instead of up. There is only one buyer and a plethora of bidders who are all trying to compete for the item by bidding the lowest price. Reverse auctions are most often done for services, such as in the construction industry, rather than an actual item.

Reverse auctions in the government sector as well as well known retailers such as Home Depot and Target have resulted in savings of 12 to 48 percent (Simpson 2005). Reverse auctions offer other benefits besides cost-savings to tax-payer funded projects. These auctions are usually hosted by a website where bidders can go and bid as well as see other bidder's postings. This means that everything is visible. There are no hidden secrets. Because the price goes down, management teams can become more knowledgeable about their costs and waste by monitoring the auction.

Wireless technology. At a 2004 Construction Industry Institute conference, wireless technology was heralded as the biggest breakthrough of e-business in the construction industry to date. With the construction industry being a $3.9 trillion-per-year industry, this means great things for the future. Wireless technology will allow business transactions to take place from anywhere at anytime. Anywhere from 5 to 10% of a construction project's cost can be saved using web-based technologies (McKenzie 2004). Communication is faster and can be done on a more timely basis. Because of instant access to information, wireless technologies save time and in the construction industry time is money.

There are already new applications on the Internet that include project management, e-marketplace venues, and real-time collaboration over the Internet. With wireless as an option these tasks are made even more efficient. There is no need to haul around heavy computer equipment in order to carry out a simple e-business transaction. The construction industry often deals with problems that need to be solved in a moments notice.

Wireless technologies allow connection to the Internet and thus e-Business transaction from any portable device over any network to any data source or application. They facilitate the use of IT technologies that include Personal Information Management (PIM) synchronization, e-mail synchronization, access to corporate databases, access to Enterprise Information System (EIS) applications, intranets, file sharing, and access to the World Wide Web (WWW) (AberdeenGroup 2001). Wireless technology is allowing the construction industry to work where they are most often, on the site and out of the office.

For wireless communications to work in today's mobile driven technology world, continuous support over the unpredictable wireless networks of today is essential. To do this successful wireless infrastructure should provide the ability to do the following: Balance the support among millions of devices, Support messaging that is not synchronized, Provide quick interaction, Preserve data, Guarantee the delivery of services, information, and business transactions seamlessly, without fault, and without change to the original content (AberdeenGroup 2001).

Web-based project management software is especially advantageous when used in conjunction with wireless technologies. The accessibility of information on a web-based management system changes from isolated to universal (Rojas and Songer, 1999). It was only a few years ago that project information was physically in the office and the only people that had access to that office would have access to that information. The web-based systems offer access to project information to anyone who has Internet access. The availability of information has made a complete 180 from limited access to fully available. Wireless technology is only helping the situation in that in addition to these web-based systems being available 24 hours a day 365 days a year, they can be accessed from any location.

Companies who are realizing the benefits of this wireless technology are equipping their employees with multifunctional phones that are capable of cellular service, two-way radio, text messaging, and are always connected to the Internet enabling access to intranets and extranets, e-mail, company calendars and date books, as well as being able to collect and calculate data when and where it happens in the field. There are faster connections, equipment, and other multimedia tools on the horizon that allow sounds,

images, and video as well as expanded e-commerce capabilities with which the construction industry should take full advantage.

Wireless technologies, reverse auctions, and electronic catalogs are all useful tools the construction industry has been familiarizing themselves with, however, there are more opportunities for e-business then the construction industry is even aware of.

These new technologies do pose a threat to the construction industry. Owners are going to see the virtual reality tools and believe that projects can be completed faster and under budget. Project management is going to become more open and more complicated. Building under budget and on time is not going to be enough anymore. "We live in an age where technology can change business by managing information in new, dynamic ways and creating collaborative, interconnected paths among crews, contractors, consultants, and customers. Go wireless!" (McKenzie 9). The construction industry needs to embrace the new technologies in order to stay on top and continue to achieve greater successes.

Web based project management. The web based project site is a new software tool that allows various individuals in the design and construction process to work together over the Internet. The idea behind project Web sites is that information in current design and construction projects are disorganized, which leads to failure in communication, and misunderstandings, which in turn leads to conflict, cost, and scheduling discrepancies. These project Web sites should offer a place that is easily accessible, reliable, and a place for storing project information that can be accessed at anytime. This should in turn allow a new level of access to project information that should replace or diminish the use of communication tools such as telephone, fax,

overnight mail, facsimile, and email. It is also supposed to alleviate the use of those huge binders that have become notorious on construction projects. A project Web site will afford all the members of team with the same information in the same format so no discrepancies should arise. This in turn should lead to better organized, better communicated project. This project Web site idea is growing and more widely accepted as the companies offering these services develop their ideas and grow with technology (O'Brien 2000).

When a construction project is in progress there are usually stacks of paper including: plans, specifications, product cut sheets, shop drawings, correspondence, schedules, operations and maintenance manuals, just to name a few. Time, money, and thus paper could be saved if all this information was put on the project web based system. Then in order to find information all that would have to be done is navigation to the site at anytime information was needed. The information would be easier to find, better organized, and take up a lot less space. Links to websites for the materials and products used on the project could also be placed on the site. This would allow the owner to stay up to date on product information and allow for easy contact to a particular manufacturer without having to search high and low for contact information.

Compatibility among e-Business Users

Software application, as well as collaborative sites, and every company database has their own information system that is unique, making incompatibility inevitable. The exchange of information becomes difficult and often impossible spending valuable time on recreating information in the attempt to exchange the information (Geissler 2001). Vital information locked into a company's data base is underutilized and can often be overlooked or has to be recreated costing valuable time and money. An example of this

detrimental situation is when only one individual in a company knows a piece of information about a project. If this person is removed from the project then the information is lost. It is better to have a central storage space where anyone has access to all the information on a project. This way if someone leaves, their knowledge of the project does not, and the project can continue seamlessly. With this in mind it is necessary to establish standards that can be used by everyone at every stage in a project so no discrepancies will occur.

Interoperability, or the free exchange of information across data barriers, is the answer. The construction industry needs to stop wasting time with repetitive tasks and create documents one time and be able to pass it on to the next software application seamlessly without fault, corruption or loss of functionality. Insufficient interoperability increases costs and allows for mistakes and missed opportunities for the construction industry. It is estimated that the cost of inadequate interoperability in the United States capital facilities industry to be $15.4 billion a year (Gallaher et. al. 2004).

“Imagine one company being able to "read" construction drawings generated by another for cost-estimating data, then taking the same drawings and extracting scheduling, maintenance and other project management data. Imagine the potential of "mining" your computerized inventory, labor and delivery schedules to develop generic invoices that would easily slip into any accounting package operated by all customers--regardless of those customers' unique needs” (Geissler 42).

The International Alliance for Interoperability (IAI) has been developing a way to translate information in different formats for exchange among different software applications. Other significant organizations have joined the IAI in their efforts for

interoperability such as, the American Institute of Architect, the Associated General Contractors of America, the Civil Engineering Research Foundation, the construction Specifications Institute, the Design-Build Institute of America and the National Institute of Building Services (Geissler 2001). This is exactly what the architecture, engineering, and construction (AEC) industries need considering the vast amounts of crossover information that occurs in these industries.

For instance, the invoice is a common transaction used across industries. The problem is that "if you have 2,000 clients, you will have 1,900 different formats in which invoices must be structured. That means that critical data such as job numbers, dates, product quantities and more must be formatted differently for each client" (Geissler 43). When companies have to reformat these or any transactions valuable time and money is once again wasted and mistakes are likely to occur.

Computer-aided design (CAD) drawings are another issue among the AEC industries. Once construction drawings are complete, shop drawings need to be designed. Once the drawings are complete it is safe to assume that estimating programs, material detailing programs, and scheduling programs would all be used. However, these programs that generate all these documents are rarely if ever compatible with each other.

To aid in this problem, IAI is working on another project for Industry Foundation Classes (IFCs). IFCs are object-oriented standards developed in ISO/STEP Express language. This language represents building components and then communicates a representation of the whole project as components linked to other components. The computer model created, the IFC, can then be understood by other IFC software (Geissler 2001).

IAI is also assisting in the development of an extensible markup language for the AEC industry of aecXML. This language is designed exclusively for the AEC industries developed with standards that will be used by software companies to ease conflicting programming problems which in turn should simplify life for everyone involved.

e-Business Language. Currently, the standard language of the Internet for business transactions is the Extended Markup Language (XML). An XML format is a collection of rules for tagging data with descriptive labels. Once the data is labeled, the data can then be exchanged without regard to the vagaries of the numerous software applications (Geissler 2001). This is a difficult language for the construction industry to use because of the mass quantity of components present. With XML it is necessary to standardize component labels and properties, such as change orders, windows, and doors. To date small steps have been taken in designing a language just for the construction industry called aecXML (Cleveland 2001). As stated previously, there is a need for standardized labels within these languages in order for logical communication to occur. Within the aecXML language there are two types of standardized labels, non-AEC specific and AEC specific.

The aecXML framework includes sets of XML schema, or a meaningful combination of one more elements and attributes, to explain information specific to exchanges between participants involved in designing, constructing and operating structures and facilities. The aecXML framework provides the AEC industry with the standard language it needs to share any information over the Internet with other users. The framework identifies the information exchanged between industry users as well as processes ruling the exchange of that data (Weng and Zhu 2001).

Software with either aecXML format or IFCs will allow business processes in the construction industry to become more streamlined while saving the integrity of data transferred as well as valuable time and money. Sir Michael Latham, lead a study that has been referenced as stating that with the implementation of interoperable information systems would allow savings of approximately 30% to the construction industry (Geissler 2001). The North American IAI, estimates that with the use of IFCs and aecXML formats in the AEC industry would yield $7.5 to $15 billion annually (Geissler 2001).

Autodesk Inc., GraphiSoft , Nemetschek A.G. and Olof Granlund Oy have been certified as implementers of IAI' s IFC 1.5.1. Microsoft is also heading up programs that will offer software with IFC 2.0. Timberline Software Corp., Bentley Systems Inc., and Autodesk Inc. are also jumping on the bandwagon to develop programs that are compatible with IAI IFC's (Geissler 2001). The continued production and organization of software developers depends on the industry leaders not the software developers. Once the industry sees the benefits and the ease at which it allows organization work flow they be more willing to help define the standards for the software developers and the success will continue to grow.

Customer Relationship Management (CRM): Customer Satisfaction

E-Business dictates fast and flexible response to increasingly dynamic market changes, but it also requires stable and enduring relationships between companies and employees as well as between companies and partners, and companies and customers (Chang and Ping Li 2003). Customer satisfaction is one of the most important roles of e-Business software providers. Customers determine the success of a company's website. Customers have confirmed the benefits the e-Business technologies had on the speed and cost effectiveness of deploying and managing integration projects. Consumers have been

gaining market power and they are in control as to the direction and pace of the economic growth of the companies who host these websites. Companies need to be devoted to customer satisfaction and be easy with which to deal if they do not want to lose customers to competitor's websites. Business applications that offer personalized customer services are especially important to most customers these days.

"In the online world, businesses have the opportunity to develop very deep relationships with customers, both through accepting preference of customers and then observing their purchase behavior over time, so that you can get that individualized knowledge of the customer and uses that individualized knowledge of the customer to accelerate their discovery process" (Krishnamurthy 3).

In order to keep customers interested and loyal to company's websites it is the customer service and customized experience that keeps customers coming back. Amazon.com employees never meet their customers face-to-face, but repeat customers are flagged and if they encounter a problem these buyers are ushered to the front customer services to speak with a high level manager. Sacks Fifth Avenue applies the same concept to their "high rollers" by moving them to the front of the customer help line when in need (Enos 2005).

"Customer-centric means figuring out what your customers want by asking them, then figuring out how to give it to them, and then giving it to them. That's the traditional meaning of customer-centric" (Krishnamurthy 2).

Improving customer experience online involves: identifying your customers' goals as well as the company's goals, commit to organizing that great customer experience, and then monitoring the customer experience as well (Hurst and Gellady 1999).

For customer service to be exactly that, customer service, it is necessary to organize the company structure and consolidate customer's records so everyone has access to these records with one click so there is no run around when assisting a customer (Enos 2005). Customers do not want to deal with a company that is not patient or takes an interest in their consumers. The website is the first place to treat the customers with respect. If customers find the website too difficult to navigate or just plain unfriendly, they are not likely to return. Companies will lose opportunities for sales, customer relationships, and positive feedback which equal losses in revenue if they do not provide a site that is user friendly. "The key driver of online success, or failure, is the customer experience" (Hurst and Gellady 3).

e-Business Applications

Because customer satisfaction is such a big deal in keeping e-Business applications running, the rate at which new and improved applications are needed is increasing. Advanced e-Markets, redrafting and optimization of supply chains, and outsourcing of business functions are all factors that drive the needs for flexible applications. The technology that is used and defined for e-Business applications needs to be able to change and be able to adapt to the constantly changing marketplaces and it is up to these technologies to make successful businesses out of successful e-marketplaces.

Virtual marketplaces can be organized in one of two ways, either horizontally or vertically. Horizontal markets offer common services to a variety of industries. These services can include financial services, benefits management, maintenance and repair, and operating equipment procurement process management. Vertical marketplaces refer to a web site that combines unrelated materials and services that are used jointly for a particular industry. The site then makes this collected data available to industry

members. In the construction industry, a vertical marketplace could provide an application service, as well as a marketplace for the sale of goods and services for the construction industry (Issa et al. 2003).

Virtual marketplaces can improve sales and distribution while reducing inventory levels. Companies are able to distribute their products to a multitude of companies worldwide that they otherwise might have never had contact. Amazon.com has been heralded as the first company to be associated with the e-Commerce phenomenon. Their e-marketplace was carefully planned and strategically placed, on the Internet of course.

E-retailing is a solution to a different type of storefront, a storefront that is established online for the selling of products and services online. E-retailing allows businesses to create, manage, and run business from their computer. The key trade that is made is that real estate is traded for web space. Real estate is the main cost of physical retailers, whereas web hosting, development and maintenance fees are the main costs of e-retailing. That is why there is the old saying: location, location, location. Real estate gets more expensive every year, and technology gets cheaper every year, and it gets cheaper fast (Krishnamurthy 2002).

Successful e-Business sites are user friendly, easy to navigate, available across any operating system. With this in mind, the cost that is put into these systems should be carefully monitored and deliberately planned so as to not lose money with the end product. In order to develop and plan for systems that are to be productive it is important to keep the necessary components of a successful e-business strategy in check. These necessitates are: the demand for real-time access to information, the need to integrate base applications that are too costly to replace, to ability to collect information from a

vast number of sources, the ability to have different applications communicate with one another to create a streamlined flow of information, the ability to communicate wirelessly, and adaptation to change (AberdeenGroup 2001).

Issa et al. (2003) explained a model they created that shows the savings and efficiencies companies realize when adopting e-Business strategies into their company culture. They explain that because new trends force the construction industry to deliver a better product with enhanced customer involvement and satisfaction, businesses must expand their market globally so every participant becomes experienced in the part they play in the whole business operation. Therefore, in order to produce the best quality product while achieving ultimate customer satisfaction, everyone on the team needs to work together. This can only be done through Internet technology. By implementing Internet technologies and thus e-Business solutions, improved quality of work will satisfy the client, improve efficiency of product development which in turn satisfies the project team (Issa et al. 2003).

e-Business integration. As stated previously, the complex nature of e-Business makes it difficult to integrate its applications into existing company software as well as other e-Business application across the web for communication purposes. The construction industry is fragmented between general contractors, subcontractors, architects, engineers, owners, and developers. This is where e-Business integration infrastructures come in. An e-Business integration infrastructure consists of several layers of different technologies that provide communication, integration, organization, and coordination services (AberdeenGroup 2001).

Investing the time to choose the right technology and supplier for e-Business applications is critical. Knowledge of the supplier of the technology selected as well as the credibility of the supplier are two important characteristics investors should be looking for when choosing the best technology for their job. The development of a strategic integration infrastructure can best be created though determining the needs of e-Business and overcoming the obstacles e-Business can present. The result of strategic planning for these infrastructures is long term benefits, which really makes it all worth it in the end (AberdeenGroup 2001).

Some industry leaders feel it might be too late to get involved in e-Business operations. However there are steps that can be taken to begin the road to e-Business success. An e-Business framework should be set up in a company in order to begin the implementation into the company's operations.

An e-Business framework should consist of three effects including: the communication effect, the brokerage effect which allows access to global markets with little cost, and the integration effect which decreases and improves the supply chain. An organization model should then be established. The next step should be a ranking of the opportunities that are available through e-Business transactions. Finally, for each of the opportunities that were listed, a potential solution should be identified using one of the three affects stated previously (Schulz 2003).

This is just a brief overview of an approach to get the ball rolling in the effort of creating a successful e-Business framework. Careful research should be done in order to create an e-Business framework that explores strategies with less risk and opportunities for greater opportunities.

Case Studies

Robert Bosch Corporation. The Robert Bosch Corporation has experienced real value in implementing e-Business applications into company operations. The director of e-commerce at Robert Bosch Corporations said "In my mind, e-Business drives your processes toward real time" (Gould 39). The implementation of at Robert Bosch Corporation is pretty conservative in that they do not like to jump into the system without knowing what is has in store for their company. They want to see the technology at work and actually succeeding before adoption companywide begins.

The e-commerce committee will first introduce a project they feel will assist the company. A return on investment of less then a year is then determined. After approval, the project is then given a three to six month test project where it will try out its success rates. If the test project is successful, the project is then issued companywide (Gould 2003).

Two of their e-Business applications include real-time inventory checks and direct purchasing through an e-marketplace. Only a web-browser is needed to interact with these applications. Bosch employees are describing these as "way better than what they had" (Gould 39).

Siemens VDO Automotive. Siemens VDO Automotive is another company applying e-Business applications into their corporate structure. Bill Macfarlane, CIO, feels the automotive industry would benefit from e-Business for procurement, supply chain management, and product development. Currently, Siemens uses web-based auctions, RFP/RFQ management, supplier communications, and purchasing. With these ideas for implementation, one of Siemens first e-Business applications was catalog-based procurement. Next in line for e-Business at Siemens include: web-based requisitions,

with workflows, approvals, and budget controls. Macfarlane says web-based technology "is the way to go. If you're not doing it web-based, you're missing the boat" (Gould 40).

TRW Automotive. TRW Automotive has begun using an online ordering system to help boost sales. Now, between 50 and 60% of TRW's orders come through the ordering system rather than by phone or fax. Another e-Business application is that of online customization for products. Customers can configure products and submit them to TRW for pricing (Gould 2003). TRW's e-Business applications have helped with customer sales, inventory management, and supplier communication.

Primavera Systems. This developer of project management software, partnered with PurhasePro.com, an online provider of Internet B2B procurement. The new marketplace is PrimeContract.com and is intended for construction companies, subcontractors, owners, and suppliers. The purpose is to speed up the purchasing process of goods and services, as well as aid in effective review of bids and project contracts. "The construction industry is ripe for e-commerce," says Joel Koppelman, president of Primavera. "PrimeContract.com extends project management into the heart of purchasing and procurement of construction materials, components and services" (Partnership 16).

e-Business Strategy

Companies that begin to re-evaluate their technology needs and usage, evaluate new Web-based solutions, and to develop, refine, select and prioritize a set of solutions will be in a good position to realize considerable cost savings, increase operating efficiencies and improve customer satisfaction and profitability.

E-Business is about the commitment and capability of companies in various industries to utilize digital technology, emphasize intellectual property, and enhance customer satisfaction across the business functions, thus changing the way of doing

business from a traditional company-centric stand-alone paradigm to a new network-leveraged synchronized paradigm (Chang and Ping Li 2003). It is the future and it is here now. Companies must embrace the new technologies if they want to survive in this fast paced, dog eat dog world.

Chapter 3, will discuss the methodology of the survey as well as the aims and objectives of this study. The steps used in order to select respondents as well as the reasoning for selecting the respondents will also be clarified.

CHAPTER 3
METHODOLOGY

This study focuses on e-Business practices in the construction industry. Current e-Business applications, available technologies, types of providers for e-Business technology, as well as current users of e-Business applications were researched to design a survey about e-Business in the construction industry today. The hypothesis on this topic is that the construction industry is growing rapidly and beginning to embrace technology and realize its benefits. They are using e-Business applications more every year and experiencing high success rates.

Scope of Work

This study investigates the views of the construction industry on e-Business and e-procurement. This information was obtained through the distribution of and response to a survey (Appendix A) that was sent out electronically to construction industry leaders. The questions on this survey were designed to determine the following: 1) the willingness of the construction industry respondents to use e-Business and e-procurement in future endeavors to help their companies make advancements in their field, 2) if they are already using these tools in their company, how far have they come since they first began using e-Business, 3) what type and size of companies are more likely to use e-Business in their everyday activities. The survey was sent out via email, to 91 corporations selected from the 2003 Engineering News Record Top 400 Contractors. These companies range from general contracting, project management, to design build companies based throughout the United States. The companies also vary in workforce

size, geographical location, and annual profits. The main focus was to determine the extent of e-Business implementation by general contractors.

Survey Methodology

The survey is designed to determine the current status of e-Business practices, the construction industries implementation of e-Business applications, and the effects e-Business applications have on the construction industry. Questions in the survey concentrate on the size of companies, geographical distribution, revenue, current e-Business practice, e-Business initiatives, e-Business processes, e-Business affects on revenue, and past, present, and future plans for e-Business applications within their company.

A similar survey was conducted in the year 2000. The updated survey for this study consisted of some similar questions as well as additional questions more specific to the technologies of today. The results of the survey conducted in 2000 and the survey conducted for this study will be compared along with any additional information obtained from the new questions in an effort to determine any trends in e-Business in the construction industry.

With answers to these questions as the goal a survey was set up in order to determine e-Businesses effects on company processes. The survey was primarily multiple choice with a few demographics questions. These sections were each designed accordingly to obtain the information needed to compile and analyze the final responses.

Selection of Survey Participants

The survey was distributed to 91 contractors selected from the 2004 ENR Top 400 Contractor list, found at http://www.enr.com. Every fifth company beginning with the number one ranking company on ENR Top 400 Contractors were selected (e.g., 1, 5, 10,

15, …). This resulted in 81 companies from ENR Top 400 Contractors List. The subsequent ten companies were then selected from The ENR Design-Build Companies List that were also included on the ENR Top 400 Contractors List but were not selected in the number sequence as previously noted.

Contractors with web sites were chosen first because of their obvious knowledge of Internet use and its capabilities. If a company was selected and it was discovered they did not have a web site, they were left out of the survey and the preceding company in ranking on the list was chosen. If this company also exhibited the absence of a website the company one rank above the selected company was chosen and so on until a company with a website was discovered. Company information from their websites was documented for follow-ups and evaluation of survey results.

This survey was prepared and administered via e-mail. The survey was sent out to ninety-one companies with a fax number included for returning the survey. This survey was arranged as an anonymous survey. The information about the companies will be kept confidential, and the data gathered are pooled together. The analysis of results is kept strictly within this study.

The results are based on responses from 20 corporations out of ninety-one organizations selected from ENR TOP 400. The businesses surveyed represent project management, general contractor, design build, and construction services companies throughout the United States. The respondent companies varied in terms of annual revenues, number of employees, and geographic region of operations. The data was collected and analyzed for the study to determine growing trends and construction industry changes in the past five years.

The next chapter, Chapter 4, will discuss the results that were obtained from the respondents to the survey (Appendix A). These results will then be analyzed and compared to a similar survey completed in 2000 (Issa et al. 2003) to determine any trends relating to e-Business initiatives and adaptations in the construction industry.

CHAPTER 4
ANALYSIS OF SURVEY RESULTS

The e- Business Assessment Survey is designed to determine the current usage in the construction industry of e-Business applications and how those views have changed in the past five years. The survey was aimed towards the construction industry's leading general contractors and their response to e-Business initiatives. Since the survey was sent to the most successful contractors in the United States it is assumed they are doing something different to advance their business success rates. The survey questions whether or not e-Business applications have anything to do with these companies successes and if so, if they plan on continuing their use and /or advancing their technology in order to better understand and utilize e-Business strategies. Questions about company revenue size, number of employees, and geographical location were asked in order to determine whether smaller or larger general contracting firms were more willing to participate in e-Business. Information about current use of e-Business applications, as well as future plans for investment was questioned to determine companies' e-Business implementation plans. Most important e-Business applications currently in use was also determined in order to assess applications that are most useful to the construction industry.

The construction industry is beginning to realize the benefits of e-Business. With the final results in, the ability to categorize companies' processes that worked became apparent. As survey results came in it was obvious that some companies had been

working with e-Business for quite sometime and had worked through all the kinks and now had e-Business working for them.

The e-Business Assessment Survey will be analyzed quantitatively to determine whether or not e-Business is finding a place in the construction industry. The results will then be compared to those results of a similar e-Business assessment survey conducted in 2000 (Issa et al. 2003). Additional questions were added to the present survey and only those questions that relate to the survey in 2000 will have comparison analysis results.

Results of the e-Business Assessment Survey

Respondent Profiles

The respondents in this survey are based on a 22 % return rate. Although this seems like a low return rate, accurate information can still be determined as well as growing trends within the construction industry. The job title of the respondents from the 2000 survey compared to the 2005 survey varied as shown in Table 4-1.

Of the responses to the survey, 5 (25%) were from executives: they all felt either knowledgeable or very knowledgeable about the company's e-Business efforts conveying the idea that the executives or senior level management makes the decisions about the business operations that are taken on within the company. Three of the respondents (15%) worked in computer systems management; they came in second with claiming knowledge in company e-Business efforts with the same type of responses as senior level management of very knowledgeable or knowledgeable. Thus, it seems that the company executives and computer systems management work together in making decisions as to what technologies the company will adopt presently and in the future.

Table 4-1: Survey respondent employee position

What are your job functions?	2000		2005	
	Profile	%	Profile	%
Executive (CEO, owner, VP, etc)	7	35%	5	25%
Operations Management	1	5%	7	35%
Financial / Accounting	0	0%	0	0%
Sales / Marketing	2	10%	4	20%
E-Business Development	4	20%	0	0%
Computer Systems management	0	0%	3	15%
Consultant / IT Provider	1	5%	0	0%
Engineering	0	0%	0	0%
Other	5	25%	1	5%
TOTAL	20	100%	20	100%

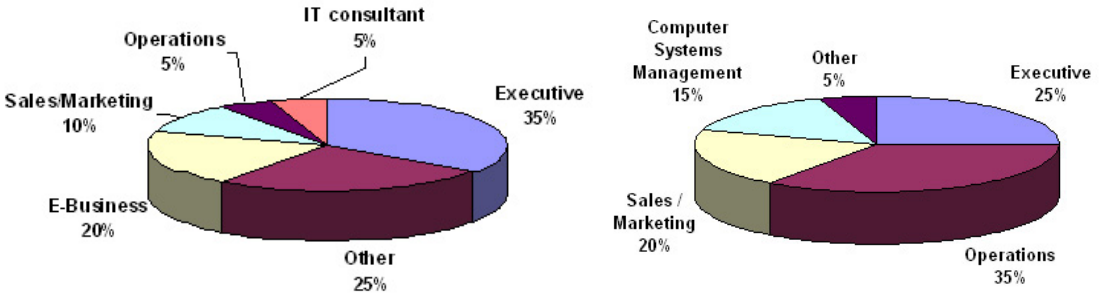

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Figure 4-1: Respondents job title distribution. A) For the year 2000 B) For the year 2005.

Firms with employee size ranging from 100 to 499 employees at their current location had the greatest response to the survey. Figure 4-2 shows the employee size distribution of all the firms surveyed compared to the survey in 2000. Because the majority of the survey respondents are of similar employee size, the comparison of results will be of even greater substance because of the companies' similar experiences in relation to company size. Of the participants, 85% (17) had other locations within the United States and 55% (11) had international locations. Companies with international locations had utilized more e-Business applications as well as more types of connections, other than phone, fax, and email, for communication with suppliers than companies that operate solely in the United States. It is not uncommon for construction companies to be spread across the nation and even the world because the project they construct are for

different clients and thus different locations demanding that they be on site to monitor progress. The surveys show the apparent use of Internet and other technologies in order to communicate from different locations.

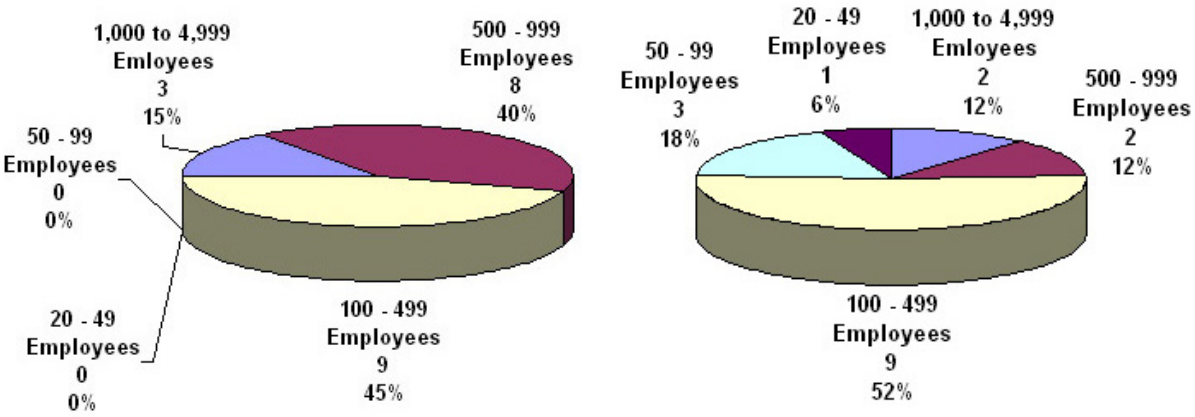

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Figure 4-2: Respondents employee size distribution. A) For the year 2000 and B) For the year 2005.

There is also significance in the fact that there is a greater distribution in size from the 2005 survey. Keep in kind that the companies for this survey were chosen based on their ranking on ENR's Top 400 contractors meaning they are successful companies. There was a 6% (1) response from companies with 20 to 49 employees: although this is a small company, they are making profits that could be attributed to e-Business efforts and their ability to communicate and expand their services.

A company's revenue can be significant when it come to e-Business operations. The amount of revenue a company brings in each year will determine their spending on other company needs such as communications within the company structure. Figure 4-3 shows the distribution of the respondent firm's revenues. There was a 32% (6) response from companies with revenue of one billion dollars or more. The companies in this revenue bracket spent more money on networking, computer hardware, intranet/extranet,

and other e-Business applications than companies making a smaller revenue. This is for the obvious reason that these companies have a greater need and a great source from which to purchase the necessary items and tools.

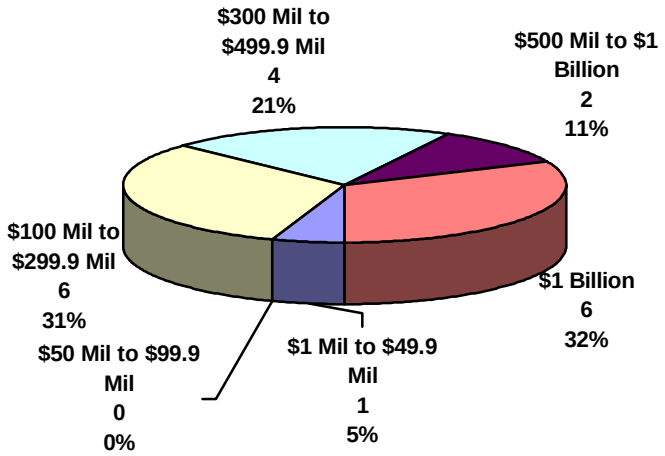

Figure 4-3: Respondents distribution by annual revenue

Survey Findings

Selected results of the survey will be discussed in the rest of the section with the following topics in mind: adoption of e-Business, communication tool usage, e-Business initiatives, intended gains from e-Business implementation, and future plans and goals for e-Business within respondent companies.

The first question on e-Business: “Are you involved in adopting any of the following e-Business applications?” was asked of the respondents to determine the current applications the construction industry is using on a day to day basis.

The distribution of e-Business applications implemented by respondent companies can be found in Table 4-2 and Figure 4-4. It is understood that technology is a rapidly growing phenomenon and that a lot can happen in five years. However, as shown in Table 4-2, even after a five year time since a similar survey was sent out and analyzed, there appears to be the same rate of e-Business implementation. Every company

surveyed is involved with e-Business applications, in some form or another, within their company. The most widely used e-Business application in 2005 is that of extranet/intranet at 75% (15), and project management close behind with a 70% (14) adoption rate. This survey also shows more adoption in the wireless category than in previous years. The previous survey in 2000 showed 0% adoption of any kind of wireless technology. Presently 45% (9) of companies are utilizing the wireless technologies in part because of technological advances as well as greater user familiarity with this technology.

Table 4-2: Adopted e-Business application adoption in the construction industry

e-Business Initiatives	2000 Results				2005 Results			
	n	%	Internal	OutSrce	n	%	Internal	OutSrce
E-Procurement	8	40%	3	0	5	25%	1	4
Customer Relationship Mgmt	6	30%	3	0	10	50%	9	1
Workflow	8	40%	3	1	8	40%	7	2
Supply Chain Management	5	25%	2	1	3	15%	2	0
Extranet/Intranet	13	65%	7	1	15	75%	12	2
E-Commerce	9	45%	4	0	6	30%	3	3
Kwldg Mgmt./ Data Warhse	9	45%	5	0	9	45%	7	3
Internet Infrastructure	12	60%	5	1	10	50%	9	2
Enterprise Resource Planning	5	25%	4	0	7	35%	6	1
Accounting / Finance	11	55%	5	0	13	65%	9	5
Project Collaboration	10	50%	4	5	11	55%	7	6
Project Management	14	70%	5	4	14	70%	8	8
Digital Exchange / Auction	1	5%	0	1	9	45%	2	6
Wireless	0	0%	0	0	9	45%	6	1

Comparing the outsourcing of e-Business applications to internal development by the companies, it is found that there is more outsourcing now than five years ago. This could be due to software development and greater understanding of the construction industry and its standards as well as its unpredictable operations that need flexible programs that can be used from project to project. The presence of more outsourcing also has to do with companies using their internally developed programs in combination with

outsourcing in order to create an application that works best for their company. Although there is still a great deal of internal development, this likely has to do with company preference of already in place processes, especially in the extranet/intranet category. It is difficult for the construction industry to move on from something that they believe is working and does not need to be changed.

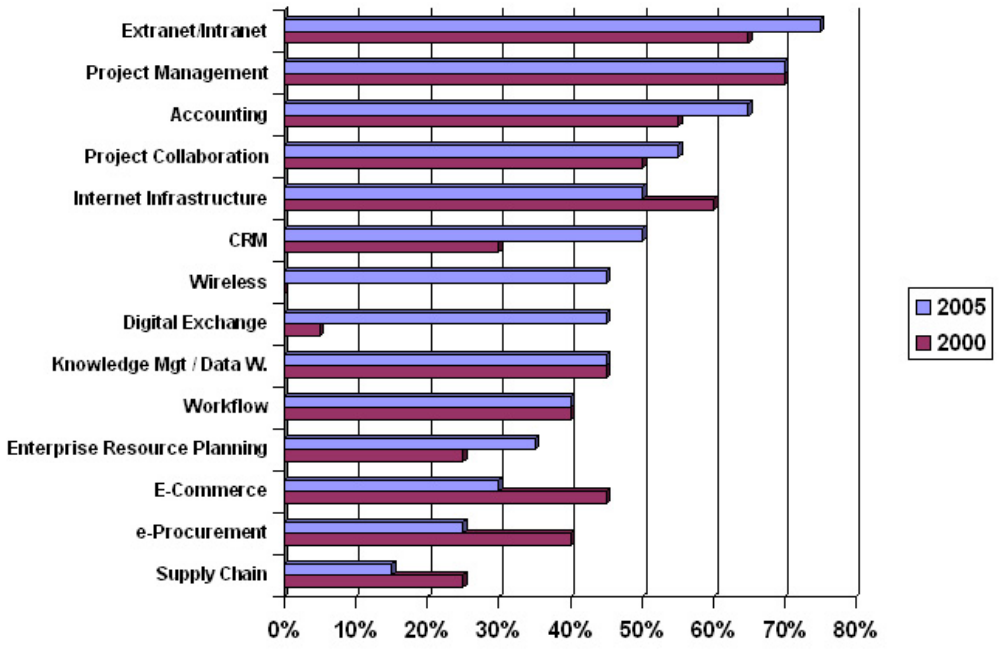

Figure 4-4: Distribution of adopted e-Business applications in 2000 and 2005

Accounting and finance tools are among the most implemented tools and are used a great deal at 65% (13) with most internally developed. Project collaboration tools are also automated and used widely among construction industry leaders. These tools are designed to help companies organize their information about a project in one place, usually a website. This allows the information to be accessed by anyone working on the project, at anytime, from any place. Thus resulting in increased productivity and a more streamlined approach which saves time and money, which is why construction industry leaders have embraced these tools.

Digital exchange has made great progress that most likely has to do with project collaboration tools and the software that is associated with these tools. More software has come out that is focused on construction industry standards in the past five years that allows for easier exchange of information over the Internet. This explains the increase in use and adoption responses. It is easier than ever before to exchange information on the Internet. Wireless capabilities have allowed digital exchange as well as project collaboration tools to be used more widely in the construction industry. Wireless has gone from a 0% usage in 2000 to 45% (9) over the past five years. Although more than 45% of companies require cell phones, which use wireless technologies, respondents were most likely considering wireless connections for laptops on site and for wireless data exchange over the Internet. The combination of these three tools has helped each tool alone and explains their greater adoption in the construction industry.

There was a change in the construction industry's thoughts on e-Commerce, e-Procurement, and supply chain management in terms of less use for these applications. They are still among the least adopted applications even though they have great potential in saving money and streamlining operations. The lack of applications using these services in the construction industry has lead to a lack of expertise in these areas simply because there is not enough industry specific operations out there for these companies to use that work with their business operations.

The construction industry is embracing e-Business application slowly but surely. The number of adoptions of these applications is sure to rise especially with the new generation of individuals getting ready to enter the construction work force. They are more computer savvy and have the expertise and experience to introduce new operations

and applications into the construction industry that can only help propel the construction industry into the computer age.

Communication. The respondents were then asked about the connections they have with their suppliers, partners, and customers. The purpose of this question was to determine exactly which methods of contact they are using to stay in touch and to exchange information with suppliers, partners, and customers. Figure 4-5 shows the distribution of respondent connections with customers and suppliers

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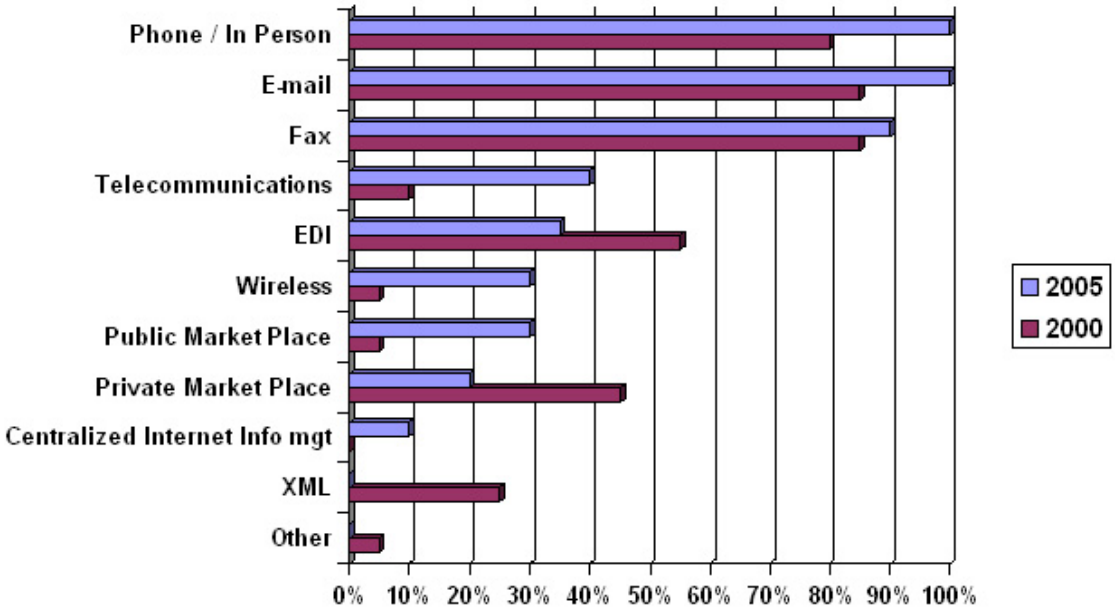

Figure 4-5: Connection with suppliers, partners, and customers

Although the survey indicated that the construction industry most often uses the old method of communicating by phone or in person there is an increase in the use of e-mail by respondents. This use of e-mail expresses the fact the construction industry is using the Internet on a daily basis to conduct its business operations. The facsimile has been around for a while and because everything is not completely automated it is necessary to

keep this communication tool in connection with the other most widely used tools, phone and e-mail. Because the construction industry is people oriented and face time with customers, suppliers, and partners is important, the use of the phone should not by any means be eliminated, just enhanced. The use of cell phones, cell phones with Internet capabilities, and cell phone Personal Digital Assistants (PDAs) is only making communication easier and more effective.

Again, the use of wireless technologies has taken a leap in the past five years in the construction industry from 5% (1) in 2000 to over 35% (6) in 2005. Electronic data exchange (EDI) is somewhat related to wireless in that wireless can increase the use of EDI. The more places you are able to exchange information the greater the chance that it will be used. Thus, with the increase in wireless communications comes increased EDI use.

The use of public and private market places is pretty low considering the recent surge in digital marketplace presence. The US construction industry is heavily dependent on personal relationships and seems to still work by word of mouth, asking around and using past suppliers and manufacturers for business operations. With the growing popularity of wireless computing, this trend is bound to grow because the construction industry will be able to reorder an item from a digital marketplace at a moments notice should something go wrong with a current building material.

Another question was asked of the survey participants about company requirements for mobile computing devices to connect with others. “Does your company require or supply employees with any mobile computing devices in order to connect with others” was asked to determine how connected these companies hope to be with clients,

suppliers, and even within the organization itself. Figure 4-6 displays the distribution of supplied computing devices to employees.

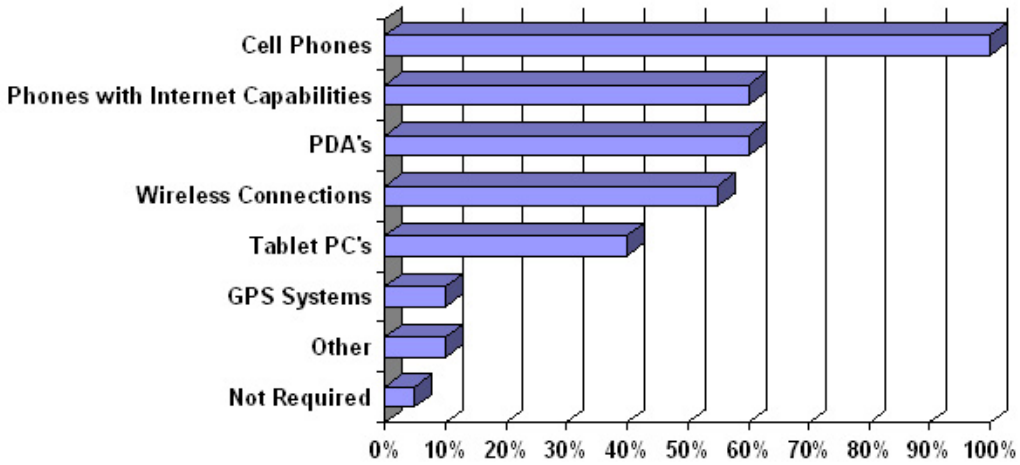

Figure 4-6: Company supplied computing devices

Although not every company required their suppliers to have mobile computing devices, all the companies surveyed supplied their own employees with cell phones and 60% supplied cell phones with varying capabilities i.e. some supplied BlackBerries™ which supply users with e-mail, speakerphone, instant messaging, and Internet browsing among other capabilities. The construction industry is a fast paced business. Employees are rarely at their desks and are often on the move. Decisions often come down to last minute details and project managers should be available at a moments notice. Cell phones make this possible which is why they are so widely issued to construction management employees.

Personal Digital Assistants (PDA) are the next most popular computing device with which to supply employees with 60% (12) of companies supplying their employees with these devices. PDAs have similar capabilities as BlackBerries™ without the ability of a phone. Internet access is common, along with personal organizers, day planners, e-mail,

and word processing are all available on these devices. Keeping track of high profile project, meeting minutes, and schedules are all made easier with the use of PDA's.

Tablet PCs are becoming more popular. Because they hold more information than PDAs, larger projects can be tracked on organized with these devices. They are larger than a PDA but are just as mobile. With wireless becoming more readily available and 55% of companies requiring wireless devices, tablet PCs are beginning to showing up on more construction projects.

Global Positioning Systems (GPS) are only used by 10% (2) of the respondents. Most companies have been using GPS system on equipment on the jobsite in order to track use, productivity, as well as to prevent theft. It is also used in automobiles as a direction assistant with helping users with finding locations of points of interest.

With the apparent use of these mobile computing devices it is clear that the construction industry is embracing new technologies and looking for new ways to increase productivity. These devices simplify processes and streamline workflow which is exactly what the complex construction industry needs. After all time is money in this industry.

Electronic Business Initiatives. The next question "Which of the following Internet-related IT initiatives are you currently working on or plan to be involved in?" was designed to determine what e-Business applications were being implemented into the construction industry. It is also designed to determine where the construction industry is lacking in terms of their e-Business efforts. Figure 4-7 displays the distribution of e-Business initiatives in the construction industry. Current practices and future implementation on procurement, supply chain, transactions, e-commerce, project

development, intranet/extranet, e-markets, order tracking, partnering, and communication were all covered to determine the industry's needs. Ninety percent of the companies that responded have implemented e-Business initiatives and have plans for future e-Business initiatives within their organization. Such a high response rate indicates that the construction industry is ready and willing to implement e-Business initiatives.

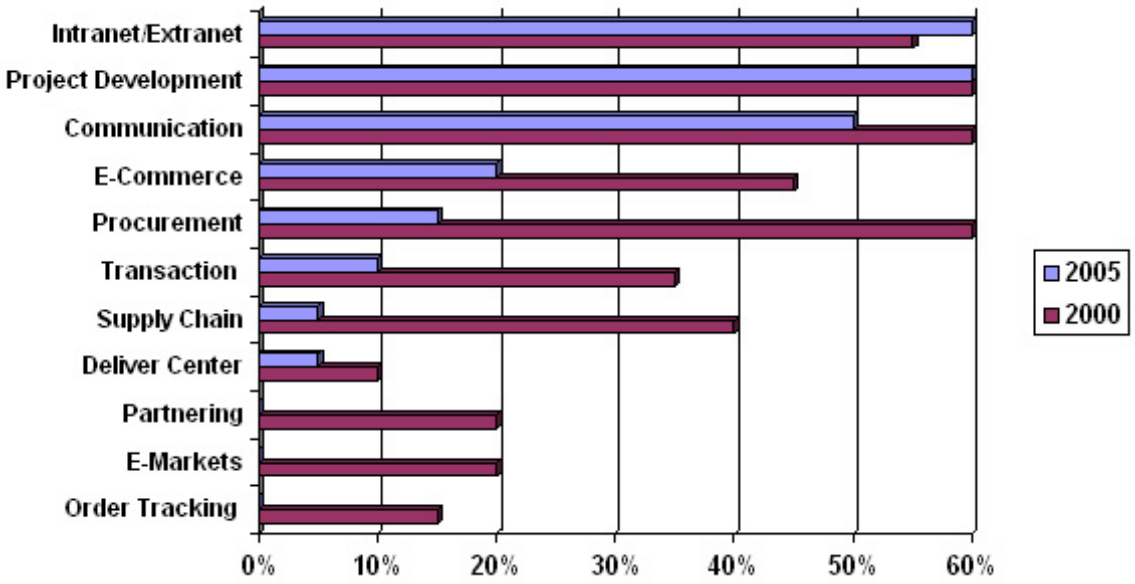

Figure 4-7: Electronic business initiatives in the construction industry

Project Development and Intranet/Extranet tools are the most used and/or are slated for greater use. Greater use of Intranet/Extranet at 60% (12) versus 55% (11) in 2000, was no surprise considering its high response rate earlier with e-Business applications. The respondent companies also have a strong focus on project development and complete organization of project systems. This is also no surprise with the high response for project management applications stated earlier. Companies, most likely, have plans to continue their use of these initiatives with plans to develop these areas further.

Communication was the next leader in initiatives although it decreased 10% from 60% (12) in 2000 to 50% (10) in 2005. This decrease could be attributed to the fact that

the respondents feel this area is important but that they are more focused on other areas at present. However, as stated previously, communication in the construction industry is key. With a constant need to keep in touch with suppliers, clients, and everyone involved on the project, communication is extremely important to construction industry leaders. These tools are important to maintain and increase productivity while reducing costs and staying on schedule.

The survey indicates that e-Procurement and e-Commerce are likely to be adopted in the near future. Respondents are aware of these tools but do not have the ability or knowledge at present to implement these into operations. As stated previously, these are the items that are outsourced indicating that the respondents are not as aware of these information applications as much as other activities and applications.

However, the survey indicates they are willing to take on these tools in the future as a means to increase productivity and improve business operations.

Prioritized goals of the Construction Industry. "Please rate the following from the least important to the most important according to your business goals." This question was designed to determine technologies the respondents saw as most important in furthering their company's business operations as well as the future structure of the company. Table 4-3 shows the respondents priorities and their rankings in order to determine how or why they plan on implementing certain e-Business initiatives. Figure 4-8 shows the distribution of the respondent companies' goals.

Table 4-3: Respondent priorities

Business Goals	2000					2005				
	Avg	Min	Max	Rank	%	Avg	Min	Max	Rank	%
Increased Internal Communication	4.9	4.0	5.0	1	65	3.8	1.0	5.0	3	37
Increased External Communication	4.9	4.0	5.0	1	65	4.5	2.0	5.0	5	68
Enhanced Customer Relationships	4.9	4.0	5.0	2	60	4.6	2.0	5.0	1	74
Expansion of geography	2.8	1.0	5.0	12	15	3.1	2.0	5.0	10	11
Innovation of product/services delivery	3.9	3.0	5.0	6	20	3.5	2.0	5.0	8	11
Shorter, accurate transaction	3.7	2.0	5.0	7	15	3.3	1.0	5.0	9	17
Transparent market	2.8	2.0	5.0	12	5	2.5	1.0	5.0	12	7
Expansion of Partnership	3.5	2.0	5.0	10	15	3.0	2.0	5.0	11	5
Reduced capital costs	3.5	2.0	5.0	8	25	3.9	2.0	5.0	4	32
Reduced travel costs	3.5	2.0	5.0	8	10	3.4	1.0	5.0	7	15
Increased productivity	4.6	4.0	5.0	4	45	4.6	2.0	5.0	2	70
Increased predictability	4.7	4.0	5.0	3	50	4.6	3.0	5.0	2	70
Reduced defects	4.1	3.0	5.0	5	30	4.5	3.0	5.0	4	58
Improved industry standards	3.2	1.0	5.0	11	5	3.8	2.0	5.0	6	21

The survey results indicate that customer relationships are of most important concern for leading construction companies ranking second in 2000 and moving to the number one goal in 2005. Increased productivity and increased predictability is a close second, moving from fourth and third respectively to tying for second. The construction industry is especially concerned with reducing cost, and increasing productivity and predictability which will in turn reduce costs as well as save time. Reducing defects and improved communication with suppliers, customers, and partners, ranks at number four as a main goal of construction industry leaders. Increased internal communication is not as high of a priority as it was in 2000 moving ranks from number one in 2000 to number three in 2005, probably due to the fact that companies have developed their internal communication and are now focusing on broader communication applications. Improved industry standards as a goal has taken a leap from ranking eleventh in 2000 to ranking sixth in 2005. Construction industry leaders seem to be figuring out that the more standards that are developed, the greater their ability to communicate effectively, and

with minimal confusions. Most of the business goals have not changed a great deal in five years since 2000 because of their similar rankings from 2000, which brings forth the trend of the construction industry's goals. These goals should help in the further development of applications geared toward the construction industry's goals as well as allowing the industry to see exactly what e-Business applications it needs to implement in order to achieve their goals.

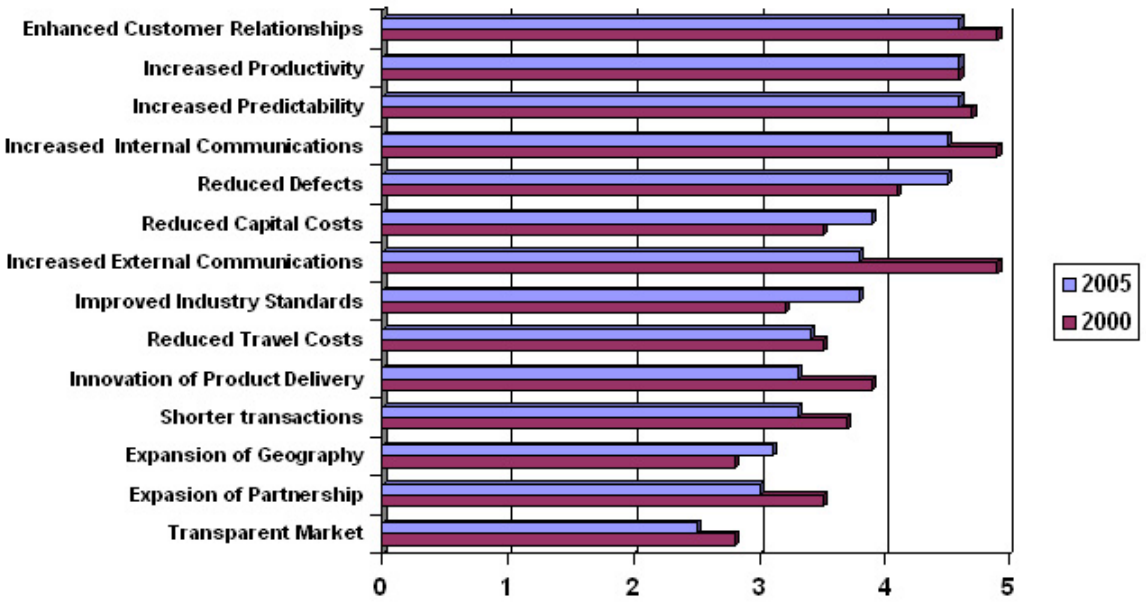

Figure 4-8: Construction industry's prioritized goals

Business to Business Exchange. "In the past 5 years has your company participated in an industry-specific Business to Business (B2B) exchange?" This question was designed to determine whether or not the construction industry is moving away from its traditional ways of buying and selling products and services. It is not clear as to whether or not the construction industry is familiar with this practice because 35% (7) did not know if their company had participated in B2B exchange, 40% (8) said no, and another 20% (5) said their company had participated in this application. These results show that B2B exchange is not implemented as much as desired due in part to it process.

The B2B exchange process involves entering information into a system and allowing the system to take it through the process with minimal human interface (Cleveland 2001). The problem with this is the mere complexity of the construction industry and its systems. The construction industry deals with a multitude of systems and coordinating these systems is difficult without the loss of information or change of data. Implementing B2B exchange is an obvious obstacle that must be overcome and is on its way to working within the construction industry.

Obstacles. "What has held you back from conducting e-Business?" This question was designed to help industry suppliers, software developers, and e-Business experts determine what they can do to help the construction industry in their e-Business efforts. Everything from lack of security and industry standards, to cost of the application is covered in this question. Figure 4-9 displays the obstacles the construction industry is facing with conducting e-Business. Because e-Business is so new to the construction industry there are few precedents of companies who have implemented e-Business applications with real time documented results. Construction industry leaders are most likely at the point in their e-Business implementation and they are all waiting to see what successes and benefits they have reaped from their efforts.

Another reason the construction industry is wary of implementing too much e-Business at one time is because of the lack of expertise. E-Business is new to construction; however it is still fairly new to all disciplines which indicates that there is going to be a lack of expertise in this area across the board. However, with the increase in computer literacy among the workforce, the implementation of e-Business is sure to be on the rise.

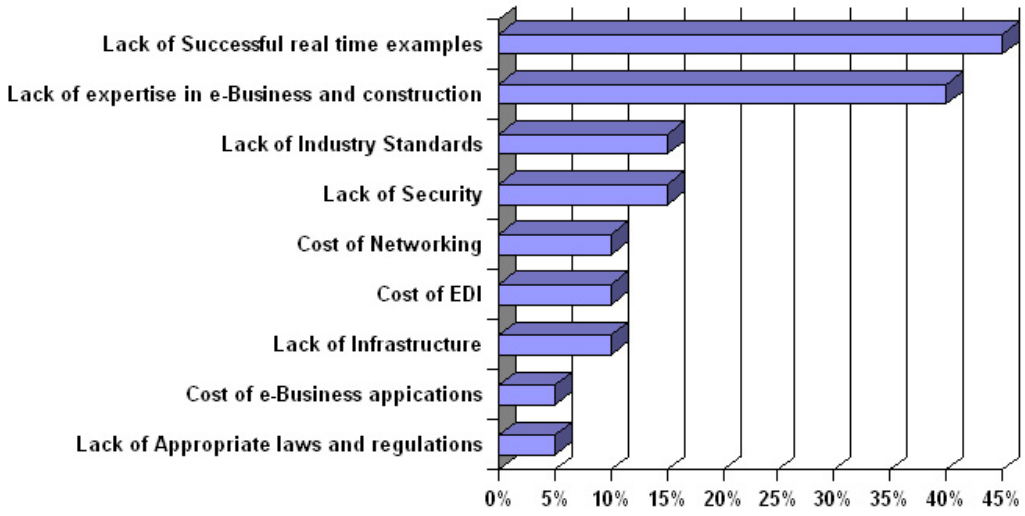

Figure 4-9: Construction industry reasons for not implementing e-Business

Benefits. "If e-Commerce applications have been implemented in your company within the past 5 years, has your company seen significant improvements in any of the following areas?" Figure 4-10 displays the results of benefits with which the construction industry has experienced with the implementation of e-Business applications. The ability to retrieve project information with ease and allowing for more effective use of time are the greatest benefits realized by the respondents in this survey with 40% (8) feeling these were benefits their company was realizing. These benefits really go hand in hand, because with the better use of time comes cost savings which is the next benefit the respondents felt in which they were taking part.

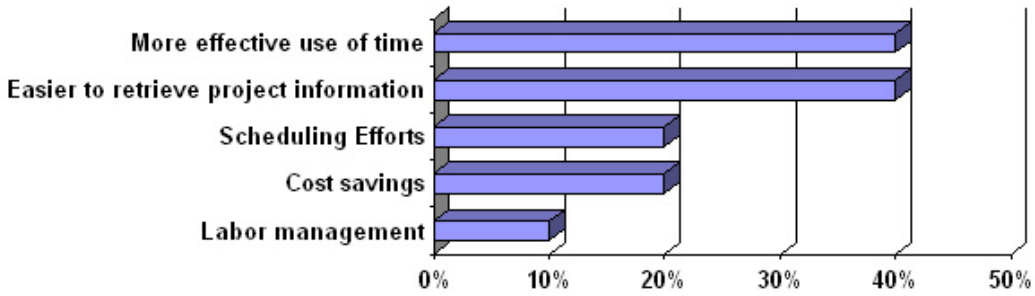

Figure 4-10: Benefits realized by the construction industry with e-Business implementation

When these construction industry leaders first implemented e-Business into their daily operations they had a few ideas about what they wanted to accomplish. The question "How would you characterize the impact of your e-Business initiatives on your main source of revenue" was designed to determine if their e-Business efforts were actually helping their company in the way they most expected it to help in reducing cost and increasing revenue. Figure 4-11 displays the 2005 respondents feeling on how they perceive e-Business' impact on revenue.

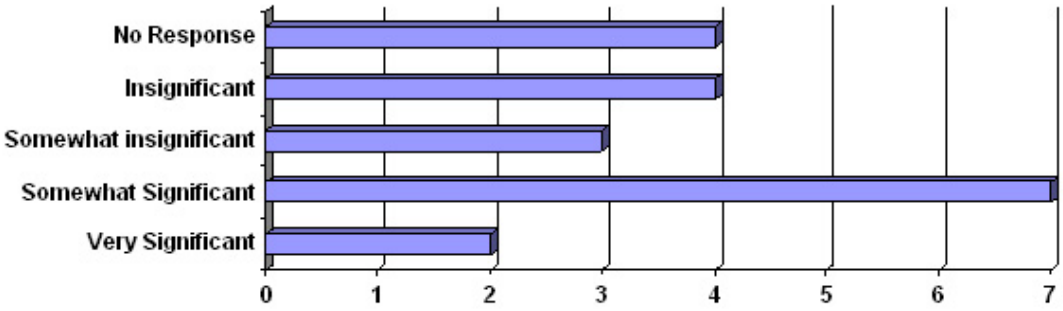

Figure 4-11: Impact on revenue

Most of the respondents felt that their e-Business adoption was somewhat significant with 35% (7). The upper portion of respondents at 45% (9) felt there was some sort of impact on revenue by the e-Business implementation. The four that did not respond were also the same individuals that felt they were not knowledgeable in their company's e-Business efforts.

Figure 4-12 shows the distribution of responses to the question. "Your company's e-Business efforts are primarily intended to?" The survey showed that an overwhelming number of respondents implemented e-Business in the hope of increasing productivity, which leads to more effective use of time, and in turn cost savings. The construction industry is big on getting things completed as fast as possible with the least amount of

steps. It is evident in this response that the construction industry "getting done" attitude is what is driving the decisions on e-Business adoption.

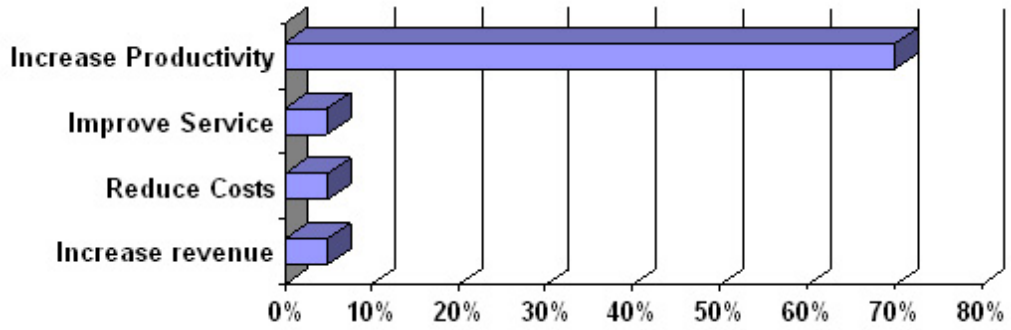

Figure 4-12: Construction industry's perceived benefits of e-Business implementation

It is somewhat surprising that earlier in the survey the top goal of these respondents was to enhance the customer relationship and here they are more focused on increasing productivity instead of improving customer service. Perhaps the industry feel that by increasing productivity and delivering projects that are on time or earlier will increase customer satisfaction and thus the customer relationship.

Future Spending. The question "your company quantifies and closely tracks the value of its e-Business efforts" was designed to determine if these companies are really paying attention to whether or not e-Business is working for them or not. Figure 4-13 displays the distribution of respondent replies. The responses here varied across the board. It was difficult to determine whether or not the construction industry is really paying attention to e-Business implementation. Although the industry is beginning to embrace e-Business, it still seems to be a new practice. Tracking is on a case by case basis and will most likely be monitored in greater detail in the future after companies have experienced it for a while where greater results can be realized.

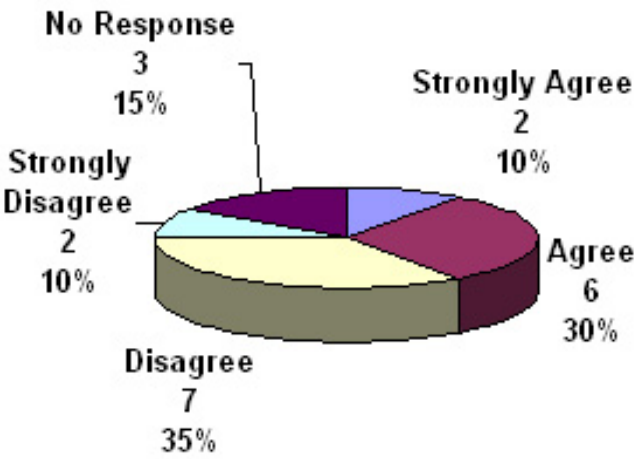

Figure 4-13: Distribution of companies monitoring e-Business efforts

The last question in the survey is "Do you expect you spending on e-commerce to increase, decrease, or remain the same in the coming year?" With what the construction industry knows about e-Business and what applications they use on a daily basis, they are able to determine whether or not they will continue on the same track or move to a different approach as far as their business operations are concerned. Figure 4-14 displays the range of responses received from the survey.

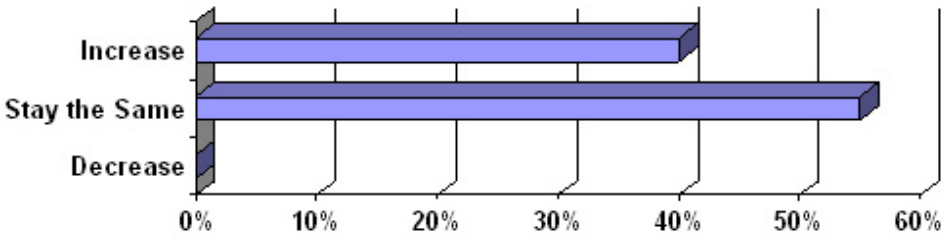

Figure 4-14: The construction industry's perceived ideas on future spending on e-Business implementation within their company

The respondents show no signs of wanting to rid their operations of e-Business implementation. Either way they plan on continued spending on e-Business in the construction industry. The companies feel that e-Business implementation is benefiting business operations and that continued support for it is crucial to business success.

The next chapter, Chapter 5, will present final conclusions and recommendations for further research in this area of study. E-Business has potential for an even brighter future in the construction industry. It has already begun is forward shift, and it seems as though there is no turning back.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

Electronic Business definitely has a place in the future of construction operations. Its benefits have already begun to show successes within the companies they have been implemented. Easier project coordination, more effective use of time, and cost savings are all promises that e-Business is delivering. However, in order for e-Business to succeed in the first place industry leaders need to determine their goals and company standards. An understanding of what customers want and how to find these customers is one area they need to develop in order to design e-Business for communications. Companies also needed to assess their products and services to determine how to market themselves and what was required to turn their company into a productive, profitable business.

Today, virtually all companies use the Internet in some sort of fashion and they will continue to expand their use and knowledge of the Internet as new uses emerge. As stated previously, the construction industry claims that 60% to 80% of the total cost of operation, including capital, labor, materials and transportation, is directly related to information management (Geissler 2001). The construction industry is a global network that can use the Internet and e-Business to connect to suppliers, customers, and partners worldwide.

The results of the “e-Business Assessment Survey” have indicated that, contrary to popular belief, the construction industry is actually implementing e-Business solutions in order to streamline operations. Not only is the industry already implementing e-Business

applications, but they are also ready and willing to embrace new applications as long as there is evidence that implementation will prove successful for their own company in the long run.

Increased productivity by the respondent companies was the overwhelming response to the perceived benefit of e-Business. However, the other benefits realized by the respondent companies that was a more tangible response was that of finding more effective use of time, and the ability to retrieve project information with greater ease. The majority of the respondents felt that because of these real and perceived benefits, e-Business implementation in the construction industry made either a significant or very significant impact on their companies business operations.

Plans to continue spending within respondent companies also expresses the industry's desire to continue e-Business implementation in the future. At this point in time, however, the construction industry has only scratched the surface of what the Internet can do for them and they have a long way to go before the industry realizes the maximum return the Internet and e-Business have to offer. The fact that the industry has only scratched the surface is not the fault of the construction industry but the complexity of the discipline and the inability, at present, for so many different systems to collaborate with accurate results.

Most e-Business applications are not designed to fit the complex nature of the construction industry. With the development of greater technologies and the aecXML language, e-Business will have a greater presence in the construction industry. In the near future, aecXML will allow for greater integration among systems as well as

functioning in the adaptable networks made up of other companies who coordinate internal and external transactions all in one place.

The study shows that the construction industry is taking an active role in e-Business implementation and that companies are making plans for future internal and external improvements in order to increase productivity and encourage cost savings.

Recommendations for Future Research

While the results of this survey provide valuable information about e-Business implementation in the construction industry, further research is necessary in order to increase maximum potential of this phenomenon within the construction industry. Since the construction industry as a whole conducts the same types of business processes just on different scales according to company size and project specifics, surveys should be conducted industry wide. The survey should seek a larger number of responses by sending out the survey to a larger number of industry leaders with a web presence not only those on the ENR top 400 contractors list. It would also be helpful to send the survey to the same companies so tracking of specific companies can be analyzed yielding more accurate results instead of just a random sampling every time.

There should also be a type of measurement for productivity in this study because it was the greatest perceived benefit of e-Business. It was only a perception because there was not a developed form of measurement to date that could be used in conjunction with this survey.

Additionally, it is recommended that future studies focus on the progress of the integration of e-Business applications amidst the complex business operations of the construction industry. The trends toward enhanced integration and interoperability will

result in even greater improvements in productivity, time management, and reduced costs.

APPENDIX
E-BUSINESS ASSESSMENT SURVEY

Informed Consent Form

M.E. Rinker, Sr. School of Building Construction
PO Box 115703
Gainesville, FL 32611-5703

Fax (352) 392-9606
Suncom: 622-5965

Dear Participant,

I am a graduate student in the Rinker School of Building Construction at the University of Florida. As part of my course work I am conducting a survey, the purpose of which is to determine the use of e-Business solutions in the construction industry. I am asking you to participate in the survey because of your close connection with these issues, as a participant in the construction industry. Participants will be asked to fill out a survey lasting no longer than 20 minutes. You will not have to answer any question(s) you do not wish to answer.

Your survey will be conducted in your workplace, after you have read this informed consent. Only I will have access to the survey that you fill out. The statistical data collected from your survey and others will be documented in my thesis. Although, your identity (if you choose to reveal it) will be kept confidential to the extent provided by the law and your identity will not be revealed in the final manuscript.

There are no anticipated risks, compensation or other direct benefits to you as a participant in this survey. You are free to withdraw your consent to participate and may discontinue your participation in the interview at any time without consequence.

If you have any questions about this research protocol, please contact me at (352) 373 – 7379 or my faculty supervisor, Dr. R. Raymond Issa, at (352)-273-1152. Questions or concerns about your rights as a research participant may be directed to the UFIRB office, University of Florida, Box 112250, Gainesville, FL 32611; Ph: (352) 392 – 0433.

By filling out the provided survey, you give me the permission to report your responses anonymously in the final manuscript to be submitted to my faculty supervisor as part of my course work.

Sincerely,

_____
Bryce Treffinger

I have read the procedure described above. I voluntarily agree to participate in the research
study and I have received a copy of this description.

_____
Signature of the participant Date

This survey has been designed to find out how the construction industry adopting the Internet tools and e-Business strategies as well as the plans for future implementations. Please take a few minutes from your busy schedule and participate in the survey. Upon completion, please either fax it to (352) 846-2772 or mail it to us at: Dr. R. Issa, Attn: E Business Survey, Rinker School of Building Construction, Box 115703, Gainesville, FL 32611-5703

1. What are your job functions? **(PLEASE CHECK ALL THAT APPLY)**

   - ❑ Executive (CEO, Owner, VP, etc)
   - ❑ Operations Management (Project Manager, Project Engineer, etc)
   - ❑ Financial/ Accounting
   - ❑ Sales/Marketing
   - ❑ E-Business Development/E-Business Strategist
   - ❑ Computer Systems Management
   - ❑ Consultant/IT Provider
   - ❑ Engineering
   - ❑ Other (Please Describe) _____

2. How many people are employed at this location and in your entire organization, including all of its branches, divisions, and subsidiaries? **(PLEASE CHECK ONLY ONE PER COLUMN)**

	At this Location	**In this State**	**In the U.S.**	**International Locations**	**Entire Organization**
❑ 10,000 or more	❑	❑	❑	❑	❑
❑ 5,000-9,999	❑	❑	❑	❑	❑
❑ 1,000-4,999	❑	❑	❑	❑	❑
❑ 500-999	❑	❑	❑	❑	❑
❑ 100-499	❑	❑	❑	❑	❑
❑ 50-99	❑	❑	❑	❑	❑
❑ 20-49	❑	❑	❑	❑	❑
❑ 10-19	❑	❑	❑	❑	❑
❑ 1-9	❑	❑	❑	❑	❑

3. What was your company's revenue in the year 2004, in US dollars? **(PLEASE CHECK ONLY ONE)**

   - ❑ $1 to $49.9 Million
   - ❑ $50 to $99.9 Million
   - ❑ $100 to $299.9 Million
   - ❑ $300 to $499.9 Million
   - ❑ $500 Million to $1 Billion
   - ❑ $1 Billion +

4. Are you involved in adopting any of the following e-Business applications**?**
(PLEASE CHECK ALL THAT APPLY AND INDICATE IF YOU ARE DEVELOPING INTERNALLY OR OUTSOURCING)

	Developing Internally	Outsourcing
❑ E-Procurement	❑	❑
❑ Customer Relationship Management	❑	❑
❑ Workflow	❑	❑
❑ Supply Chain Management	❑	❑
❑ Extranet/Intranet	❑	❑
❑ E-Commerce	❑	❑
❑ Knowledge Management/Data Warehousing	❑	❑
❑ Internet Infrastructure	❑	❑
❑ Enterprise Resource Planning	❑	❑
❑ Accounting /Finance	❑	❑
❑ Project Collaboration/Project Specific Web Sites (e.g. E-Builder, Project Talk, Constructware, Endeavor, etc…..)	❑	❑
❑ Project Management (e.g. Prolog, Expedition, etc….)	❑	❑
❑ Digital Exchange/Auction	❑	❑
❑ Wireless	❑	❑
❑ None of the above (PLEASE SKIP TO QUESTION #7)		

5. What type of connections do you have with your suppliers, partners and customers? **(PLEASE CHECK ALL THAT APPLY)**

- ❑ Phone, in-person
- ❑ E-mail
- ❑ Fax
- ❑ Electronic Data Interchange
- ❑ XML
- ❑ Private Web-based market places
- ❑ Public Web-based market places
- ❑ Wireless
- ❑ Centralized Internet Based Information management
- ❑ Telecommunications
- ❑ Other (Please specify) _____

6. Does your company require or supply employees with any of the following mobile computing devices in order to **connect with others within your organization**: **(PLEASE CHECK ALL THAT APPLY)**

- ❑ Cell Phones
- ❑ Tablet PC's
- ❑ PDAs
- ❑ Phones with Internet Capabilities
- ❑ Wireless connections
- ❑ GPS systems
- ❑ Other _____
- ❑ We do not require mobile computer devices

7. Does your company require or supply employees with any of the following mobile computing devices in order to **connect with suppliers, partners, and customers**: **(PLEASE CHECK ALL THAT APPLY)**

- ❑ Cell Phones
- ❑ Tablet PC's
- ❑ PDAs
- ❑ Phones with Internet Capabilities
- ❑ Wireless connections
- ❑ GPS systems
- ❑ Other _____
- ❑ We do not require mobile computer devices

8. How knowledgeable are you about your company's e-Business efforts? **(PLEASE CHECK ALL THAT APPLY)**

❑ Very Knowledgeable ❑ Knowledgeable ❑ Somewhat Knowledgeable ❑ Not Knowledgeable

9. Over the course of one year, what dollar values do you buy, specify, recommend, or approve in purchases of the following products or services: **(PLEASE CHECK ONLY ONE PER COLUMN)**

	Networking/ Telecommunications	Internet/ Extranet/ Intranet	Computer Hardware	Service/ Support	Materials/ Equipment	Electronic Commerce
$500,000 or more	❑	❑	❑	❑	❑	❑
$400,000 to $499,999	❑	❑	❑	❑	❑	❑
$300,000 to $399,999	❑	❑	❑	❑	❑	❑
$200,000 to $299,999	❑	❑	❑	❑	❑	❑
$100,000 to $199,999	❑	❑	❑	❑	❑	❑
$50,000 to $ 99,999	❑	❑	❑	❑	❑	❑
Less than $50,000	❑	❑	❑	❑	❑	❑

10. Which of the following Internet-related IT initiatives are you currently working on or plan to be involved in? **(PLEASE CHECK ALL THAT APPLY)**

- ❑ Procurement/Purchase
- ❑ Supply Chain
- ❑ Transaction Processing
- ❑ E-Commerce/Sales
- ❑ Project Development/Project Specific Web Site
- ❑ Intranet/ Extranet
- ❑ E-markets
- ❑ Order Tracking
- ❑ Deliver Center over the Internet
- ❑ Partnering
- ❑ Communication

11. Please rate the following from the least important (1) to the most important (5) according to your business goals.

	Very Important	**Somewhat Important**	**Important**	**Not very Important**	**Not Important at all**
	5	**4**	**3**	**2**	**1**
Increased external business communication	❑	❑	❑	❑	❑
Increased internal communication	❑	❑	❑	❑	❑
Enhanced customer relationship	❑	❑	❑	❑	❑
Expansion of geographical opportunities	❑	❑	❑	❑	❑
Innovation of product/service delivery	❑	❑	❑	❑	❑
Shorter, accurate transactions	❑	❑	❑	❑	❑
Transparent market	❑	❑	❑	❑	❑
Expansion of partnership opportunities	❑	❑	❑	❑	❑
Reduced capital costs	❑	❑	❑	❑	❑
Reduced travel costs	❑	❑	❑	❑	❑
Increased productivity and profitability	❑	❑	❑	❑	❑
Increased predictability and project performance	❑	❑	❑	❑	❑
Reduced defects and accidents	❑	❑	❑	❑	❑
Improved industry standards	❑	❑	❑	❑	❑
Other (PLEASE SPECIFY)	_____				

12. In the past 5 years, has your company participated in an industry-specific Business to Business exchange?
    - ❑ Yes, If Yes Please Specify _____
    - ❑ No
    - ❑ Do Not Know

13. Please tell us what has held you back from conducting e-Business? **(PLEASE CHECK ALL THAT APPLY)**
    - ❑ Lack of Security
    - ❑ Lack of industry standards
    - ❑ Lack of appropriate laws and regulations
    - ❑ Cost of EDI
    - ❑ Cost of e-Business applications
    - ❑ Cost of networking / telecommunications
    - ❑ Lack of infrastructure
    - ❑ Lack of expertise in e-Business and construction
    - ❑ Lack of successful real time examples

14. If e-commerce application have been implemented into your company within the past 5 years, has your company seen significant improvements in any of the following areas: **(PLEASE CHECK ALL THAT APPLY)**
    - ❑ Easier to retrieve project information
    - ❑ More effective use of time
    - ❑ Labor management
    - ❑ Cost savings in any department
    - ❑ Schedule Efforts

15. How would you characterize the impact of your e-Business initiatives on your main sources of revenue?

❑ Very Significant ❑ Somewhat Significant ❑ Somewhat Insignificant ❑ Insignificant

16. Your company's e-Business efforts are primarily intended to: (Select Only One)

❑ Increase Revenues ❑ Reduce Costs ❑ Increase Productivity ❑ Improve Service

17. Your company quantifies and closely tracks the value of its e-Business efforts: (Select Only One).

❑ Strongly Agree ❑ Agree ❑ Disagree ❑ Strongly Disagree

18. Do you expect your spending on e-commerce to increase, decrease, or remain the same in the coming year? (Select Only One)

❑ Increase ❑ Decrease ❑ Stay the Same

LIST OF REFERENCES

Aberdeen Group, *e-Business Infrastructure Integration: Practical Approaches. An Executive* White Paper, *(2001).* Aberdeen Group, Inc. 2001. As Seen on 29 Jan 2005. <www.AberdeenGroup.com>

Chang, Sung-Lung Steven, and Ping Li Carl H. Peter. *How to Succeed in E-Business By Taking the Haier Road: Formulating E-Business Strategy Through Network Building*. Competitiveness Review, Vol 13, Issue 2, 2003, 34 – 46.

Cleveland, A.B. *B2B in the Construction Industry: Putting First Things First*, Leadership & Management in Engineering, Vol. 1, Issue 1, Jan 2001, 56-57.

Enos, Joel. *Click with Customers*, Ziff Davis Smart Business, As Seen on 9 Feb 2005, <http://www.Smartbusinessmag.com>

Fisher, Susan E. *Can Construction Adapt to Online Markets*? InfoWorld, Vol. 22, Issue 20, 15 May 2000, 38.

Gallaher, Michael P., Alan C. O'Connor, John L. Dettbarn, Jr., and Linda T. Gilday. *Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry*. NIST U.S. Department of Commerce Technology Administration: NIST GCR 04-867. 2004. As seen on 9 Feb 2005 < http://www.bfrl.nist.gov/oae/publications/gcrs/04867.pdf >

Geissler, Richard. *Building Data Bridges*. Roads & Bridges, Vol. 39, Issue 2, Feb 2001: 42 – 45.

Gould, Lawrence S. *Suppliers Talk about E-Business: It's Becoming Business As Usual*, Automotive Design & Production, Vol. 115, Issue 6, Jun 2003, 38 – 40.

Hurst, Mark, and Emily Gellady. *Creative Good White Paper: Building A Great Customer Experience to Develop Brand, Increase Loyalty, and Grow Revenues*. CreativeGood As seen on 9 Feb 2005 <http://www.creativegood.com/creativegood-whitepaper.pdf>

Issa, R.R.A, I. Flood, and G. Caglasin. *A Survey of E-Business Implementation in the US Construction Industry*, ITcon, Vol. 8, 2003, 15-28. <http://www.itcon.org/2003/2>

Krishnamurthy, Sandeep. *The Amazon*. E-Commerce Management: Text and Cases, 27 Sept 2002: 1-45. As seen on 19 Feb 2005: <http://www.swlearning.com/marketing/krishnamurthy/first_edition/case_updates/amazon_final.pdf >

McKenzie, Kevin. *Wireless Technology Helps Improve Bottom Line*, Business Journal: (Central New York), Vol. 18, Issue 13, 26 Mar 2004, 9.

O'Brien, William J. *Implementation Issues In Project Web Sites: A Practitioners Viewpoint.* Journal of Management in Engineering, May/June 2000, 34-39.

Partnership Creates E-Commerce Marketplace for Construction Industry, Facilities Design & Management, Vol. 18, Issue 11, Nov 1999, 6.

Perkowski, Michael. *Is E-Business Finally Living Up to Its Hype?* Cio Insight, Issue 30, Sept 2003, 73 – 89.

Regan. *Doing Business on the Internet*, Organizational System Research Association, 17 Feb 2002, As Seen on 15 Feb 2005 <http://www.osra.org/2002/regan.pdf>

Rojas, Eddy M., and Anthony D. Songer. *Web-Centric Systems: A New Paradigm for Collaborative Engineering*, Journal of Management in Engineering, Vol 15, Issue 1, Jan/Feb 1999, 39 – 45.

Schulz, Yogi. *How to Cook Up a Quick E-Business Strategy*. Computing Canada, Vol 29, Issue 10, 23 May 2003, 24.

Simpson, Catherine. *Reverse Auctions: Before Bidding, Know Your Base Costs*. Fort Worth Business Press, Vol. 17, Issue 13, 26 Mar 2004, 32.

Webopedia. *Definition of B2B e-commerce*, Webopedia, As Seen on 21 February 2005: <http://www.webopedia.com/TERM/B/B2B.html>

Weng, Ray, and Yimin Zhu, *aecXML Framework*, International Alliance for Interoperability. 25 June 2001, As Seen on 16 Feb 2005: <www.iai-na.org/aecxml/aecXML_Framework_R1.doc>

BIOGRAPHICAL SKETCH

Bryce Treffinger was born in Milwaukee, Wisconsin, on May 2, 1981. She and her family moved to Orange Park, Florida in 1987. She attended elementary school, junior high, and high school in Orange Park, Florida.

After graduating from high school in 1999, she attended the University of Florida Gainesville to obtain her Bachelor of Design in the College of Design, Construction, and Planning. After completion of her bachelor's degree in 2003, she attended the M.E. Rinker, Sr. School of Building Construction at the University of Florida to obtain her Master of Science in Building Construction, ,which she was awarded in May 2005. Shortly after graduation (May 28, 2005) she was married.

The future holds bright things in store for Bryce Treffinger. She plans to work for a large commercial construction company where she will use her knowledge and skills in design and construction management, learned from the University of Florida, to lead a successful career.