A review on past, present and future of web based project management & collaboration tools and their adoption by the US AEC industry

Burcin Becerik[1]

ABSTRACT | The term "Construction Project Extranet" (CPE) in this paper refers to Internet sites, which offer communication platforms, project management functionalities and hosted collaboration spaces for Architecture, Engineering and Construction (AEC) Industry projects. The paper focuses on web-based CPE offerings and examines in-depth analysis of the past, present and future of CPE solutions for design and construction projects as implemented by the AEC industry in United States. The paper builds upon previous research as well as structured interviews that were conducted with technology providers, users, and experts. The findings from the interviews and literature search were analyzed to address these questions: *How has CPE technology been developed? How much are these systems accepted and used? What are the barriers to widespread adoption? How will the market for such systems evolve?* The main goals of this paper are to fulfill the need of research related to the developments in this field, to provide a concise, updated overview of existing implementation practices and the current situation of CPE market, to discuss the reasons for slow adoption of CPE technology by the industry, and to understand the adoption and technology development patterns to forecast the future trends in this field.

KEYWORDS | adoption, AEC Industry, communication, extranets, Information Technology, and Web-based project management

1 Introduction

The real estate and construction industry is the largest industry in the world. In US about $1,1 trillion[2] of construction was put into place in 2002. [1] The industry has very distinctive characteristics such as fragmented organizations (around 700,000 establishments[3] in US) the uniqueness of each project, relatively short period of production, outdoor and unstructured working conditions, and labor-intensive activities. Successful completion of construction projects requires communication and collaboration of numerous multidisciplinary and sometimes geographically separated team members. Continuous and accurate formal/informal communication among project participants is key to resolve conflicts, keep the project on time, on budget, speed up solutions, and to share knowledge for coordinating these efforts.

The task of managing all the information needed to design and construct any major facility is a real challenge, and many believe that more efficient information management is a primary mechanism for the construction industry to increase its productivity. [2] The rapid advances of web-based project management and collaboration technology offer new opportunities to improve existing construction project communication and enhance the collaboration. However, despite many benefits of these technologies and all the efforts that have been put into facilitating the communication among the participants in AEC projects (much less effort has been put into having shared understanding), utilization of this technology hasn't progressed beyond simple document storage, exchange and management. When the first extranet services were launched, many industry pundits forecasted that this market would grow dramatically to reach multi-billion-dollar size within a few years. Despite the admonitions of vendors, consultants, journalists and even fervent early adopters in design and construction firms, widespread customer adoption in the AEC industry has been far slower than initially projected. There is a strong resistance from the industry participants to adopt these new technologies in their full capacity and change how work has traditionally been done. [3]

Relatively little research has been done related to what had happened in the past in this field, the current situation of the CPE market and the reasons of slow adoption of CPE technology by the AEC industry. The purposes of this study are to summarize the developments in this field, to provide an updated overview of existing implementation practices and the current situation of CPE market, to discuss the reasons for slow adoption of CPE technology, and to forecast the future of CPE technology based on our current knowledge. The following questions are addressed in the paper: How has CPE technology been developed? How much are these systems accepted and used? What are the barriers to widespread adoption? How will the market for such systems evolve? The paper aims to articulate answers to these questions clearly and thus to help in definition of an agenda of research needs for the future.

2 Construction project extranets

In this paper, the term "Construction Project Extranet" is used to define any number of web-based technologies for capital construction projects, which are hosted by an Application Service Provider (ASP). This allows members of a project team to access it directly through their Internet browser, with limited if any downloaded plug-ins. In this ASP configuration, information generated by project team members is automatically saved to the CPE on the web for permission-based access by other project team members. Although business models vary among CPE
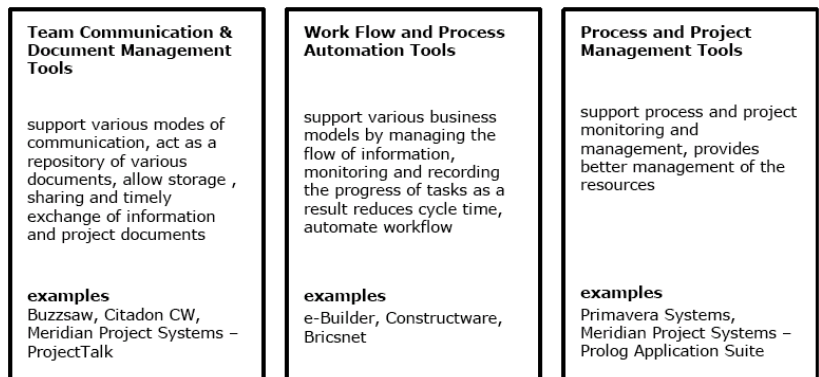
Team Communication & Document Management Tools	Work Flow and Process Automation Tools	Process and Project Management Tools
support various modes of communication, act as a repository of various documents, allow storage, sharing and timely exchange of information and project documents	support various business models by managing the flow of information, monitoring and recording the progress of tasks as a result reduces cycle time, automate workflow	support process and project monitoring and management, provides better management of the resources
examples Buzzsaw, Citadon CW, Meridian Project Systems – ProjectTalk	**examples** e-Builder, Constructware, Bricsnet	**examples** Primavera Systems, Meridian Project Systems – Prolog Application Suite

Figure 1. Categorization of Construction Project Extranets

providers, these services are typically leased for either a periodic and/or per-user fee. The CPE definition does not include web-enabled client applications where the Internet is used to connect directly to remote applications and databases. Unlike a web-based application, a web-enabled application is not based on the HTML language, but is instead a special software application that is distributed across the Internet much like standard network programs that are accessed over a Local Area Network (LAN).

CPE solutions can be classified in three categories [4]:

1) Team Communication and Document Management Tools
2) Work Flow and Process Automation Tools
3) Process and Project Management Tools

3 Research methodology

The primary research sources for this paper are publications of the industry and academia as well as in-depth interviews with users, vendors, practitioners, consultants, and technologists. First, a literature search of written history of these tools and an investigation of various available tools in the market were done. After gaining adequate understanding of the market, 26 in-depth interviews were structured and conducted with leader technology developers, CPE users, and industry experts to capture different perspectives. Structured

phone interviews, which each lasted approximately one hour, were conducted with:

- CPE vendors (total of 9) to gain the knowledge about the products, their development, vendors' missions, and unwritten history of these tools,
- CPE users (total of 10) to understand the problems in implementation and operation of these tools, their requirements, needs, and desires,
- Industry experts (total of 7) to get more knowledge about general trends in the industry and to learn more about specific implementations.

The information requested was straightforward and didn't involve sensitive material, so potential bias was not high. Comparative analyses of key-characteristics showed no indication of bias. Prior to the interviews, requests were sent to the interviewers to find the most suitable time for interviews. The interviews deepened the author's understanding of the step-by-step logic of a situation as it occurred, the interviewees' experience with the tools, the lessons learned from the implementations and the users' opinions about the future and improvements areas.

Some of the interviewed CPE vendors include but not limited to: Buzzsaw, Constructware, e-Builder, Meridian Project Systems, and Primavera. The author also interviewed industry experts from some research centers, which focus on CPE area such as FiaTech[4],
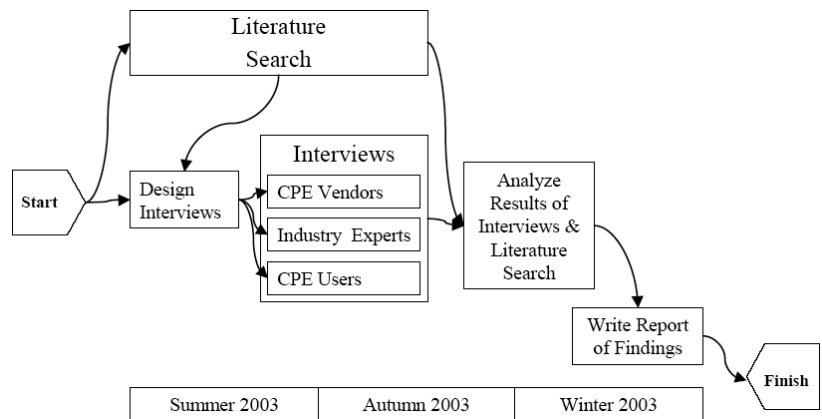

Figure 2. Research Execution Plan

4. www.fiatech.org

and the Digit Group[5]. To have a better understanding of specific issues, and to get a wider perspective, experts such as lawyers, consultants, educators and technologists were also among the interviewers. Last but not least, users of CPEs were interviewed to get information regarding the implementation and usage of these tools within the real life context. The users were chosen with the help of US General Services Administration[6]'s (GSA), Public Building Services (PBS), which is the world's larges civil landlord of the civilian federal government. [5] The professionals interviewed included project managers, architects, engineers, and general contractors. To encourage frank and honest responses and to protect potential sensitive data, the name of the interviews and their companies are omitted from the paper.

4 History of construction project extranets

Prior to the emergence of the Internet as a business information platform, Information Technology (IT) solutions were generally restricted to implementation within a single organization. However, the rapid development of Internet technology has improved organizations' ability to comprehend, utilize and manage these technology solutions beyond their previous technological borders, and made them aware of technology's potential to create new business process efficiencies and improve inter-company workflow practices. [6] Technology providers responded to this opportunity by developing networks and applications that leverage Internet technologies for sharing information within the secure boundaries of organizations (known as Intranets) as well as with outside organizations (known as Extranets). Intranets and Extranets are both created with the same underlying Internet technology for sharing information and facilitating collaboration on projects. The key difference is that an Extranet allows participants from outside an organization's firewall to access and utilize it. Intranets and Extranets are widely seen as one of the

most powerful applications of Internet technology for communication and collaboration in businesses.

Internet speed and adoption have both increased dramatically in recent years. Prior to that some construction companies developed document-handling systems, which allowed sharing of documents (but not drawings), but in a more primitive way, that was not user-friendly. [7] Most of the early adopters of Internet technology were from academic environments where they learned the potential impact of the technology. Based on the successes of the early adopters many businesses started experimenting with the Internet. Most began by installing Internet gateways (called SMTP gateways for Simple Mail Transfer Protocol) to hook their e-mail systems to the rest of the world. They added access to Internet newsgroups, and created their own internal newsgroups. When Web server and Web browser software were introduced, it soon became evident that businesses could use those same browsers to access internal information, such as policy manuals, business documents, and etc.

Initially, internally deployed Internet technology was identified by many different names, including internal webs, Internet clones, corporate webs, or private webs. [8] In November 1995, the Wall Street Journal coined the term "Intranet" to describe the use of Internet technologies by managers in organizations to reform their IT strategy, [9] and the term quickly gained popular acceptance after that.

1995 also marked the first initiatives to use Internet technology to improve the project management process in US businesses by enhancing communication and collaboration. This ignited a process of rapid product innovation and development, and generated tremendous expectations for productivity enhancements from the use of web-based project management and collaboration solutions. A number of early pioneers such as e-Builder, Collaborative Structures and Framework Technologies launched

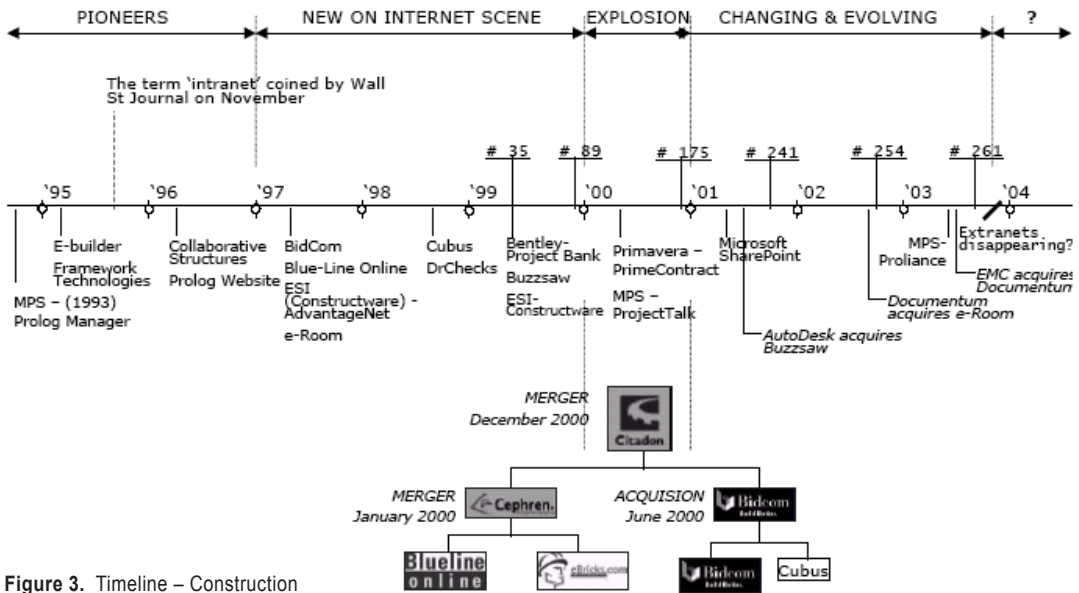5. www.thedigitgroup.com
6. www.gsa.gov

Figure 3. Timeline – Construction Project Extranets

CPE offerings in 1995 and 1996. Since then the CPE market has witnessed many start-ups, spin-offs, acquisitions, re-acquisitions, mergers, and failures.

The CPE Timeline (Figure III) shows the movement and development of the CPE market from 1995 to 2004. After the launches of early entrepreneurs in the *"Pioneers"* period from 1995-6, the second period of the timeline, from 1996-9 is called *"New on the Internet Scene"*. During this period more than 80 start-ups were rapidly funded and formed, and many existing companies launched web-based offerings to compete for a share of the emerging CPE market. Some of these start-up companies include Constructware, Blue-Line Online, e-Room and Cubus. Among the established companies entering the web-based market were CAD-makers AutoDesk and Bentley Systems. This new wave of Internet-based solutions enabled end users to create shared workspaces, to manage their projects online without any additional software on their computers and to easily span organizational boundaries and geographic distances.

The third period in the timeline, *"Explosion"* is

focused on the year 2000. This brief but intense period marks the heyday of the dot.com frenzy in the AEC industry. The period witnessed numerous additional start-ups, entries from established firms, acquisitions, and mergers among the existing CPE players to form stronger offerings. Examples include:

- Bricsnet, which was offering architectural design software and project extranet capabilities, acquired Viscomm, a leading producer of building product data.
- Primavera Systems, which had long dominated the market for client-server scheduling and project controls software, introduced PrimeContract, a web-based collaboration solution with advanced workflow management functionality.
- eBricks merged with Bluelineonline to form Cephren in January 2000.
- One of the start-up companies, Bidcom whose initial goal was online bid management, acquired Cubus Corporation, known for its strong offerings in design communications in June 2000.
- In December 2000, Cephren and Bidcom merged and formed Citadon, with the hope of dominating the CPE market.

The fourth period in the Timeline, between 2001 and the time of this writing, is called *"Changing & Evolving"*. Further consolidations, numerous business discontinuations, and very few new entrants to the CPE market have characterized this period. As of May 2004, there were a total of 270 extranet service providers operating in the US market according to Extranetnews.com, [10] an online publication that tracks these types of services. Of these, 82 only focus on the AEC industry.

As the CPE market continues to change and evolve, there are many ongoing discussions about its future. One school of thought holds that Extranet applications themselves are disappearing as singular offerings, and are being blended in as features of existing applications to create larger, more comprehensive offerings. Others believe that the path of consolidation among the current surviving products (e.g. Bricsnet, E-Builder, Constructware, Buzzsaw and others) will continue until a few key players share the entire market. The future actually may be in some combination of both of these scenarios. For example, eRoom, which was founded in 1996, launched its first product in 1997. It was then purchased in December 2002 by Documentum to be the web-based collaboration component of its heretofore enterprise-oriented document management offering. That aspect made Documentum even more attractive as an acquisition for EMC, which purchased them in October 2003. [11]

However the CPE market has always been a fast changing environment, so predictions are tenuous at best. Much of the future direction for this technology will hinge on its successful and widespread adoption by AEC firms, a group not traditionally known for leadership in adopting advanced technologies. The next section of this paper will examine the history and dynamics of CPE adoption thus far.

5 The reasons for slow adoption of cpe solutions

As a whole IT is advancing at a faster rate than any other area of technology and it is increasingly pervasive in its influence over work practices. IT will continue to be predominant agents of change within the AEC industry. [12] The primary uses of computers in the construction industry have been shifting, over the past four decades, from the evaluation of proposed design solutions, to their graphical (and other) representation, and more recently to facilitating collaboration among the various professionals who are involved in the design process. [13] Although the AEC industry is often described as a laggard industry in adopting new products, processes, and technologies, it is heavily information based, and IT offers great potential for improving management practices, communication, and overall productivity of the industry.

There have been a number of surveys about new technology usage in the construction, which gives us some indications regarding the adoption[7] behavior of the industry. Although many of these surveys show very clearly that Internet connectivity and the general use of email and the World Wide Web is already very high in the industry, many other studies demonstrated that new technologies are adopted slowly and ineffectively in AEC industry. [15] Being in the market for almost four decades, 2D Computer-Aided-Design (CAD) is now pervasive. 3D CAD is a well-established technology that is beginning to enter mainstream use. 4D CAD, an incorporation of 3D CAD and time, has started to be used by the innovators of the industry.

Although CAD had been in use by architects since 1975, the real diffusion process didn't start until a decade later. Similar to CAD adoption, which took almost 25 years to be commonly adopted, the CPE adoption has also slow. Adoption of new technology among AEC firms appears to have lagged behind adoption among large manufacturing firms by 3 to 5

---

7. Adoption is the process by which an individual or organization identifies and implements a new technoloy. [14]
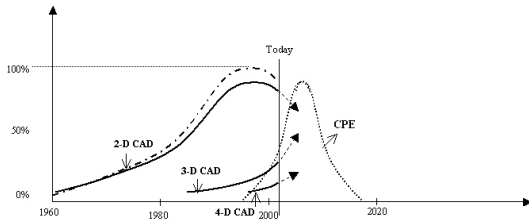
Figure 4. AEC Industry's Adoption Cycles for Different Technologies[8]

years for a comparable stage of adoption. [16] There was early reluctance to adopt and then use CAD, which was available at least 10 years before real adoption occurred and several years after engineering firms made similar moves. In other words, a "rapid shift" is not occurring in terms of new technology adoption in AEC industry. It might also be argued that the technology being adopted was not superior to "present" practice at that time. However there are many reasons for this slow adoption patterns in both CAD and CPE technology.

Despite the obvious benefits and explosive growth of Internet usage in many areas of business, the AEC industry has not completely realized the benefits of web-based project management and collaboration technology. Due to the lack of a single dominant system provider (such as AutoDesk for CAD system) it is difficult to find out the overall picture from figures provided by ASP providers, since each of them tend to have only small market shares. However, many if not most, CPE start ups servicing the AEC industry go out of business as a result of slow adoption rates, even though many can offer demonstrative benefits to AEC industry in terms of cost, time, quality or/and safety. Those that survive suffer from poor adoption even though some innovative technology has proven to add significant measurable value to the AEC industry. [17] AEC industry professionals have been reluctant to change their traditional way of working to accommodate and integrate these new tools in general. Although CPE tools had been available for

several years and were being aggressively marketed, only 40% of General Contractors had tried project collaboration software by late 2001, [18] according to the Construction Financial Management Association's 2002 IT survey for the AEC industry.

Unfortunately, little research to date has investigated the reasons why the AEC industry adopts new technologies slowly, nor the mechanisms involved. There are many factors that contributed to this slow adoption of CPEs that are addressed in the following section, ranging from vendor behaviors, to media hype, and to customer cultural barriers.

5.1 The Dot.com Implosion

A major factor was the remarkably rapid rise and fall of the widely publicized dot-com "New Economy", and the resulting slowdown in all types of web-based software deployment. A major concern for many projects considering using the technology is the long-term reliability of third party services. This is a very volatile market where the turnover of service providers has been very fast. [19] After the flow of investment capital into all kinds of Internet companies dramatically dried up in April 2000, many formerly high-flying companies that had once loudly proclaimed their "industry-leading solutions" went out of business abruptly, often leaving customers with no access to their data. It became easy for AEC companies to view the entire group of web-based offerings for their industry as part of a dying fad which had no real value, and to dismiss remaining survivors as merely "circling the drain" before their inevitable extinction.

5.2 Clicks Meet Bricks

Contributing to this resistance from AEC customers was the fact that many of the start-up vendors of new solutions were young, technology-oriented entrepreneurs with limited experience in the AEC

---

8. Adopted from CIFE Seed Proposal: "Bridging the Innovation Gap in the AEC Industry; Investigation of the adoption of 2-D, 3-D & 4-D CAD tools"

industry. They were pursuing what appeared to be a perfect market for Internet-driven efficiencies: very large but fragmented, multi-firm project-oriented, and information-intensive. They expected AEC customers to immediately embrace their long lists of theoretical benefits and take a leap of faith in the same direction that every other major industry seemed to be heading.

The AEC industry was a famously rapid adopter of both fax and cell phone technologies, but each of those is an easily understandable and very tangible tool that integrates non-disruptively into existing workflows, requires minimal infrastructure upgrade and provides obvious and immediate benefits.

What many of the new Internet vendors lacked was a crucial understanding of the time-tested and industry-accepted workflows and relationships that actually drive the AEC industry. As a result they were unable to develop compelling real-world value propositions to justify the expense, disruption and difficulty of implementation and integration that their tools would require.

5.3 Bleeding Edge Promises

Another factor was the over-enthusiasm of many of the vendor companies, which were on a mission to radically transform the entire global construction industry overnight through technology. The industry was fascinated by business-to-business (B2B) ideas where supplies and buyers find each other such as amazon.com, ebay.com. The resulting technology overload actually backfired, and probably contributed to the market resistance to their solutions. The target users simply were not ready to absorb the technology that the vendors were promoting.

The failure of many of these companies is due to the overoptimistic business plans they were based on, both concerning the growth of use of such services and the price levels it would be possible to charge for the services. [19] One example of this is

Buzzsaw, which spun out of AutoDesk and became an independent company in November 1999 with a very broad mission of project communication, project management, procurement, e-commerce, and online catalogues and specifications of building components. [20] The company realized that although their whole mission was a very valid one, they would have to break it into phases based on the functions and features that customers were ready to absorb. Buzzsaw's wide offering was just way ahead of what the end users' ability was to digest it. This re-thinking of their approach to the market, coupled with the scarcity of investment funding resulted in Buzzsaw being reacquired by AutoDesk in 2001. AutoDesk successfully achieved the first step of the mission, which was providing easy-to-use project websites with appropriate tools to securely track information on a project.

There are numerous other examples of companies that sought to capture and manage the huge amount of procurement activity in the industry. Although estimates vary, it is widely believed that total, worldwide construction industry purchases exceed $3 trillion annually. Many vendors tried to emulate web-based advances in Supply Chain Management for manufacturing industries by creating many-to-many marketplaces or one-to-many, catalog-driven procurement websites for construction. In hindsight it is clear that although the concept is powerful, the scope of such a widespread transformation will require decades of interim steps and incremental changes in business processes to fully realize the vision.

5.4 Marketing

Exacerbating the problem of credibility was the fact that in many cases, marketing was far ahead of actual Technology Development, especially for start-ups. There was a strong sense of urgency to be the first-to-market with a solution, driven by the belief that the adoption would be quick and the customers would be loyal. As a result, tradeshows and publications were

overflowing with promotional efforts by a flood of new and established vendors trying to gain instant mind share and market acceptance for their brands. In reality, good technology takes time to develop, and much of what was being offered was in beta or even alpha modes. In many cases there was no technology at all, but that fact was hidden behind slick marketing packages intended to buy time or attract capital. It was often said at the time that the most popular technology development platform for these new AEC Internet offerings was not Windows or Java, but was PowerPoint.

Unfortunately, once AEC industry professionals began to look under the covers, or to sign up for some of the services, they were often very disappointed with what they experienced. Since bad news spreads ten times faster than good news, this damaged the credibility of the whole group of offerings and slowed adoption in general.

5.5 The Information Superhighway Was Not All Paved

In addition to the vendors' applications not being ready-for-Prime-Time, the underlying technology of the Internet was not mature enough to handle the onslaught of business users, who were expecting the kind of reliable and fast performance they were accustomed to with desktop and client-server solutions. The Internet has only been widely in use for about 10 years, which is a relatively short period of time for a major technology and it is still maturing today with increases in bandwidth and stability. Also, most of the web-based applications available to the AEC industry are far younger than that. So it was unrealistic to expect that an integrated platform of applications and infrastructure would reach maturity in just a few years and be able to take its place as a standard for global business. That day will come, but its absence has contributed to slower adoption.

5.6 The Culture of the Industry

Another cause is the presence of inherent cultural barriers to technology adoption. Many of the decision-makers in organizations that could benefit from these tools don't fully understand the business value of using the technology. On the company/customer level there is often an age barrier, which undermines technology adoption initiatives in many industries, not just AEC. Owners and top management of the larger, industry-leading AEC firms are generally over 45 years old. Although there are a growing number of technology advocates in that group, there is still a large percentage who are either reluctant users of technology in their work, or who have simply avoided dealing with it. For instance, even if their companies have e-mail systems many of these executives have their administrative assistants print them out as if they were letters or faxes, and mark them up manually to be responded to by the same process. These are not likely adopters of web-based technologies, which require both frequent presence online and comfort with invisible transfers of large amounts their companies' valuable information. They will resist change unless they see a clear value and are either personally comfortable with, or directed by a client to make the investment.

There is also a fundamental factor that differs between the management of a business and the management of a design practice, which is the perception of the bottom line. [21] For the businessman the bottom line is quantitative; business success is measured in the amount of money or output. In the creative professions there is a qualitative bottom line: is the output as good as possible? [22] This points out one of the major differences between AEC industry and other industries, which are usually rapid to adopt new technologies, such as manufacturing industry. The failure of CPE vendors to prove the added value in quality of the total outcome also results in the slow adoption of these tools.

5.7 Lack of Education and Training

On a broader industry level there is also a problem of lack of education. Industry associations, technology providers together with academic institutions should take a strong leadership role and actively educate their members who are potential users of these tools in the industry. Industry associations should be advocating adoption of the technologies with a focus on how to use and apply them profitably in the business world. Technology providers should help to promote the vision for their industry instead of trying to sell only the individual applications. And academic institutions should realize the responsibility to teach their students the new technologies and innovative ways to use them.

5.8 The Lack of ROI Statistics

The primary motivator for actors in the AEC industry to adapt new technology innovations will always be the opportunity for direct gains and benefits in their own operations. In order for the actors involved to realize these benefits there must be a framework in place to measure the relevant cost and benefits associated with the investment. [23] The metrics to measure the rather complex causal chain causing the overall cost savings and quality improvements have still only been sketched at, and reliable measurements with large enough data sets to isolate the effects of the learning curve or external factors are missing. [19] Unproven price-to-performance is another issue that prevents new technology adoption. The lack of any quantitative study by an objective party on Return on Investment (ROI) has made it difficult to justify cost/benefit.

5.9 The Potential Impact on Work Processes, Liability, Ownership of Data

There are also a number of issues related to concern about the amount and type of change that adoption of these solutions might cause. Examples include:

- If a new technology is adopted, how will it affect the work processes that each company is already

familiar with, and relies upon for its operation? If the new technology requires new or altered work processes that take more time, add cost or create problems who will be responsible?

- Creating a central online repository where project information can be accessed by many parties raises issues of liability, ownership of information, and changes in the traditional lines of responsibilities. [24]

- Many CPE users are uncomfortable with the unprecedented visibility that many of the tools provide for monitoring team members' performance at various level of detail and tracking each team member's level of participation, by which they are now evaluated.

5.10 Inadequate Implementation

Inadequate planning for, and execution of technology implementation is one of the major causes for unsuccessful CPE experiences. Unfortunately, many of the vendors were focused on development of their tools, and provided little or no support or training for their customers to successfully implement the technology. In fact, a popular misconception of the time was that because a web-based tool requires no resident software to use, then it requires no implementation to make it successful. "Just log-on and go." This created enormous frustration and damaged credibility, which in turn slowed further adoption.

5.11 Team-wide Value Proposition

Many Owners and Contractors are uncomfortable forcing the use of a technology tool onto other members of a project team. The vendors have not done an adequate job in documenting the value proposition for every member of the team. Even if only one member is paying for the use of the tool by the rest of the team, all members need to understand why it benefits them to use it, otherwise utilization is inconsistent and the success is compromised. This "pushback" by companies who are asked to use a CPE

tool continues to be a major retardant to adoption and growth of acceptance. The problem with a CPM system is that successful use requires that all of these adopt the system at the same time. [19]

5.12 Top Management Buy-in

Often, the champion for trying a CPE application in an organization is a Project Manager who recognizes the potential for beneficial process improvements. [25] As mentioned before however, many senior management executives are unaware of, or in some cases biased against Internet technology tools for AEC. This lack of top management support caused many CPE experiments to fail due to lack of resources, weak enforcement of new procedures and unclear expectations. Once an experiment failed, other Project Managers were less likely to try, fearing similar results. Success requires top-down commitment.

5.13 Distribution

Another reason for slow adoption has been specifically related to the lack of effective indirect distribution channels into smaller-sized customers. In order for solutions to become widely accepted, they have to be widely available to all strata of firms in an industry. As with poor implementation support, in many cases most management attention at the vendors was focused on product development, and inadequate attention was paid to developing an effective distribution network if one didn't already exist.

5.14 Too Much Choice

Overall, the industry experienced an avalanche of too many applications, claiming too many un-validated benefits, all competing for attention with tremendous marketing noise, which resulted in overwhelming customer confusion. The predominant approach was to "wait until the winners emerge". And the identity of those winners is still in question.

6 Anticipated future of CPE technology

Web-based project management and collaboration technology holds a great promise and is surely bound to replace "old economy ways", but only if these tools can adequately fulfill the specific needs of building designers, constructors, owners, managers, and suppliers. Today, a significant proportion of all computer applications provide some form of collaborative access even if only through interfaces to other applications. Microsoft has already added collaboration features to Microsoft Project, and launched Office 2003 on 21st of October with inherent collaboration functionality to connect people, information and business processes. [26]

These developments indicate that collaboration is rapidly becoming an integrated part of operating system infrastructure. For example, TeamCenter has been launched into the market based on Microsoft SharePoint [27] because the developers realized that basic collaboration capabilities were really part of operating system infrastructure. Moreover, Microsoft SharePoint, which provides a server to allow teams to create web sites for information sharing and document collaboration, and aims to increase individual and team productivity, is free with Windows 2003. SharePoint supplies web sites with document storage and retrieval check in and check out functionality, version history, and flexible, customizable views. [28] It appears that collaboration is a dominant trend across the technology industry and most of the software vendors see the value of providing collaboration functionality to improve the workflows among project teams.

According to some industry professionals, Extranets have already lost their separate identity. This is analogous to computer graphics, which was once an industry, a market, and even a profession. So instead of Extranets being a new and distinct entity in the computing landscape, the extranet model is merely a new source of business for specialized IT consultants. However, although many construction professionals

expected the number of CPE vendors to collapse radically at the end of the dot.com era, the number of the companies has remained relatively the same. The reasons for that can be traced to both monetary and legal concerns. To shut down may be more expensive than to keep a skeleton version of the product alive. Or the benefits are increasingly being realized and accepted by the industry, so the demand is still growing for CPEs.

The development of the technology is intricate. Therefore, it is difficult to predict the future trends and their impacts to the AEC industry. Although there is still some resistance from industry participants to adopt this technology and change how the work has traditionally been done, CPEs are being accepted and used more widely, and definitely are firmly in the mainstream as a project management and collaboration tool.

Although industry experts share the opinion that CPEs will be the dominant platform to manage and control projects and facilitate communication and collaboration in the future, opinions regarding the application of these tools vary. Some think that these extranet companies will disappear eventually and collaboration will become a part of operating system infrastructure. According to Joel Orr, Editor of Online Journal; Extranet News, the companies that have the highest likelihood of success are smaller firms that:

- Remained vigilant about staying profitable rather than investing in an extensive array of features and functions,
- Focused strongly on a defined market niche,
- Are supported by another range of products like Primavera or AutoDesk.

Generally, almost all industry experts agree that the future is bright. It is very clear based on the growing interest by so many large, prominent firms that CPEs will permanently change the way work is done in the construction industry. Much the way that e-mail became a widely accepted work tool; at some point in the future web-based communication and collaboration will be the accepted, standard way to manage construction projects.

According to Amar Hanspal, Senior Manager of Buzzsaw, in the future there will be three types of approaches will be left:

- Some very generic systems such as Microsoft SharePoint will be used in every industry whether it is legal, construction, finance or health industry. Utilization of this type of tools will be similar to Microsoft Excel or Word,
- The CPE market will be dominated by some of the companies with strong backgrounds, which would offer AEC specific services,
- At the high end, some systems such as Oracle, SAP would be taken and customized as project management systems by some large companies such as Shell Oil with very large IT staff, as generic solutions will be so basic and AEC specific solutions will be so broad for them.

As with all new, widely publicized and cutting-edge technology innovations, there is a predictable adoption curve of emerging technologies. The US research firm and technology industry analyst, The Gartner Group refer this as The Hype Cycle. It was introduced by Jackie Fenn of Gartner Group, in a July 1995 report about Windows 95 titled The Microsoft System Software Hype Cycle Strikes Again. [29]

Gartner's Hype Cycle tracks a five-part process through which all technology innovations pass:

- **Technology trigger:** In the case of CPEs this stage would be the initial launches by the early pioneers and the subsequent interest expressed by AEC firms in the potential benefits of the technology.
- **Peak of inflated expectations:** For CPE's this was the Explosion period, concentrated in 2000, where hundreds of product offerings were being marketed feverishly, though very few were backed up by real technology. The only enterprises making money at this stage were conference organizers and magazine publishers
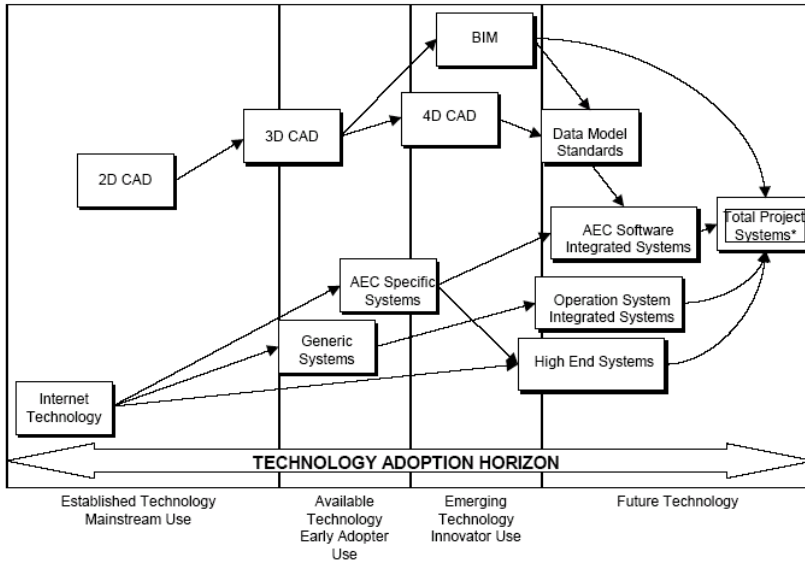
Figure 5. Trends of use of IT in AEC Industry[9]

• **Trough of disillusionment:** This followed the Explosion phase, when savvy AEC professionals realized that there was more hype than substance in the claims of the solutions. CPE technology became unfashionable and the press abandoned the topic, because the technology did not live up to its over-inflated expectations.

• **Slope of enlightenment:** This represents the phase CPE technology is in today, where successful implementations by an increasing number of organizations is leading to a better understanding of the technology's applicability, risks and benefits.

• **Plateau of productivity:** This is the coming future state of the CPE industry, where the e real-world benefits of the technology can be measured and are widely accepted.

In fact, the adoption may be faster in developing countries, where geographic constraints will drive the change in behavior more rapidly, because there will be no choice other than collaboration to complete projects efficiently. Examples could be an American firm building infrastructure in India, or a French company trying to do business in China. The future is inevitable, however the question is: are we going to wait for the next generation or try to hasten the process and eliminate the inefficiencies as soon as possible?

So what is next for the CPE industry? There are several ways in which it may develop. One of the themes is interoperability. Even companies wishing to standardize on one tool usually find themselves using many tools to accomplish their work. If the systems were truly interoperable, companies could use their choice of tool in any project. However, interoperability seems a very difficult challenge. Vendor companies have little desire to become interoperable. The value to the customers is obvious but what the value is for the vendors remains undefined. Who will pay for it? What will happen to competitive advantage? Another objective is for these online tools to be designed to allow use of their information in corporations' knowledge management systems, so that even those individuals who didn't work on a particular project can benefit from knowledge gained.

9. Adopted from: "Interwoven Threads: Trends in the Use of Information Technologies for the Construction Industry", prepared for the Berkely-Stanford CE&M Workshop, Thomas Froese, Associate Professor, Department of Civil Engineering, University of British Columbia, 1999
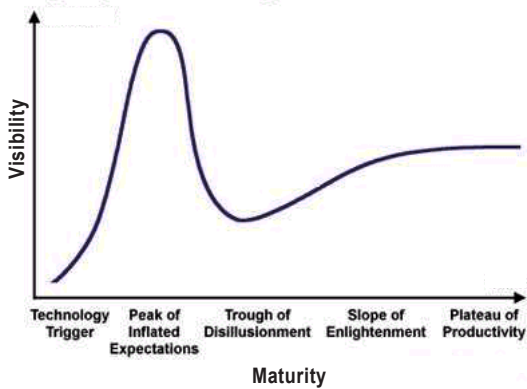
Figure 6. Hype Cycle of Emerging Technology

This technology has a lot of potential for the near term. It has to be rethought as we move to towards intelligent data structures. Current available CPE solutions are now very document oriented, which lead the industry to move from paper to electronic. In fact, they clearly demonstrated the industry could gain efficiencies there, however they need more intelligent workflow to survive in the future.

7 Conclusion

The most important problems are organizational and physiological. The nature of the AEC industry is unique among other major, global industries. Although there are always a few early adopters and visionaries, the sector is usually slow to adopt most new technologies. The current slow economic climate in the AEC industry is certainly contributing to retarding adoption but the largest factor lies in the culture of dynamics in the industry itself. Unlike the manufacturing industry, where there is a centralized concentration of power and influence on the supply chain by the leading companies, the AEC industry is more fluid, and project based. Relationships are more temporary and consultative in nature. And the industry consists of many players with different organizational cultures and objectives. There are liability and power issues, which engender skepticism and limit the use of technology to creating electronic paper, but nothing more.

As cultural barriers are slowly broken down, the industry will realize that CPE technology is not driving revolution, but more evolution, and the adoption will increase. Ultimately it will reach the Plateau of Productivity and become mainstream. Although there have been some initial efforts to study ROI, there are no valid results available today to spur industry leaders towards faster adoption. A rigorous benchmarking exercise is needed to prove that these tools bring increased efficiency to the entire process of making buildings.

However, the breakdown of cultural barriers will not happen quickly. Attitudes and ways of working established over decades cannot change quickly. Industry associations, technology providers together with academic institutions should take a strong leadership role and actively educate their members who are potential users of these tools in the industry. The vendor companies will resist interoperability because they are focused on a battle for market dominance, both in US and in the overseas markets in which many also operate.

But the future is still bright. These tools are generating benefits for those who use them and the surviving vendors are listening carefully to their customers to drive additional features and functions. Although there are not enough solid ROI figures to quantitatively demonstrate benefits, anecdotal evidence of solid productivity gains and cost reductions is being generated everyday. Building on these small successes the CPE industry will keep moving forward to drive better communication, increased productivity, and higher quality in buildings.

Acknowledgements

REFERENCES |

[1] Department of Commerce, Bureau of Economic Analysis' website: http://www.census.gov/econ/census02/advance/TABLE1.HTM, accessed on 04/18/2004.

[2] Egan, J.: 'Rethinking Construction, Report of the Construction Task Force on the Scope for Improving the Quality and Efficiency of the UK Construction Industry', Department of Environment, London, 1998, published at http://www.dti.gov.uk/construction/rethink/report/, accessed on 05/09/2004.

[3] Issa, R.R.A., Flood, I., Caglasin, G.: 'A Survey of e-Business Implementation in the US Construction Industry', Edited by Bjork, B., *Journal of Information Technology in Construction,* Vol.8, 2003, pp 15-28

[4] Tuzmen, A.: A Distributed Process Management for Collaborative Building Design, PhD Thesis, Arizona State University, May 2001

[5] GSA's website: http://www.gsa.gov/, accessed on 04/18/2004.

[6] Bakos, J.Y.: 'Information Links and Electronic Marketplaces: The Role of Interorganizational Information Systems in Vertical Markets', *Journal of Management Information Systems,* Vol. 8 No. 2, 1991, pp 31-52

[7] Sturley, R.: "Project Extranets Explained", *The Architect's Journal,* published http://www.ajplus.co.uk/proj_collaboration/?ChannelID=28 on 01/03/2003, accessed on 01/15/2004.

[8] Hills, M.: Intranet Business Strategies, Wiley Computing Publishing, New York, 1997

[9] Callaghan, J.: Inside Intranets and Extranets: Knowledge Management and the Struggle for Power, Palgrave, Hampshire, New York, 2002

[10] Extranet News' website: www.extranetnews.com, Online Journal, accessed on 05/13/2004.

[11] Documentum Press Release: published at http://www.documentum.com/news/announcements/emc.htm, accessed on 11/10/2003.

[12] Froese, T.: 'Interwoven Threads: Trends in the Use of Information Technologies for the Construction Industry', prepared for the Berkeley-Stanford CE&M Workshop, University of British Columbia, Department of Civil Engineering, 1999

[13] Kalay, Y.E.: 'The Future of CAAD: From Computer-Aided Design to Computer-Aided Collaboration", *CAAD Futures '99,* Atlanta, GA, 1999

[14] Rogers, E. M.: Communication of Innovations: A Cross Cultural Approach, Free Press, New York, 1971 [15] Lillrank, P.: 'The Transfer of Management Innovations from Japan', *Organization Studies,* published at http://static.highbeam.com/o/organizationstudies/ on 02/05/1996, accessed on 05/11/2004.

[15] Lillrank, P.: 'The Transfer of Management Innovations from Japan', *Organizations Studies,* published at http://static.highbeam.com/o/organizationstudies/ on 02/05/1996, accessed on 05/11/2004 at 12:32 PM

[16] Boström, G.-O.: " CAD and Consequences in the Swedish Architectural industry", *Services Marketing Quarterly,* 2003, Vol. 25, Num. 2, pp 25-41

[17] Taylor, J, and Björnsson, H.: 'Identification and Classification of Value-drivers for a New Homebuilding Supply Chain', *Proceedings of the Tenth Annual Conference of the International Group for Lean Construction IGLC-10,* 2002, pp 1-12

[18] CFMA's 2002 Information Technology Survey for the Construction Industry: Construction Financial Management Association, IT Survey 2002

[19] Bjork, B.: 'Electronic Document Management in Construction Research Issues and Results', Edited by Turk, Z., *Journal of Information Technology in Construction,* 2003, Vol. 8, pp 105-117

[20] Interview with Amar Hanspal, Senior Director, AutoDesk, Buzzsaw: published at http://usa.autodesk.com/adsk/servlet/index?siteID=123112&id=2407898, accessed on 10/09/2003.

[21] Coxe, W.: Managing Architectural and Engineering Practice, Van Nostrand Reinhold Company, New York, 1980

[22] Boström, G.-O.: 'Information Technology Adoption Affects Management Paradigm, The Case of CAD and Swedish Architectural Firms', *Vildmarkskonferensen, Industriell och teknisk förändring, Nordisk workshop för ny forskning inom teknikstudier, innovationsekonomi och forskningspolitik,* 24 – 26 November 1999

[23] Svavarsson, D, Björnsson, H, Ekström, M, and Bergendahl, G.: 'Evaluating IT Investments in the AEC Industry', *Ninth European Conference on Information Technology Evaluation,* Université Paris-Dauphine, 15-16 July 2002, France

[24] Dogramaci, O., Gangopadhyay, A., Yesha, Y.: Electronic Commerce: Technical, Business, and Legal Issues, Edited by Adam, N.R., IBM Canada Laboratory Centre for Advanced Studies Prentice Hall PTR, September 1998

[25] Castle, C.M.: 'Construction Project Networks: A Study of Internet-based Interorganizational Information Systems In the Building Industry', Doctoral Dissertation, Harvard University, Graduate School of Design, 1999

[26] Collaborate with Office 2003 Editions and Windows SharePoint Services, published at http://www.microsoft.com/office/editions/prodinfo/technologies/sharepoint.mspx on 08/15/2003, accessed 01/15/2004.

[27] Orr, J: 'Serious Manufacturing Collaboration: EDC TeamCenter Community', *Extranet News,* published at http://www.extranetnews.com/ on 10/06/2003, accessed on 01/15/2004.

[28] Microsoft's website: http://www.microsoft.com/sharepoint/, accessed on 01/15/2004.

[29] Fenn, J.: The Microsoft System Software Hype Cycle Strikes Again, Gartner Group, July 1995