Communication and Information Technology in Construction Management: Are Corporate Owners of Real Estate Focusing on Technology to Speed the Delivery of Buildings?

by

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ABSTRACT

An exploratory study was conducted to determine the importance of communication and information technology in speeding the construction of buildings. Five corporate owners of real estate were interviewed with the purpose of determining their needs and priorities as related to managing their construction projects, and whether communication and information technology had a role in addressing these needs. The hypothesis tested was that communication and information technology could be used to construct buildings faster.

Research results showed that, among the five companies studied, there was not proof to support a definitive conclusion. Among the five companies, speed in construction was a common goal. However, four of the five companies were concentrating their efforts on people issues such as accountability rather than on information technology issues. Organizational issues such as ownership of processes seemed more important than speedy exchange of information. Research explored issues of accountability that arose in each of the case studies, and explored the emphasis of one of the five companies on technology to speed the delivery of buildings.

Analysis of the cases showed a common priority of accountability, in varied states, among the companies. Included in the analysis is an examination of a relevant paper by John D. Macomber entitled, Beyond Fast-Track: Next Steps in Speed. It was presented at Harvard University on June 25, 1998 as part of the IDRC Executive Symposium: Infrastructure Challenges for Fast-Growth Companies. The premise of the paper is that corporate owners of real estate should be looking to information technology as a tool for dealing successfully with compressed project schedules. In particular, the paper speculates that use of Web based project communication systems would improve accountability among project team members. By providing greater information access, organization and accountability the delivery of buildings would be accelerated. The relevance of Macomber's premise to the five companies studied is discussed, and an analysis and comparison of the major ideas identified in the paper with the issues that arose in the case studies is presented.

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Introduction and Methodology

The subject of my research was communication and information technology (I/T) in construction management. I was particularly interested in whether corporate owners of real estate were focused on technology as a way to speed the construction process and deliver buildings faster.

Construction management is a complex endeavor that involves many separate entities that are brought together to form a project team. Entities such as architects, designers, engineers, contractors, sub-contractors, consultants, owners and internal customers (end users of the building) must work together to complete a project. A huge volume of information flows through this complex value chain, and in order for the speedy completion of a building to occur, information must be exchanged efficiently. The critical path of execution in the construction of a building is reliant upon the transfer of information. Therefore, how quickly crucial information is exchanged among the members of a project team will come to bear on how quickly the project is completed.

My study examined five corporate owners of real estate with the purpose of determining their needs and priorities as related to managing their construction projects, and whether communication and information technology had a role in addressing needs. The hypothesis tested was that communication and information technology could be used to construct buildings faster. I was interested in discovering how important speed was to corporate owners in delivering buildings—it was very important. Once the importance of speed was established, my research attempted to discover where companies were focusing their efforts to accomplish greater speed. In addition to speed, other priorities in achieving more efficient management of construction projects emerged in my research, and these were explored.

The five companies included in the study were State Street Corporation and Fidelity Investments, both financial services companies; Reebok International, a manufacturer and marketer of athletic shoes and apparel; Genzyme Corporation, a biotechnology company; and Children’s Hospital. Research primarily consisted of interviews with top-level managers in the facilities groups of the participating companies. Interviews were organized broadly into categories designed to discover: (1) The way in which each corporate real estate group was organized. (2) The internal customers’ needs. (3) The way that the facilities groups managed their architects and general contractors—who communicates with whom, and how do they communicate. (4) What communication and information technologies were being used in construction management, and were they effective. Also, what information technologies did the facilities groups think would be beneficial in improving efficiency and speed in construction management.

Results were interesting, if not totally expected. Since my methodology was exploratory, I wanted to allow emerging issues the necessary room to emerge, and I believe I was successful. The study has provided a first look into the needs of corporate owners of real estate, particularly as those needs relate to achieving efficiencies in construction management. As information technology has become more and more pervasive in other industries, it has begun to make inroads in construction management—yet it is just the beginning. The five companies in my study were most definitely using information technology in construction management—from voice mail to e-mail to more sophisticated on-line systems for project management. The
research results suggest however, that in four of the five companies, information technology was not the primary focus to improve speed and efficiency in construction. Instead, the companies were concentrating their efforts on people issues such as accountability and motivation. Analysis of the research explores emerging issues and priorities in improving construction efficiencies among the five companies, and suggests where these priorities might dovetail with the potential benefits of information technology.
Literature Review

The subject of my research was very new, and therefore there was not much relevant literature available. I searched ABI for literature on technology in construction management and found hundreds of entries that turned out to be about computer aided design tools. There were not any significant publications on the subject of communication or information technology as applied to construction management.

Literature on project communications published by the Construction Industry Institute was helpful in identifying and exploring the crucial importance of communications among project team members. Studies found that the flow of information among project teams bore directly on the success of a project. (A successful project was defined as one that was brought in on time, on budget and with technical accuracy). The literature provided methods for assessing and improving project team communications generally related to partnering models. These readings were instructive in providing the most current research on improving project communications through organizational models that addressed alignment of interests. The readings did not deal specifically with information technology as a tool for improving project communications.

A Harvard Business School case study entitled, George B. H. Macomber Company: 1990, was helpful in providing a sense of the fragmentation of the construction industry and the consequent inefficiencies in communications. Although the case was more specifically about construction estimating it provided a good general overview of the difficult nature of information exchange in construction management.

An article from Harvard Business Review entitled You Can Manage Construction Risks, by John D. Macomber, was helpful in providing general information about project risks from the standpoint of an owner. This article was useful in developing interview questions since it provided insight into owners’ concerns in undertaking construction projects. Sections on Matching Risks with Capabilities and Building a Construction Team, and Picking the Right Kind of Contract were particularly instructive.

A paper by John D. Macomber entitled Beyond Fast-Track: Next Steps in Speed presented at Harvard University to the IDRC Executive Symposium on Infrastructure Challenges for Fast-Growth Companies was instructive in providing a framework for analyzing specific applications of communication technology in construction management. It also examined ways in which business and organizational models might adapt and improve given more technologically advanced project teams.

Methodological literature consisted of an excellent article by Kathleen M. Eisenhardt entitled Building Theories from Case Study Research, and a book by Earl Babbie entitled The Practice of Social Research. These were useful in terms of learning concrete methods for conducting exploratory research and presenting results. Eisenhardt’s article in particular was insightful in stepping the researcher through the process of developing theories from the analysis of qualitative data.
Robert J. Thomas’ book entitled *What Machines Can’t Do* provided general background on technology and its implications for improving business processes. Although this book did not deal with the construction industry specifically, it was nonetheless good background reading on expectations for and impact of technology in general.

Finally, Jerry Adler’s book entitled *High Rise*, about the construction of a skyscraper in Manhattan, provided an excellent insider’s look at a construction project and the doings of its team members.
State Street Corporation
Interview with Mary Ann Marino, Senior Vice President of Planning and Development
North Quincy, Massachusetts

June 9, 1998

State Street Corporation was a financial services company with 16,000 employees. Real estate projects were internally financed.

The Facilities Team
The Facilities Management Group consisted of approximately 55 people in five sub-groups (business units). The heads of each sub-group reported to the head of facilities management who reported to State Street’s chairman. Following is a summary of the five groups and their primary functions:

Corporate Insurance
- Negotiated and secured all corporate insurance coverage for State Street – both domestic and international
- Evaluated exposures working with business units and consultants
- Acted as a liaison between the bank and the insurance marketplace

Finance
- Prepared annual capital budget
- Managed accounts payable (included paying architects, contractors, etc.)
- Performed landlord allowance tracking
- Performed construction accounting
- Produced financial analyses

Procurement
- Purchased all goods and services ranging from corporate computers to paper

Security and Support Services
Security
- Managed security guard services
- Provided investigative services
- Performed background/due diligence investigations for new hires, also for joint ventures, partners, suppliers, etc.
- Managed physical security design, development and installation
- Monitored safety and access

Support
- Managed document technology and delivery
- Managed courier services
- Managed leased vehicles and garage administration
- Managed mail room
- Managed Receiving
Planning and Development/Consulting Services
The planning and development/consulting services group managed State Street’s construction and renovation projects as well as leasing of space. This group was divided into three areas of responsibility: project services, consulting services and property services. These three subgroups were responsible for different functions related to State Street’s real estate holdings. Real estate holdings consisting of the following:

- State Street’s total occupied space was 4,283,553 square feet
- 2,800,613 square feet of the total occupied space was managed by State Street’s property services group
- There were locations in 16 states and 19 countries

Project Services performed the following functions:
- Construction management
- Engineering design
- Data center support
- Environmental control
- Design
- Furnishings acquisitions
- Capacity planning
- Signage
- Artwork

Consulting Services performed the following functions:
- Site selection
- Space acquisition/disposition
- Lease negotiations
- Consulting on design, construction and property issues for international locations
- Travel, food service, contract compliance, business recovery

Property Services performed the following functions:
- Property management
- Relocations
- Safety and regulatory compliance for owned/leased properties

Planning and Development
Since this group was responsible for the construction and renovation of space, research for this paper was focused on their activities.

Consulting Services: The consulting services side of the group had a total of four people each of whom was in charge of specific business areas: The employee services manager was in charge of travel, food service and the corporate card. The contract administrator was in charge of contract administration and special projects (e.g. administering contracts with general contractors and others, Y2K coordination and strategic planning.) The leasing services manager was in charge of domestic leasing services including the acquisition and disposition of space. Finally, the
international services manager was in charge of international real estate. He managed everything from leasing space to completing fit-out work. He had one staff member on site in Europe and one scheduled to be located in the Pacific Rim.

The international services manager was an Australian national with a finance background. His office was located in State Street’s Quincy, Massachusetts campus. He was viewed to be especially well suited to his position since he had worked for State Street in Australia, and was therefore able to access his own first-hand perspective of the needs of overseas employees. This was advantageous both for State Street’s internal customers and facilities managers. His role was to work with internal customers to evaluate space needs and to follow through on needs by either procurement or disposition of space. He also managed the selection process for architects, engineers and contractors.

**Project Services:** The project services side of the group had *three project executives* each of whom headed a *partnership group*. State Street had begun an initiative to integrate the design and construction groups, the ultimate result of which would be to have one person responsible for a project from start to finish. Currently, these three senior level project executives were also functional managers in specific areas of expertise. For example, one project executive was the functional manager for design. In addition to her work on her assigned construction projects, she advised other project executives and partnerships on design issues. Another project executive was also the functional manager for property services, capacity planning and artwork, and the third project executive was the functional manager for construction, engineering and data centers. State Street’s engineers reported to the functional manager for engineering (there were two mechanical engineers and one electrical engineer on staff.)

Each of the three project executives headed a partnership group consisting of construction managers, project managers and design coordinators reporting to him or her. There were six employees in each of the three partnership groups. Each of the partnership groups worked on specific facilities projects for specific customers. Ultimately, Mary Ann Marino foresaw the elimination of the distinction between construction managers and project managers in favor of a single position that would incorporate both roles. This would further advance State Street’s goal of causing one person to *own* a project from start to finish – of having each person be responsible for a fewer number of projects, but for more areas within each project.

**Facilities and Internal Customers**
State Street occupied a total of 4,435,748 square feet of space of which 1,640,438 square feet was owned, 2,051,934 was leased in the USA, and 743,376 was located in foreign countries. They managed 3,197,470 square feet of the total amount. Building locations were in 18 states and 20 countries.

Construction projects were primarily renovations rather than new buildings. Leasehold renovations for 1999 were projected to be at $100 million. State Street’s buildings were used almost exclusively as offices with the exception of two data centers, one in Westborough, Massachusetts and the other in Quincy, Massachusetts. A third data center was currently under construction in Kansas City, Missouri.
Special internal customer requirements included heavy electrical usage measured in watts per square foot, heavy cooling needs and other infrastructure items. Space also had to comply with the company’s open office policy that required buildings to have more workstations and fewer offices. Vice presidents with more than ten direct reports had offices; all others had workstations. The reasons for this policy were (1) to focus on a team environment with more open space, (2) to allow more natural light into interiors, (3) to allow more flexibility and ease in changing space configurations for alternative uses, and (4) to minimize build-out expense.

A Typical Project
A typical project for State Street’s facilities team was the renovation of domestic office space. At the start of a project, the State Street project manager who was assigned to the project would interact with the internal customer to define the customer’s needs. The project manager would then select and hire an architect, and interact with, as well as supervise the architect throughout the project’s life. The State Street construction manager who was assigned to the project would select a general contractor or construction manager and interact with, as well as supervise the general contractor throughout the project’s life. In some cases, jobs were put out to bid for general contractor selection.

Currently the project manager and construction manager had separate responsibilities. State Street was attempting to integrate these functions so that one person would stick with each project from start to finish. Engineers for projects were sometimes hired by State Street and sometimes hired by the general contractor. Project teams were well organized and there was good communication throughout the process of conducting renovations.

The type of contract used was varied, but generally State Street used a guaranteed maximum price (GMP) contract. GMP contracts allowed the general contractor to get involved in the project earlier (i.e. before a full set of project documents was completed.) Early involvement of the general contractor helped to collapse the time line for project completion—always a priority.

Communication
Communication among project team members took place in weekly project meetings attended by internal customers, project manager, architect, construction manager, security and I/T people. Meeting notes were published and distributed to all team members and to Mary Ann Marino. There were also weekly construction meetings attended by State Street’s construction manager, the general contractor, architect and engineers. State Street’s project manager had recently begun to attend these meetings, to learn more about the construction area, in anticipation of the initiative to merge project management and construction management into one job. Meeting notes were published and distributed to all team members.

Project vendors were on-line so meeting notes were sent via e-mail. State Street was working on creating a system that would incorporate a project schedule statement into the meeting minutes detailing project progress and budget.

Generally, more communication problems occurred during the phase of initiating and getting a project underway than during the course of construction. Once a project was underway it usually
moved toward completion on schedule and with only minor problems. State Street had rarely missed a move-in date.

The problems at the initial stage of a project centered on the fact that no one person took ownership of a project. The design people worked with the customers and developed a project schedule. Then if there were delays by the internal customer, the design people would simply shorten that schedule. Finally, when the design team handed the project over to the construction team, the construction team had to get up to speed. The fact that there was no one person managing the project from start to finish caused inefficiencies.

State Street was moving toward having the three project executives take ownership of projects that belonged to their assigned internal customers. It was expected that project executives would then drive to adhere to scheduled completion dates and budgets. Before this initiative, it was unclear who owned projects.

Another example of State Street’s effort to reorganize in order to consolidate responsibility was in the leasing area. In the past, leasing led the charge on projects in the sense that project team members would wait for the leasing manager to say that the deal was done before moving forward. The leasing manager was not really responsible for starting the project rolling — yet others believed that he had a kind of de facto authority. Consequently, project teams waited for the leasing manager’s signal to begin work and nobody really had responsibility for moving a project to the starting line. State Street’s reorganization redefined the leasing manager’s role as that of a consultant to the project teams. Project managers now came to the leasing manager and said, “my internal customers need space.” Project managers controlled the process and were responsible for getting projects off the ground. The leasing manager acted as a consultant, remaining in the loop, but taking direction from the project team. The effect of this reorganization was to shift the responsibility for a project from the leasing manager, to the people who actually worked with the internal customers.

Currently, there were 164 projects greater than $20,000 and 75 projects less than $20,000 underway at various stages of completion. Prior to the reorganization, the project executive who was the functional manager for construction would have been responsible for all of these projects. Now, each of the three project executives was responsible for 1/3 of the large projects and 1/3 of the small projects. Project executives had kept the dual roles of functional managers in their areas of expertise. The project executive who was also the functional manager for design might still sit in on a design meeting or review design plans. The net result of the reorganization was that each project executive had greater focus on a fewer number of projects, and yet still had time to provide functional management of an area. The new organization was designed to reduce the number of times responsibilities were handed off, and to create ownership of projects. The reorganization had been extremely effective in reducing the frequency of communication breakdowns.

**Information Technology**
The State Street facilities team used e-mail and Firstline, project management database and communication software. They were satisfied with e-mail but were still uncertain about the benefits of FirstLine due to some internal systems issues.
FirstLine was being used on a project to build 400,000 square feet of new space at Lafayette Corporate Center in Boston. Problems with FirstLine were restricted to slowness of the system in accessing data.

FirstLine was installed with the expectation that it would facilitate communication among a larger than usual project team. State Street was leasing the land at Lafayette Corporate Center. Project team members were meeting with both the developer and the base-building architect. State Street was building a joint cafeteria with an external customer that was going to occupy space in Lafayette Center. In addition, internal customers wanted to make this project an image statement for the company so they needed to have a lot of input into the building’s design.

State Street was holding partnering sessions for project teams for both the new data center and for Lafayette Center. An outside consultant conducted these sessions. The sessions’ purpose was to cause all project team members to make a commitment to each other and to the project’s success. State Street was satisfied with the results of the sessions and was recently recognized by IFMA for their efforts in this area.

**Improving Project Communication: Back to the Organizational Chart**

There had been some problems sending and receiving plans to project team members via e-mail. People preferred looking at actual documents rather than electronic document images. Reliance on weekly project and construction meetings emphasized this preference. Overall, Mary Ann Marino was satisfied with effectiveness of project communication. She felt that there was always room for improvement, but that gains in this area would come from going back to the organizational chart rather than from new technologies. The priority was to get *one* person focused on an *entire process* as much as possible. Marino expected that this, more than anything else would improve project communication.

There was one area where State Street’s project-related IT was lacking. This was the area of project authorization. Authorization to proceed with a new project had to be obtained from the highest level within the relevant business unit, then from the head of facilities, and then from myriad people depending on project scope, right up to State Street’s chairman. A form 1260, *Customer Request for Work*, had to be completed in order to procure all of the signatures for approval. This form included an estimate of project expenses among other details. It was considered to be an awkward, cumbersome form requiring various attachments that were frequently lost during the rounds of signature procurement. Communication breakdowns in this area were troublesome because they would give rise to questions such as, “Do we have authorization to proceed with a project before we spend $20,000 in design fees?” State Street was in the process of trying to automate this function. They had hired a technology consultant to develop an application based on Lotus Notes that would have Web capabilities. The new system will automate the financial justification and approval process for acquiring and fitting out space.

When asked if State Street would benefit from a Web based technology to share project documents and communication, Mary Ann Marino thought that although it might be useful she was not certain exactly what it would accomplish at this time. She thought that this was a technology that State Street would need to explore further in 1999. She believed it was a good
idea not to have too many new systems brought on board at the same time. The financial justification and approval system was a big technology initiative for State Street. Marino believed that simultaneously adding other technology initiatives would dilute this project.
Reebok International Limited
Interview with Douglas W. Noonan, Director of Corporate Real Estate/Facilities
Stoughton, Massachusetts

June 4, 1998

Reebok was an athletic shoe and apparel design and manufacturing company and had 1,200 employees working in their corporate offices in Stoughton, Massachusetts. The current office building was 375,000 square feet. They also occupied three warehouses totaling 1.1 million square feet located in Stoughton and Avon Massachusetts, and Memphis, Tennessee. Reebok was building a new 460,000 square foot corporate headquarters currently under construction. They were also building a new 650,000 square foot warehouse in Holland. In addition to these properties, Reebok’s real estate portfolio included nine domestic sales offices at 12,000 square feet each, and several international properties for which there were not any square footage figures available.

The Facilities Team
The facilities team consisted of six people: (1) The Director of Corporate Real Estate/ Facilities (Doug Noonan) and (2) his administrative assistant, (3) a Capital Projects Space Planner who was an architect by training, (4) his assistant who handled moves and furniture orders, (5) a Facility Manager, and (6) a maintenance person.

Responsibilities were divided on a project basis into two general categories: (1) physical buildings and operations, and (2) space design and furniture planning and moving. The division of labor was informal with people contributing according to their expertise. There was a sharing of skills and roles.

Doug Noonan was an engineer by training. At Reebok, he handled a broad range of tasks from financing (e.g. new corporate offices under construction were held under synthetic leases which required his attention to various financial documents) to installing sophisticated engineering equipment in the research center.

Noonan reported to Reebok’s CFO.

Facilities and Internal Customers
Reebok’s primary facilities were corporate offices that also housed R & D and a human performance engineering facility. The need for office space grew and shrank periodically with business cycles. Reebok had developed a strategy for facilities that aimed to build stabilized space that would be flexible enough to accommodate cyclical increases/decreases in the number of employees. Cost control was always a priority, but it was especially so now because of a current period decline in the business cycle. In addition to the corporate offices, Reebok occupied warehouses and satellite sales offices.

The research center (R & D) was where technical designers and engineers operated machinery to cut molds, make outsoles, and produce athletic shoes. It had full shoe making operations including a prototype laser machine.
The human performance facility included a full basketball court with sensors and accelerometers for measuring foot biomechanics. It also had video equipment for observing and evaluating foot and shoe performance.

**Managing the Building Process**

Reebok was actively engaged in building a new corporate headquarters. This was a unique, large-scale project that was, according to Doug Noonan, likely to occur once in a corporate real estate director’s lifetime. Prior to beginning work on the new headquarters, Reebok had been active in renovating the current office space. They were also constructing a new warehouse in Holland.

**A Typical Project:** An internal customer would come to Noonan with a request for additional space, for example for thirty-five customer service people. As a result of consolidating four customer service field offices into two, Reebok was bringing thirty-five people back to headquarters. The process for handling the request for space would move through several stages:

**Stage 1:** Reebok’s project planner would evaluate options for accommodating the internal customer’s space needs and telecommunications needs. In this particular case he chose to locate the new space in the Avon facility.

**Stage 2:** Once this evaluation was complete, an outsource space planner would be hired to provide drawings that would show how people fit into the space. At this stage, Reebok’s assistant project planner would oversee the development and implementation of the final plan.

**Stage 3:** Plans would be completed and agreed, furniture would be purchased and the move would be scheduled.

**A Bigger Typical Project**

In 1996, Reebok completed a $2.5 million renovation to construct a sales/showroom facility at their corporate headquarters. The impetus for the renovation came from Doug Noonan who had learned through informal channels from internal customers, in this case Reebok’s sales people, that they needed a place at headquarters to showcase and sell their products. Noonan was also dissatisfied with the condition of some of the corporate offices and thought that the project could include an efficient renovation of both areas. He convinced Reebok’s head of USA operations to be the internal customer spearheading the project.

A local architect was selected. Noonan and the project planner stayed very involved with the outside designers from the start. They also hired an outside construction manager since they were going to work on two areas of renovation at once and there were time constraints.

The team of owner, construction manager and architect worked together during the course of seven months to renovate 100,000 square feet of space. It was a good process. In this case, the impetus for the project came from internal customers in a very informal way. Noonan listened to the sales people, interpreted their conversations, and came up with ideas to address their needs. The results included an improved building exterior, cleaner interior spaces, new facilities to
showcase and sell products on the fifth floor, and improved office space with higher density capacity. The increased density was important for efficiency, but the challenge for Noonan was to make it work, to give it a good feeling. This was successfully accomplished with additional and improved lighting.

According to Doug Noonan, “Reebok is a young organization so its processes are less formal.” Noonan had 25 years of experience in real estate and facilities management so he was comfortable taking the lead. The project planner was a trained architect so the combination of skills that Noonan (engineer and manager) and the project planner (architect) had was effective in leading Reebok’s real estate plans.

**New Corporate HQ: A Very Big Project**

The new corporate headquarters was the result of the chairman’s vision of a consolidated facility for Reebok. Key priorities for this facility included the creation of flexible, adaptable spaces, providing a showcase for the brand, knocking back heads with a big wow, and becoming a place that provided a memorable experience for customers.

The project got started with anecdotal proposals of information from various people at Reebok to Doug Noonan. For example, Reebok managers proposed a space requirement of 800,000 square feet, a $40 million budget, an 18-month project time frame, and the desire for a new highway interchange. Noonan then brought this information to an architect with the caveat, “program this company.” The architect interviewed Reebok’s business managers to assess their needs. His conclusion was that 800,000 square feet was appropriate for the new facility. Following this study, Reebok reorganized and the need for space decreased, hence the building’s 460,000 square foot actual size.

While the architect was doing the use study, Noonan prepared a reasonable project budget. He included cost comparisons of alternatives. Ultimately, Reebok’s chairman chose the site, and then charged Noonan with the responsibility of finding the set of circumstances that would make sense for this site to be bought. Reebok paid $13.5 million for 42 acres of land, and Noonan moved ahead with plans for constructing the new offices. Total project costs were budgeted at $125 million including the land.

Noonan then conducted two searches, one for an architect and one for a construction manager. For public relations reasons, his priority was to choose local firms, since Reebok was working on gaining economic development subsidies from the state in the form of infrastructure improvements and real estate tax relief.

A local architecture firm was selected and worked on the project for six months to no satisfaction. Communication between the owner and architect was very good during this time. They met weekly, the architects interviewed Reebok business managers for input, but notwithstanding, the design results were unsatisfactory.

Despite Reebok’s strong desire to keep the design work with a local firm, they eventually fired the original architects and hired a West Coast firm. The new architects offered leading edge, non-traditional designs that literally did not incorporate any straight lines. The design concepts
were beautiful – the building’s design definitely reflected what Reebok wanted in terms of its vision and image. However, when the time came to build it there were problems. For example, the building’s curvilinear design required that the steel guys work with little tiny cantilevers no two of which were the same. This was a source of great frustration. The set of design drawings was a stack two feet thick. Drawings were nicely drawn but not located anywhere. For example, the drawings showed a structural line with a very precise radius but there was no origin point located for the radius. Ultimately, the design concept remained intact but Noonan had to value engineer every detail.

The project’s construction manager was a large multinational company in a joint venture with a local firm. Noonan ran the construction process along with Reebok’s project planner (trained architect) who focused on interaction with the architects. Reebok directly held all of the engineering contracts including those for civil and site engineers.

**Information Flow:** Project communication methods included videoconferencing, e-mail and scheduled meetings. These methods worked well.

There was a teleconference daily at 3:00 PM for any project team members to dial into and participate in as they wished. Participation was available to the entire design team, construction team, and owners. Project team members could dial in if they had an issue that needed to get out to everyone and receive focused input. There was no requirement for dialing in, but generally the architect and construction manager participated daily, and the owner participated nearly every day.

There was a scheduled on-site construction meeting every Tuesday morning attended by team members and the architects’ representative.

The project was started without having a complete set of drawings. There was a cost plus contract with a guaranteed maximum price (GMP). Hard costs were at $88-89 million on $125 million total cost budget so they had to do extensive value engineering.

**Design Changes:** If a change came through, for example a steel change, before pricing it was considered an addendum, after pricing it was considered a bulletin. Bulletins required the approval of the head of the particular discipline in question (steel in this case) as well as pricing by the construction manager and the relevant sub-contractor. Finally, the change had to be accepted by the owner.

The landscape architect kept designing hardscape around the building despite passing a cut off time for ending this activity. Doug Noonan’s way of handling this situation was to ignore the landscape architect, then hire a local guy and have him wrap it up. According to Noonan, the best way to get people to stop designing was to ignore them.

The project was split into two areas: (1) core and shell which at the time of this writing was out to bid, and (2) interiors which was not yet out to bid. Consequently, design changes such as expanding rooms, moving doors, or substituting light fixtures were not yet issues. Noonan believed that they were in possession of a good first pass at a workable design.
Technology and Communication Tools
For communication among team members, Reebok’s facilities team used e-mail, CAD (the entire new headquarters project was on CAD), file disks sent via overnight delivery, daily conference calls, weekly site meetings, and an all-inclusive project meeting every 3-4 weeks. There were 6-7 design entities working simultaneously on the project and as a matter of course they e-mailed files back and forth between firms. One firm (the civil engineers) had a Web site that was able to post drawings. Project team members could access the site to pull out and deposit documents.

Communication Issues: Pride in One’s Work
Doug Noonan had built relationships over time with the project team members. He knew them and knew how to get them to work together. He thought that it was important to motivate team members to form a strong esprit de corps. To keep team members focused and responsible, Noonan leveraged everyone’s desire to participate in a glamorous, high visibility signature project. Essentially, he was successful in creating excitement about the project and the chance to participate in it and this was a powerful tool for keeping team members efficient and accountable in their communications.

Due to the necessity of simultaneous input from various team members on issues at hand, the best way to communicate was often face to face. For example, if the civil engineer changed the door elevation, then that would affect the grading plans that would in turn affect the drainage, etc. The project was moving fast to make up for the front-end delays caused by the original architects (the project schedule was collapsed from an original 18 months to 8 months). This meant that design changes had to move quickly through evaluation, agreement and approval. Face to face meetings had the advantage of allowing several experts from the different areas that were affected by a change, to discuss it together. This process was speedier than any alternative.

Doug Noonan did not believe that having more documents available on-line would expedite project work. He said that from a practical standpoint Reebok did not have the ability to review such documents. He also thought that a 15” typical CAD monitor was not the best way to view drawings — it was better to look at actual drawings. He thought that on-line documents would be useful if he had the ability to print them on site, but Reebok did not have the resources for this type of printing. He thought that ultimately, the best method of communicating design information was to have the architect send drawings by overnight delivery.

Noonan believed that the best way to handle issues that arose from real or alleged lost faxes or e-mail was simply not to tolerate this behavior. People who worked with Reebok’s team were expected to own their responsibilities and to take the initiative to get the information that they needed. Noonan had a no excuses policy. He thought of a project as a boat in which, “we’re all pulling oars – hopefully in the same cadence.” His most important communication tool was his strong ability to motivate people to be proud of their work. Pride had the fortunate by-product of causing people to be responsible and accountable.

He believed that a big part of successfully accomplishing a team spirit was ensuring that every team member had a clearly defined role. The project team was about to hold a partnering session in which team members would formally commit to helping each other succeed. Noonan believed
that in addition to this kind of team building atmosphere, it was also necessary to have brutally candid discussions.

**Information Technology**

Noonan would have liked to have a Web page on an Intranet that would allow him to advertise the project to Reebok employees. This would have been a benefit from a public relations standpoint and also useful for answering the flood of questions directed at him. The reason they did not have this was twofold: (1) the CFO wanted to keep the project confidential, at least initially, and (2) the MIS group was not capable of supporting it.

In terms of coordinating documents between groups (e.g. the steel guy had it one way and the architect changed it and didn’t tell him) there was room for improvement. Noonan would handle matters like this, depending on the impact of the architect’s change, by making the architect go back to the plan he had when steel bid on it.

Another example of this coordination problem happened in the current project when the architect took a column out of the design. This required that the building have 350 lb./foot steel members at one end. When Noonan learned of the change he called the architect to question him. The architect told him that the change enhanced the design causing the building to appear to float. Noonan told him to put the column back. This saved an increase in the steel costs for the project of $25,000.

When asked if it would be useful in managing design changes to have all of the project drawings up and running on a central, transparent database Noonan said that it would not be useful. He thought that this might work if they had only one firm working on the project, but not for a large group of firms like those involved in the Reebok project. He thought that the ideal tool would be to have everyone on the same CAD system and work through a Web type approach where everything would reside on a Web site. Project team members could go to the Web page and access data. This would eliminate problems like the one Reebok’s landscape architect was having importing objects from the civil engineers. Instead, they could eliminate e-mail and go directly to the Web page—he thought that having all of the project information in one place would be a tremendous help.

One potential problem with this idea became apparent when Noonan was working in a prior facilities management job at Fidelity. They had all of the project communications on a local network and they scanned everything into the system. The problem was the chore of updating the data – this chore was so large and difficult that team members revolted. Noonan commented, “in order for this type of system to be effective you need to have 100% discipline – anything less than that is equal to 0. Getting 100% was very hard.”

**MIS Role:** Reebok’s MIS department was very focused on cost control. They were not inclined to get excited about new technologies since investing in these meant spending money. Fidelity had a very different approach in this area – the real estate department was very big and broad, and the company’s chairman was interested in new technology. In terms of the number of staff, Fidelity had what amounted to a small company devoted to real estate.
Genzyme Corporation
Interview with Henry Fitzgerald, Senior Director Engineering and Facility Development
Framingham, Massachusetts

June 2, 1998

Genzyme was a fast-growing biotechnology company. From 1989-98 Genzyme went from 50 employees to 3,800 employees worldwide, and from $30 million in sales to $600 million in sales (1997.)

The Facilities Team
There were a total of 55 facilities team members, the core of which consisted of the following groups:

Facility Planning: This was a one-person team scheduled to hire another person shortly. The focus of this job was to assess the current needs of the company and what would be needed for the future, and to plan accordingly.

Project Management Group: There were four project managers that were trained engineers. They received assignments, from Henry Fitzgerald, the Senior Director of Engineering & Facility Development. These assignments consisted of various capital programs to be carried out. Project managers performed the following functions:
- Set up project budgets
- Established project schedules
- Interacted with architects, construction managers and in-house people
- Managed programs and all attendant entities from start to finish

Computer Aided Design and Documentation (CAD) Group: This group was a subset of the Project Management Group, and consisted of three CAD gurus whose function was, among others, to maintain Genzyme’s project plans on an in-house network system. The CAD team designed and developed this network so that qualified people were able to look up drawings on the system. Training on the system was a prerequisite for use. The CAD team also administered the system. Project design changes traveled from the engineer to the CAD team to be placed on-line so that updated information was available on-line.

Engineer Services Group: This group consisted of two chemical engineers, two mechanical engineers, one HVAC engineer, one electrical engineer and three instrument and control engineers (two of whom were also chemical engineers and one of whom was also a mechanical engineer). These people supported the project manager in the more detailed areas of a project. They were used in a matrix format, as if they were an engineering company, to review systems such as engineering, clean steam and gas distribution. When project work had to do with a system of any kind this group was responsible for it. Since they needed to interact with the people who developed processing at Genzyme, their backgrounds were key. Henry Fitzgerald reported to Genzyme’s Senior Vice President of Process Engineering. Genzyme’s company-wide policy was to integrate systems and facilities into processes. The process-engineering group developed the company’s processes, and the facilities group implemented the processes.
Maintenance Organization: This was a large group that performed Genzyme’s maintenance work. They did not perform janitorial work—this was contracted out. The maintenance group was comprised of technicians that supported both general facilities and production facilities. A typical technician was someone that had good mechanical and instrument skills (e.g. plumbers, HVAC experts and electricians.)

Facilities and Internal Customers
Genzyme’s corporate organization owned and occupied 1 million square feet of real estate in Massachusetts housed in 14 separate buildings. They also supported operations outside of Massachusetts including clinical laboratories across the USA, and separate divisions of the corporation. Divisions included Genzyme Tissue Repair and Genzyme Transgenics.

Many of Genzyme’s products were proteins or enzymes derived from the normal metabolism of living cells. The cells were modified via recombinant DNA techniques and cloned to produce millions of nearly identical cells. Cell cultures were grown in bioreactors and when conditions were right, cells would absorb the nutrients and excrete the proteins of interest into the media of the reactor. Later, they were decanted and purified. Genzyme’s facilities included offices that housed MIS, accounting, treasury, legal, sales and marketing, as well as pilot facilities and production facilities, the latter requiring expensive, sophisticated clean rooms and specialized utilities. Production facilities were essentially a series of R&D laboratories that looked like standard biology laboratories with sinks and counters. These facilities did not appear to be unique on inspection, but in order to keep them operating the facilities team needed a good deal of technical knowledge.

Genzyme Tissue Repair had two products, one that caused skin to grow (used for burn victims) and one that replaced and repaired cartilage. The facilities team helped to support the facilities and clean rooms for this division.

Genzyme Transgenics derived products from animal milk. Their facilities included a goat farm. An example of facilities team support for this division was their assignment to determine the correct size of the barn to build for the herd. In order to maintain the scientific integrity of the herd, goats had to be separated into several groups including males, females, prodigy groups and breeding groups. There had to be a certain amount of physical space between each group. The assignment was to build a barn of the correct size to accommodate the separated goats as the herd reproduced. The facilities team derived a mathematical model for the size of the herd needed to support sustained growth, then from this model they were able to determine what size barn would support a healthy animal population of this number. The first step was to determine the size of the herd needed to maintain the correct scientific population, then using this data they were able to determine the barn size.

Managing the Building Process
Genzyme Corporation was constantly involved in both renovating and building new buildings. Recently, they had been involved in more new construction than renovation as evidenced by growth in occupied space from 50,000 square feet to 1 million square feet. Nonetheless, they
often redesigned space for new uses. They also create or acquire new organizations such as the recently acquired Genzyme Molecular Oncology. This acquisition required additional laboratory space for 24 people and additional offices for 15 people.

A Typical Project: The call could come in from anywhere, it could be a planned budgeted program or completely unplanned (as in the case of a project that has been kept confidential.) Usually the impetus for new space was that an internal customer had a need to develop a new product. The facilities team responded in a series of stages:

Stage 1: Understanding the Needs: This involved assigning the key planning person from the facility planning group to get a picture of the whole program. He gathered comprehensive information. For example: How many people will need to be housed? How many square feet were required? Did they have the real estate in-house, or did they need to buy new property? Genzyme collected this information on a standardized detailed analysis spreadsheet used to ensure that all of the necessary questions were asked and answered. Once this information was collected the planner made preliminary estimates for the project.

Stage 2: Assignment of Project Manager: Assuming that the end user wanted to proceed after preliminary estimates were reviewed, Henry Fitzgerald assigned one of the four project managers to the project. At the outset, the project manager worked with the planner to get up to speed. The project manager would likely ask for engineering money to study the project and understand it. After completing a study, he would prepare a capital requisition that described the project and its economics, including schedule, cost, payback and alternatives. Depending on the size of the project, either the planner or the project manager could prepare the capital requisition. In either case, the preparer received help and advice as needed from the rest of the facilities team.

Stage 3: Project Approval: Genzyme had two levels of project approval in two tiers: Level one was for projects that were less than $250K and required approval by Henry Fitzgerald, as well as people at the vice president level and senior vice president level. Level two approval was for projects of $250K and higher, and required a second level of approval by officers of the company including division presidents, CFO and CEO.

Stage 4: Project is a Go: Selection of architects, engineers, construction managers, site and civil engineers would take place at this stage. Henry Fitzgerald would assign team members to support the project manager in the matrix. These would include an assistant to the project manager and support staff, specific engineers and maintenance staff. At this stage, the facilities team would also pull together relevant information from all other groups of the organization such as MIS, corporate communications, and quality assurance.

The quality assurance group (QA) was extremely important because all facilities that were used for pharmaceuticals must be inspected and approved in a formal process known as validation. In order to be validated both plants and processes must demonstrate that they were operating under control. The QA team has to validate all project plans to ensure compliance with standards, and to validate that the plans were actually constructed as designed. This was a costly and painstaking process so early involvement of this group was important.
The project manager would meet with the architects to produce a schematic design showing the interrelationships of the building and uses. Next, the architects produced drawings and developed a plan to provide a first pass at the design of the facility.

Genzyme hired architects, engineers and construction managers at the same time, and all of them reported directly to the Genzyme facilities team. Outside consultants were hired whenever it was necessary. For example, Genzyme hired technical consultants to work with them on building a large animal facility expansion. The technical consultants had expertise in animal facilities and they supported the project’s engineering company. The final design was a combination of the internal customers describing their needs, the technical consultants translating these needs into something the architects could understand, and the architects coming up with a design.

**Review of Design**
When the project manager received the design prints he distributed them to the relevant parties, including internal customers, for review and approval. Genzyme had strict ground rules on turnaround time for this review – everyone was allowed two weeks to look at the prints and get back to the facilities team with their comments.

**Once the Project was Up and Running**
Once project work was underway responsibilities were as follows: Architects were responsible for submitting stamped drawings that met all codes. Engineers were responsible for putting the infrastructure into the buildings (e.g. HVAC, specialty systems and utilities). The construction manager was responsible for construction of the project, permits, schedule control and budget control.

The project manager interacted with the architect, engineer and construction manager through bi-weekly meetings, e-mail, telephone calls, and voice mail. He interacted with facilities team members similarly. The role of the project manager at this stage was largely to help others define their roles: He let people know who was responsible for specific tasks. He also coordinated with various groups such as MIS to determine what equipment they needed and the implementation procedures that would be required.

**Design Changes:** Changes in design occurred frequently in a typical project. If there was a simple change to an office design that was not yet in the process of being built, the change procedure might involve a simple note with a provision to approve or decline. If the project was up and running and the design change would effect a process then it was a more complicated procedure. The change had to be documented to meet quality assurance validation compliance. For example, if there was to be an engineering change to a system, there was a very formal procedure to implement it. It was necessary to document all materials and specifications to formalize compliance with both operational and design qualifications. For this type of complex design change the project manager would let QA handle it.

**Information Flow:** There was a tremendous amount of information flow surrounding the renovation and new construction of facilities at Genzyme. Henry Fitzgerald estimated that one
third of the total information exchanged occurred in face to face meetings, and two thirds occurred through e-mail, voice mail, written letters and prints and drawings.

As a project moved along, if there was a specified item that had been approved by the engineer for installation, such as a light fixture, then the construction manager would hire a sub-contractor to install that light or its *equivalent*. If the sub-contractor chose to use an *equivalent* fixture then he would send this information to the construction manager for approval, who would then forward it to the architect for approval. At the same time it would be forwarded to Henry Fitzgerald’s engineering people so that they were aware of the substitution. Information about the light substitution had to be communicated to all of these people or the sub-contractor could not buy what he needed to do the job. This process of information exchange tied into schedule control since the sub-contractor had to wait for approval before he could place a purchase order. Everyone in the decision making process was constantly turning around packages of information that they had reviewed and approved. This was generally accomplished through face to face interaction and e-mail.

**Glitches in the Flow of Information:** The biggest problem was dispute resolution concerning who was at fault for delays that arose out of inefficiencies in the process of information flow. For example, sticking with the example of the sub-contractor and the light fixture, assume that Genzyme did not approve the *equivalent* light. The sub-contractor replied, “fine it will take 14 weeks to get the one you want instead of 12 weeks for the one I had proposed.” Genzyme must resolve this – was there another source? Assume that Genzyme conceded and took the *equivalent* light originally proposed by the sub-contractor, installed it and hated it. Now what should they do? The project manager or Henry Fitzgerald must decide how to handle the situation. The inferior light was approved – so what was their recourse? In this instance, Fitzgerald would usually go back to the construction manager and try to seek a compromise. Genzyme would usually absorb some of the costs or else live with it rather than get involved in a legal dispute. Resolution was more complicated if there was a deceptive substitution of the light fixture. If Genzyme was not informed about a substitution then there was a stronger issue at hand.

**Standardization of Communication Process: Coping with Throughput:** Genzyme had formal procedures in place for every step of a project to ensure that there were no surprises. No matter what type of project they were working on – they had established good practices and standards across the board. They had established clear internal policies on communication among project team members. These policies included specified turnaround times for information packages and approvals. If a situation arose where a two week turnaround time was specified for a particular item, and detailed design specifications were not yet available for that item, Henry Fitzgerald would make the decision whether to forfeit internal review or delay the schedule in favor of a thorough review.

Problems in the communication of information were due to volume of throughput rather than inefficiencies in the modes of communication. Information was flowing to highly skilled people who were making calls on very critical systems. Decisions were made in areas that required high levels of expertise, especially with regard to the *validation* process.
Where I/T Plays a Role: Frequently people could not attend one or more of the critical project meetings. A team member might be responsible for issues arising from a meeting that they were unable to attend, and therefore they needed to get that information. Such information would usually be communicated via e-mail notes with responsibilities and action items described. This was critical information that had to get to people – it was put out via e-mail. E-mail had generally worked well for all of the project teams. However, verbal communication was the method of choice for interaction between the project manager, architect, construction manager and engineers. If a project was going well then using e-mail saved time.

Genzyme generally gave the architect a lead role in a project’s triumvirate structure of architect, construction manager and engineers, especially in the early stages of a project. Having the lead role meant that Henry Fitzgerald had trusted the person to make thing happen, and there was an understanding by other team members to get this person what he needed. All three had equal access to the owners, and the owners made full use of this by leveraging their position and playing one off against the other when necessary. If a project were fast tracked then the construction manager would usually be assigned the lead role. Genzyme did not generally use the design build method. They preferred to hire separate architects, construction managers and engineers.

Genzyme’s On-Line System: Genzyme had an on-line engineering system where all project documents resided. The architect could send drawings on-line to all team members. Team members were not able to make changes to base drawings. They could suggest changes but could not actually change base drawings. Once changes were made to a drawing the updated version resided on the system along with any prior drawings. Usually a project moved so fast that this on-line exchange of information did not happen very well. It was more likely that people would get together around a table to look at drawings. The face to face method had the advantage of allowing everyone involved to express his or her ideas simultaneously. If someone said something that effected someone else’s area then they could address the question together. For example, if xyz area needed to be changed and it would impact abc area, and the change could not be effectively contemplated without input from the abc people. The on-line system did not allow for this kind of simultaneity of inputs.

Information Flow and Architectural Changes: If an internal customer said that he needed a room to be bigger – meaning that a wall, a door and a corridor must be moved – it was often necessary to change all of the building systems as well as the design. Since the internal customer did not realize the magnitude of what was involved, he would be happy to propose such changes. The process of instituting this change involved getting the architect, construction manager and all of the engineers together to work it out.

If a project was phased then it was equal to three $10 million projects rather than one $30 million project. But questions usually arose as to which phase should absorb the costs of infrastructure. The internal customer did not understand that systems must be supported later. (e.g. in the case of transformers – should multiple transformers be purchased in phase one? Or should the right one be bought? A decision must be made in the first phase that would impact the final phases). How about emergency generators – should three be bought at once? Or should one be bought for each phase? The facilities team might be forced to front-load a project to get it to the next phase.
This was a problem if the remaining phases of the project were not completed. The key was for internal customers to let the facilities team know what decisions were being made at the time they were placing the next phase in jeopardy.

Simultaneous input on projects from many people was important. It did not matter if input was in the form of e-mail to 36 people, or if everyone sat around a table – what was of primary importance was feedback. Good feedback came from the professionalism of those involved in the process. Sometimes people did not respond in a timely manner – and this might cause information to get lost in the shuffle. Genzyme was working to further centralize policies on communication protocol that would address this issue. Henry Fitzgerald wanted more aggregate project communication and more effective communication.

From a cash flow standpoint Genzyme’s mode was to wait, wait, wait and then go at an extremely fast pace because facilities projects were so costly. The facilities team had to be aware of this because collapsed times for project completion impacted the pace of their work and put pressure on efficient communication.
Children's Hospital
Interview with: Paula Quan, Executive Director of Corporate Real Estate
Boston, Massachusetts

June 18, 1998

The Facilities Team
The Executive Director of Corporate Real Estate, Paula Quan, headed the facilities team at Children's Hospital. She reported to the vice president of facilities management. The facilities team under Quan consisted of the following people:

The Director of Real Estate performed property management functions and handled all real estate transactions. She was responsible for negotiating new leases and also for working with internal customers in a support capacity during transitions to new space, for example in the areas of distribution and mail systems.

The Director of Facility Planning had two people reporting to him: one was a CAD expert, and one was a senior facilities designer. This group was responsible for overseeing facilities planning and design processes. In addition, they performed design work for smaller projects.

The Director of Project Management had four project managers reporting to him. The project managers handled every aspect of a project from start to finish. One of the project managers also handled all of the maintenance for the hospital.

There were two administrative assistants for the facilities team that handled communication and performed secretarial functions. The hospital was in the process of upgrading their e-mail and telephone systems. Once the upgrade was completed, the administrative assistants' tasks would be shifted to focus more directly on projects.

Children's Hospital had a separate engineering group that worked very closely with the facilities team. The engineering department was responsible for ensuring that the facilities and systems were running properly.

Facilities and Internal Customers
Children's Hospital owned and occupied 14 buildings totaling 2.1 million square feet that comprised the main campus in Boston. They leased 21 additional sites throughout Massachusetts totaling approximately 250,000 square feet.

Building uses included outpatient and inpatient facilities, ambulatory care, critical care units, radiology including laboratories, medical research facilities and surgery. All uses were specialized and required the facilities team to possess high levels of technical knowledge. For example, facilities team members had to be familiar with ventilation of medical gases, emergency generators and myriad codes and code compliances for medical facilities.

Internal customers included the hospital’s senior staff, clinical chairmen, medical directors, research people, and support staff.
Children’s Hospital conducted both new facilities construction and renovation of existing space. There was not a lot of space churning at Children’s Hospital, a fact that fit with hospital uses in general. Children’s Hospital was moving toward a more flexible model for space design to make space adaptable for alternative uses.

**A Typical Project**

**Request and Approval**
A request would come in from an internal customer with a need for space, or renovation. The facilities team would then e-mail, to the internal customer, a project request form that solicited information about what was needed and the reasons for the renovation or new space. This form was returned to Paula Quan.

This initiated a three-step process to gain approval and funding for the project. First, the project manager conducted a study including cost estimates, a project schedule and a high level schematic drawing of the proposed space and its uses. The schematic drawing was created in conjunction with the facilities planning department.

The internal customer then received back a package requiring signatures and approvals in his or her department. Once signatures and approvals were in place, the internal customer sent the signed package back to the facilities team. At this point, the facilities team hired an architect. The architect prepared drawings that would be used to bid the project.

In the third step of this process, the facilities team prepared a document with the actual numbers for total project costs including all fees, furniture, etc. that was sent to the internal customer for signatures and funding approval. Once this phase three document was signed and returned to the facilities team the project was executed.

**Project Execution**
Project managers were responsible for executing projects from start to finish. Project managers interacted directly with architects, general contractors and internal customers. They were responsible for managing the entire design and construction of projects, and for ensuring that the internal customer’s needs were met. Project managers, almost exclusively, communicated with architects, general contractors and internal customers throughout a project’s life. Project managers were also responsible for communicating with all ancillary and support functions to ensure that the project was properly equipped, for example I/S, materials, laundry and linen, and engineering.

Children’s Hospital generally did not have complete project documents at the time a project was put out to bid. They attempted to use a flexible approach when bidding projects, understanding that without full documents there would be areas where expectations would have to be adaptable.

Children’s Hospital had a short and a long list of architects and general contractors. Firms that were on these lists were periodically evaluated by internal customers for competence and service. The selection of an architect for a particular project involved an RFP. This was followed by architects’ presentations to the internal customers. Finally, the internal customers, along with the
facilities team, made a recommendation for the architect they believed best understood their needs.

Once design drawings were completed and reviewed by project team members and internal customers, the project was bid to three of the general contractors on the list. Project work went to the lowest bidder.

**Design Changes**
If an internal customer requested a design change there was an internal form generated that stated the price and estimated delay for the change in work. Signatures were required on the form to authorize the design change. If the form was authorized and submitted, then the design change would be done, otherwise the design remained unchanged.

**Communication**
Children's Hospital generally used local architects and general contractors so communication across broad geographical areas was not a factor.

Project team members held weekly scheduled project meetings that were attended by the project manager, architect, general contractor and internal customers. Meeting notes were distributed to everyone on the project team.

Communication tools included e-mail, telephone and voice mail. There was also an on-line system available through some of the architects employed by Children's Hospital that allowed project team members to send CAD drawings to each other. Currently, there were unspecified delays in the system so team members were not gaining much advantage from using it. Quan believed it would be a useful method of project communications if the delays could be fixed.

Quan was moderately satisfied with the efficiency of project communications. There was room for improvement, for example in correcting the delays in the on-line CAD system, but overall there were not any major problems. They were working to improve their e-mail system used for communication among architects, general contractors and project team members. They were also in the process of trying to unify the hospital's interdepartmental computer systems. Currently, due to incompatibility problems, it was not always possible to open a document that was sent from one internal department to another.

They had looked at Web based systems, but currently they were more interested in an automated project control system to manage the finance side of a project. The expectation was that such a system would streamline the purchasing and accounts payable pieces of a project. For example, currently the facilities team sent a purchase order signed by a project manager to the purchasing department to be stamped and processed. The purchase order then had to be sent to the accounts payable department. This was a cumbersome time consuming series of manual transactions that had the additional disadvantage of not allowing the project manager the ability to check the status of invoices. Invoices came into the accounts payable department and the project manager had no way, on-line or otherwise, to look at their status.
Communication with Internal Customers

Communication with internal customers presented some problems for the facilities team. They were working to make internal customers more aware of the processes involved in designing and constructing space. Quan believed that educating internal customers would improve project efficiency. For example, internal customers were continually asking questions such as, “why does it take so long to order and receive furniture?” And, “why can’t I just change that door?” She believed that they needed to be educated about causes and effects in the construction process. When an internal customer wanted to change a door, they did not understand that CAD drawings were already out, approvals were in place and that even a (perceived) minor change would impact the entire project. This was the reason Children’s Hospital had the internal change form, but Quan believed they should do more.

In fact, she was implementing processes to achieve further gains in the education of internal customers. The goal was to make internal customers accountable, and for this to happen they needed to understand the costs, time and paperwork that go into a project. Step one of Quan’s efforts to educate internal customers was the sending forward of project costs and schedules to them. This was important because it provided a means for internal customers to understand the project and gave them an opportunity to develop correct expectations for costs and schedules.

The communication issues that needed to be addressed at Children’s Hospital were not those surrounding the interaction of the project team members, but those surrounding the interaction of the internal customers and the facilities team.

Quan believed that project efficiency would be well served if Children’s Hospital had a communication system for senior level people at the hospital to access information about ongoing facilities projects. Ideally, they would be able to look at the status of projects and the total number and scope of current projects. This would give senior level internal customers a clear view of the working status of the entire facilities team. The expectation was that this knowledge would prevent internal customers from making unrealistic project demands on the facilities team.

Strategy Initiative

Children’s Hospital had just completed a preliminary master plan analysis. Facilities team members met with division chiefs and other senior level people to determine project development strategies going forward, for the main campus. A new senior vice president of strategy was hired to clarify the strategic mission for real estate at Children’s Hospital. The expectation was that she would work with senior management and the facilities team to spearhead a big picture strategy for facilities development that would be implemented by the facilities team.
Fidelity Corporate Real Estate, LLC
Interview with Sarah K. Abrams, Vice President of National Real Estate Portfolio Management
Boston, Massachusetts

June 11, 1998

Fidelity Investments was a privately held financial services company with 30,000 employees worldwide. They occupied approximately 8 million square feet of real estate in the USA. Their national real estate operating budget was approximately $120 million annually; their annual capital budget was variable; it was $200 million in 1997 and was projected to be approximately $175 million in 1998.

The Facilities Team
Fidelity Corporate Real Estate, LLC had 165 employees. The group was headed by a president who had four direct reports. They were:

- CFO
- Vice President of Planning and Acquisitions
- Vice President of National Engineering
- Vice President of Portfolio Management (including construction)

These four executives functioned as a team, attending weekly staff meetings and contributing to every aspect of managing the corporate real estate group. For example, the real estate planning function consisted of trying to understand how Fidelity's business units were growing and the impact of this growth on future space needs. The vice president of planning and acquisitions took a lead role during this stage of a project. Demographic research on the geographic area being considered was needed to determine if an appropriately trained workforce could be hired there. In order to plan new facilities, this type of demographic information was factored into the process of making decisions. Locating near customers and an appropriately trained and sited workforce was important.

Determining locations for business units also required financial forecasting and evaluation of physical realities such as where to locate buildings and how to handle telecommunications infrastructure. Fidelity's four top real estate executives addressed these areas of planning according to their expertise. Thus, the four executives contributed to each project as a team at each stage of the project.

The vice president of planning and acquisitions led the acquisitions stage of a project. This stage involved leasing and/or buying real estate. During this stage, there would be heavy contributions from Sarah Abrams, Vice President of Portfolio Management, in all due diligence areas such as construction cost estimates, infrastructure capability/availability and environmental condition.

Real Estate Construction and Portfolio Management
Once land was bought or space was leased and the acquisition became a project, Abrams, as Vice President of Portfolio Management took the lead role. Her group consisted of 75 people of whom approximately 65 were operational people and 10 were project managers. They were responsible for all construction projects whether a new building or a tenant fit-out project.

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group was also responsible for physically moving business unit clients into new space and for managing the space over the long term.

Within the portfolio management group, the country was divided into separate regions each with a regional head and a staff. Each region had a project manager with construction expertise and a move coordinator. The regional staffs were frontline liaisons with the business units.

The portfolio management group received support from the CFO’s financial group in the form of financial analysts assigned to each region. The head analyst, who oversaw the regional analysts, supported Sarah Abrams and provided her with information on a rolled-up basis. Each region generated budget forecasts on a rolling basis each quarter. These were prepared with the assistance of the head analyst. These consolidated forecasts were then rolled into the corporate-wide financial forecast.

**National Engineering**
The primary function of this group was staffing and operating Fidelity’s mainframe and mid-range data centers considered to be mission critical for the company. A professional engineering staff was on the job 24 hours a day, 7 days a week at each of the data centers.

In addition, the national engineering group had a director of technology who, among other responsibilities, supported the portfolio management group on real estate projects. He also tested and evaluated new technologies for potential use at Fidelity. For example, he tested mini UPS systems (uninterrupted power systems) to determine under what conditions it would be beneficial to use centralized systems or distributed systems. He also determined which brand of mini UPS the company should purchase. The director of technology test piloted a number of brands, evaluated each, determined which brands were best for Fidelity, and then negotiated prices with vendors. The director of technology also played a role in supporting critical infrastructure and worked closely with the building managers.

**Reorganization of the Facilities Team**
The corporate real estate group had undergone reorganization about four years ago. During the four years since reorganization, square footage under management at Fidelity had more than doubled while the staff shrank from 240 to 165 employees. In order to achieve success while adding space and subtracting staff, Fidelity changed their management model. This change included the way they staffed the real estate positions using outsource facilities managers as new space was brought on-line. Fidelity employees were used only when there was *real value* added for doing so. *Real value* was added when it was imperative to the success of a function to have specific knowledge of Fidelity (e.g. relationships and business units.)

Prior to the reorganization, Fidelity had an internal design staff that was now gone. In the prior period, there was a centralized construction management group that had shrunk in the new model. Construction managers were now dispersed to regional sites. In the prior model, the project management and operational pieces were separate functions. This meant that when a project manager finished a project it was handed off to the operations people. The operations people had had no experience with the project until this point. When problems arose they didn’t have the depth of project knowledge and history required to effectively manage them. The new
model provided an integrated functionality between project managers and operations people each of whom reported to the regional head in their region of the country.

**Facilities and Internal Customers**
Fidelity occupied approximately 8 million square feet of real estate in the USA. They also occupied space in foreign countries, but this was generally managed by separate subsidiaries.

- There were data centers with very specialized uses – housing Fidelity’s extensive computers.
- The majority of space was office space that also incorporated call centers that were set up with 5 x 5 cubes and labs for various systems developers.
- Fidelity had 85 retail centers; small buildings like bank branches, located around the country.
- There was a print mail facility in Kentucky where all of Fidelity’s direct mail was printed and mailed. It was highly automated and ran 24 hours a day, 365 days a year. There was a US postal inspector in an office on site so that mail could travel directly from the facility to the airport. The building had its own zip code.

**Typical Construction Projects**
Each region had partnering relationships with a few construction companies, architects and engineering companies. Fidelity had a process of selecting the partnered companies that included interviews, evaluation of qualifications, and the bidding of fees. Fees were bid up-front for all work, and contracts were signed up-front at the time a company was accepted as a partner. Fidelity accomplished this by having partner companies submit fee structures and general conditions that would remain in place throughout the life of the partner relationship. Contracts were reevaluated every couple of years based on each partner’s competence and service.

This system allowed Fidelity to have a group of professionals on board who knew their requirements and the type of service they needed. It also saved time when new projects were initiated since contracts did not have to be negotiated. Partners were able to communicate electronically with regard to financial tracking and project tracking. Fidelity did not have to re-educate designers, contractors and engineers for each new project.

Fidelity used the partnering relationships for all but the very largest jobs. For example, on projects of $2.5 million or less (this amount varied by region) they would simply pick a construction company from among the partners and there would be no bidding. On projects of more than $2.5 million they would bid the fee piece out to their partners, saying effectively, “let’s do better than our partnering arrangement.” Finally, on projects of very large magnitude, for example the construction of a 250,000 square foot new building, Fidelity would not use the partnering relationship at all, but would put the job out to an open bid.

**Project Responsibilities and Communication**
A project manager in each region would manage large projects. For small projects, one of the region’s real estate managers (property managers) would handle it. For all projects, the real estate manager responsible for that asset was part of the project team, contributing to operational perspective and coordinating client moves.
For projects costing more than $5 million an analyst from the finance department was assigned to help the project manager with the financial paperwork (e.g. check labor rates on invoices from the contractor, etc.) Since project managers were often doing more than one project at once, this was necessary support. Each project was staffed according to its size and complexity.

Project managers supervised construction work and dealt directly with architects, engineers and contractors. Each project manager reported to a regional head. For greenfield projects the project manager would usually report directly to Sarah Abrams, or to the president of corporate real estate. Project team responsibilities and reporting were often matrixed.

Both the regional project manager and the real estate manager (operations) interacted with internal customers and with architects. Fidelity’s business units often had their own planning people who acted as liaisons with the corporate real estate group for all space planning and project issues.

Fidelity had certain design guidelines so they were not starting from scratch with each new project. For example, offices were generally designed on the core and light fixtures were standardized.

The Beginning of a Project: The Approval
Official sign-off for project approvals was accomplished with a paper form known as a Project Approval Request (PAR.) The exception was for projects over $5 million that required a Project Funding Request (PFR) in addition to the PAR. Both of these forms contained estimated project budgets and a project justification. The approval process was often time-consuming depending on the number and level of signatures required.

Communication and I/T
Fidelity employed the following methods of communication among project team members:
- Weekly project meetings
- Email
- Voice mail
- Project Web sites with capabilities to post project documents on-line
- Portfolio Management Web site that allowed employees to look up corporate real estate organizational charts, regional site buildings and business units including maps, directions and directories of business unit locations. Also, access to building keys, whom to call for hot/cold issue, etc. This Web site was not used as a way to exchange project information, but as a research tool for accessing static facilities information.
- Corporate Real Estate Web site (work was underway on this.)

Abrams was generally satisfied with effectiveness of project communications. Projects were generally finished on time and internal customers were usually happy with the product. Fidelity would like to improve its way of managing communications for projects at remote sites. This could involve either a client server based or Web based application.
Fidelity Corporate Real Estate, LLC
Interview with Robert R. (Bob) Couture, Principal Project Manager
Boston, Massachusetts

June 15, 1998

Project Management at Fidelity: The Art of Speed
Outsourcing was a big issue at Fidelity; project teams were diversified. In the past, the architects took the role of master builders and were responsible for all aspects of a project. Today, architects were no longer taking this role; they were not embracing the project. The reason for this shift might have been desire on the part of architects to minimize responsibility in order to avoid liability.

Another big issue at Fidelity was getting the product to market more quickly. Smithfield was a good example of typical turnaround time for a large-scale project. It was less than two years from the day Fidelity made the decision to build in Rhode Island to the completion and occupancy of the 250,000 square foot project that included a parking deck for 1,150 cars. When they broke ground in late fall of 1996 they had only a conceptual idea of what the building would look like. Fidelity believed in quick turnaround for construction projects. Fast turnaround required architects and contractors to use more staff for a shorter period of time. Consequently, project managers placed a premium on the speed and accuracy of communication among the project teams.

Project delays occurred primarily for two reasons:
- The difficulty of making decisions when either the architect, engineers and/or contractor were remote
- The difficulty of making decisions when internal customers (i.e. business unit bosses) were traveling and unreachable

Given the large number of people involved in large projects including the owner, construction manager, designers, engineers, consultants and myriad others working on the project team, and the fact that often these people were not on site, getting sign off on design changes and approvals was a tough job. With very tight project turnaround time, the loss of three days for sending overnight drawings to an architect for approval, or to a business unit boss, was critical.

Smithfield was a good example of how quickly projects moved at Fidelity. The project broke ground without complete construction documents and then had to move very fast through many design changes. The short timeframe plus the many design changes made efficient communications a priority. The big questions were: “Do you have approval?” And, “do you have the latest up-to-date information?” Bob Couture, Smithfield’s principal project manager might be in Dallas, Rhode Island or Boston; if his approval was needed on an action item it was difficult to get the drawing or document to him. There was also the question of whether he had received the most updated version of the drawing or document. Speed and accuracy were top priorities in project communications. The question was how to achieve both in the best possible way.
I/T for Project Management
Bob Couture used the following tools for project communications:

- Digital photographs
- Email
- Scanner in combination with Email (to send scanned documents via email or file them electronically)
- Overnight delivery service
- Facsimile
- Third party project management software
- Voice mail

These tools were successful on a limited basis, limited largely because not every member of the project team was on the system. Email was the most useful resource, but the architect had an incompatible document attachment function so they were unable to open documents sent by email. Other hurdles in project communications occurred when a French speaking precasting company located in Canada was hired. Since Smithfield was a highly detailed building with a great deal of precast work, the remoteness of the precaster coupled with the language barrier was a communication challenge. The steel fabricators were in Maine – yet another remote site where information had to be delivered. Other project team members were similarly spread across the USA making communication and coordination among the building trades difficult.

The construction manager that Fidelity hired for the Smithfield project had an internally developed a Web based system for project communications that they were using with success. They also used a commercially available construction project management system, but this product was developed primarily for the construction industry and did not prove to be useful to team members who were outside of this discipline.

The most significant problems with current modes of project communications were lost faxes, incorrectly filed document hardcopies and failing to send the latest, most up-to-date version of a document. For example, Fidelity was currently negotiating a land purchase with multiple agreements, covenants and contract attachments. There were quite a few lawyers, brokers and Fidelity people involved in the transaction. It seemed that every fifteen minutes a new document was generated that required someone's response. Problems occurred when one person received the document, called someone else to discuss a response, then found later that they had two different versions of the document – one latest version and one that had been generated and transmitted prior to the latest update. This type of inefficiency in the exchange of information happened frequently and caused delays.

What was the Ideal I/T Solution?
The key idea was to centralize project data so that everyone had access to the latest updated information. The goal was to cut weeks, and even months out of a project. Also, during the life of a project, from conception through design and construction and finally into occupancy and operations, there were a number of people who jumped into and out of the project team. One advantage of a central project database was that there would be a complete electronic history of the project available for everyone. This continuity was important going forward for the operations people who managed the building.
Ease of use was a priority as it would be necessary to overcome people's natural inclination to resist anything new, especially if it were perceived to require new skills or additional work. This fact seemed to point ideally to a Web based technology since it was non-threatening. A Web technology had the advantages of having nothing to implement, no learning curve and no extra time involved for users. A Web application would eliminate the typical complaint of, "I don't want to take the time to put my data up on a new system." Because the answer would be, "you don't have to."

Low cost was also a priority because if, for example, an architect didn't have the system, Fidelity could hand him a laptop computer with the system loaded and say; "here you go." For Fidelity a cost of less than $5,000 including hardware would be acceptable. This cost would mean that there should be no reason for even the smallest consultants or sub-contractors not to participate.

Fidelity had one special consideration as a mutual fund company -- they were held to strict accountability for access to company-wide information. Since Fidelity employees had access to company computer networks that held customer accounts, they were required to be bonded. There were firewalls surrounding company-wide local area networks (LANs) - no outsiders were allowed access. This meant that it would be impossible for Fidelity to develop an in-house system for development and construction projects that could be accessed by outsiders such as architects, engineers and contractors. The solution would have to come from a third party provider - either a third party posting a LAN or a Web based application with a server located at the provider's site.

Ideally, Fidelity would like to have their internal customers on-line with the project communication system. There were a lot of people moving around at Fidelity and it would be far more efficient if the information required to move them was centralized. For example, if John Smith moved from Boston, cube #1 to Smithfield, cube # 150 then Fidelity's telecommunications people would get involved to provide the correct type of set-up for John Smith's station requirements. If this information were entered into a database that could be built over time to incorporate all of John Smith's information, then the process of moving employees would be improved. This meant that a fewer number of recourses would be required.

**Products and Systems**
There were a handful of products available to address construction communication issues and they were in the early stages of development. Products like Firstline, a new Web based system developed in Boston by Collaborative Structures, allowed users to communicate from anywhere in the world where they had access to a Web browser. There was no need to carry a computer while traveling — with a browser, project team members would have all updated project documents available on-line, and would be able to access them, and/or generate new ones from any location.

Additional benefits of systems like Firstline included storage capabilities — Fidelity currently had to have third party resources print documents and then deliver them. For example, they would send original plans and specifications by overnight delivery to Charette. Then Charette would produce the prints and send them back. The loss of time involved was critical and delivery costs
were staggering -- $90,000 in overnight delivery and messenger costs for the Smithfield project.
A system like Firstline, with storage capabilities, would allow Fidelity to download documents to
Charette and receive back prints in a much more efficient process.

There were also benefits to centralizing the data in one database. This would eliminate problems
with faxes that never arrived or were lost, and with delays caused by telephone tag. It would also
be useful to have linkage among project data so that, for example, weekly cost reports could be
tied to monthly reports.

Couture believed that clear explanations of how to use new products and systems were key to
how well they would be received. I/T needed to be easily taught in order to be effective,
otherwise people would only scratch the surface of its intended effectiveness. If new
technologies were overwhelming, then he believed nobody would even take the first step toward
learning how to use them.

Fidelity’s projects typically required a lot of very custom, leading edge work for technology and
infrastructure. For example, a computer room was recently built during a one-year design and
construction period. During that time, the computer equipment that was programmed for the
space had changed dramatically to keep pace with the leading edge of advancements in computer
technology. This meant that the project design had to be changed continually to keep pace with
the new requirements.

Fidelity had experience with third party project management software and found it to be a great
tool for managing and tracking the components of a project. The drawback was that it was
focused too heavily on the construction side of project work and not enough on owner or design
requirements (e.g. change orders, revisions and costs.)

Prolog was a centralized database where project documents could be filed. It saved team
members from having to search for hardcopy documents. Prolog did not yet have a Web based
system, but one was in development. The big advantage to having a Web based system was that
all that was needed for access anywhere in the world was a Web browser. Team members would
be able to access up-to-date information anytime and from anywhere.

**Reaction among Sub-Contractors**
Fidelity’s sub-contractors were extremely interested in new technologies to improve project
communication. Their interest grew out of witnessing firsthand what Prolog was able to
accomplish for general contractors. When information was entered into Prolog it was
automatically time and date stamped. There was an *out date* and a *back with response* date so
that users could establish a date when they wanted a response to information that was sent out
and track the response. Users could hit a report key and generate a letter to every project team
member who had an outstanding issue.

Firstline had the capability to produce similar reports using a separate commercially available
report writer such as Crystal Reports. Firstline was considered by Couture to be a good place to
store and use information but it didn’t go much beyond these capabilities. He viewed having a
place to store and use information as very valuable. He also believed that ultimately, the best project communication systems would go beyond this to provide many ways of communicating.

Although the sub-contractors were interested in I/T systems there was one problem. This problem was that large sized documents were difficult to print out without a plotter. However, since a plotter was only a $2,000 item it was not considered to be prohibitive. Contractors could have one in the trailer on site and print out the latest drawings from the architect.

Once the sub-contractors were on-line it would be easy to move shop drawings around through an I/T system. The sub-contractors seemed to feel pressure to get on-line, especially those who worked on jobs like Smithfield which had both a customer and general contractor interested in the leading edge of technology for project management.

The general contractor for the Smithfield project had an internally developed on-line system for project management that came about in response to the wish lists of project managers. They were continually adding functionality to the system as project managers developed bigger wish lists. This system had the advantage of having in-house support from the system developers.
Analysis of Data

Communication and the Primary Issue: Accountability

The primary issue that emerged in four out of the five company interviews was that of accountability. In the construction process, both speed and accuracy were priorities for each company. Speed was important due to the compression of project schedules. In light of collapsing time frames across the board the companies believed that project communications needed to be extremely efficient. In four out of five companies, the predominant issue in construction management was accountability. In one way or another, each company had evidenced that accountability was key in achieving more efficient project communications. The expectation was that improving accountability would improve speed.

As a project team moved through the process of construction, how well they were able to turn information around, including drawings and documents that required approvals and signatures, came to bear on the speed of the overall project. In these instances, the accountability questions were: “Who had the information? Was it the correct information? What was the status of the approval? And finally, if there was a delay in approval, why was there a delay? Other issues of accountability arose in project teams’ interaction with internal customers. For some companies, I/T was seen as a useful way to manage the accountability issue; for others solutions to accountability problems arose from other means.

State Street Corporation: The Organizational Chart

At State Street the primary means of improving project communications to deliver buildings faster was the organizational chart. Mary Ann Marino believed that the key to delivering construction projects more efficiently was creating a sense of ownership of a project. Ownership could be thought of as a powerful combination of motivating forces; responsibility, control and accountability. When these three forces were concentrated in the hands of a project executive, or project manager, that person effectively owned the project.

The recent reorganization of the facilities team was designed to reduce the number of times that a project was handed off, and thus create ownership of projects. Central to the model for creating ownership were strong individual project executives with responsibility for certain projects from start to finish. These project executives supervised the work of entire project teams, as well as managed relationships with internal customers. In the organizational chart, one level down from the project executives, project managers were also given more responsibility and control over the nuts and bolts of total projects. Consolidation of construction and design responsibilities into one job, that of project manager, meant that this person owned the hands-on work of a project in its totality. Functions were merged to give rise to the model of strong individuals with responsibility for total projects.

Accountability was facilitated because clear roles were defined. Once people were given clear responsibility for a total project they understood that they were accountable. Accountability went hand in hand with responsibility and control.
Reebok International: Pride in One’s Work—the Importance of Personal Motivation
Reebok, like State Street, evidenced a primary concern with accountability to make the construction process speedier and more efficient. Doug Noonan’s approach to making people accountable was to use his skills as a strong motivator. The interviewer’s perception was that he was able to make this method work. To accomplish individual accountability among project team members, Noonan did two things: He defined clear roles for team members – each person knew what was expected of him. And, he built strong relationships with, and among project team members, effecting an esprit de corps. Once he had forged a loyal, team-oriented project group then people were motivated to do excellent work – nobody wanted to let everyone else down. Noonan also motivated team members by generating excitement about the project itself – everyone wanted to participate in what they believed was a signature building. They were proud of their work, proud to be a part of the team, and loyal to each other.

Noonan also evidenced the ability to be very firm when necessary. For example, when asked about alleged or real lost faxes or e-mails that are the usual manner in which team members duck accountability, he said simply, “I don’t tolerate that behavior.” When discussing a landscape architect that would not stop designing hardscape despite passing a deadline for this activity, Noonan said that he just ignored the architect. He hired another landscape architect to wrap up the job.

Noonan seemed to have the right balance, of being both well liked and well respected by project team members, to give rise to motivation and accountability. Project team members knew that they had a friend, coach and mentor as long as they did not get out of line. This worked well for keeping the prevailing mood of the project positive, and for keeping people from getting out of line.

Genzyme Corporation: Dealing with Throughput — Internal Policies for Turnaround Time
At Genzyme, there was a heavy volume of information flowing to highly skilled facilities people who were making critical decisions. The technical complexity of Genzyme’s facilities, in combination with collapsed timeframes for construction projects, placed a great deal of pressure on efficient communication.

Henry Fitzgerald believed that the volume of throughput could best be managed by implementing clear internal policies for turning information around. In order to cause people to be responsible and accountable, Genzyme had established best practices and standards across the board. Internal policies specified turnaround times for various types of project information. Standardized project communication processes clearly defined exactly how long project team members had to turn information around. Ultimately, Fitzgerald recognized that accountability depended on the professionalism of the project team. However, if they were given clear standards it was more likely that they would strive to adhere to them. Focusing on communication processes would serve to improve the speed and efficiency of projects.
Children’s Hospital: Accountability of Internal Customers

The communication issues that were being addressed at Children’s Hospital were not those surrounding the interaction of the project team members, but those surrounding the interaction of internal customers and the facilities team. Internal customers were making unrealistic demands on the facilities team, especially with regard to design changes for projects that were underway, and with ongoing project schedules. Paula Quan’s goal was to make internal customers accountable, and for that to happen they needed a better understanding of the costs, time and paperwork that go into a project.

Quan believed that educating the internal customers would cause them to have more realistic expectations. For example, if an internal customer required a design change and they were aware of exactly what processes that change affected, then they would understand why the change caused additional costs and delays. Accountability for delaying the project or adding costs would reside with the internal customers since they would be fully educated on the impact of their requests. Project efficiency would be improved with greater accountability since internal customers would be more thoughtful about requesting design changes, and more realistic and less argumentative about implementation.

Fidelity: Speed and Accuracy – Technology Plays a Role

Fidelity had the biggest real estate operations of the five companies in this study. They were also the most active in terms of the sheer volume of current period construction projects. Like the others, they placed a priority on the speedy delivery of buildings. They were less focused on accountability – not because it was not important, but because many of their accountability issues had already been worked out in the recent reorganization. Since they had already addressed accountability, they had moved on to the next generation of issues, those of information technology.

Fidelity was focused on speed and accuracy – most projects were fast-tracked. On any given project, they were generally working with multiple parties including designers, general contractors, sub-contractors, consultants, brokers, lawyers, engineers and internal customers. Frequently, many of these parties were remote from the project site. Bob Couture, as a principal project manager, acted as the CEO of a project – overseeing the project from start to finish. His number one priority was the speedy delivery of buildings. Along with speed, he required technical accuracy and the effective execution of evolving project designs.

Couture believed that I/T was the best way to achieve these goals. The best I/T solution would organize project information into one central database that would be accessible for all project team members. A Web based technology would allow team members to dial into a project site from anywhere in the world where they could access a Web browser. Couture believed that this would greatly reduce delays in crucial project communications—he believed they could cut weeks, perhaps months, out of project schedules. Technology of this kind would also provide huge cost savings by reducing the number of overnight deliveries required to carry out typical project communications.
Information Technology: What was it for?
Each of the five companies used I/T in construction management – sometimes for similar, and
sometimes for different purposes. Everyone used e-mail and voice mail. In addition, Genzyme
used an on-line project CAD system, Children’s Hospital shared the use of its architects’ on-line
project systems, and Fidelity used third party project software, scanners, digital photographs and
they used their general contractor’s internally developed on-line project management system.

Current period priority technology initiatives at four out of five of the companies were not
designed to directly address speed in project team communications—although speed in
delivering completed projects was a priority for each of them. At State Street, the priority
technology initiative was to automate and streamline the process for project approval and
financial justification. At Reebok, the technology wish list was headed by an Intranet that would
allow employees to access information about projects. Children’s Hospital had an initiative to
educate internal customers and would also like to develop an on-line system for internal
customers to access project data. Genzyme said that they would like to have a project Web page
but this did not seem to be a crucial priority, and it was not apparent exactly what additional
benefits they expected from such a system. Only Fidelity was actively pursuing I/T to directly
improve the efficiency of project communications with the goal of delivering buildings faster.

Communication issues at four of the five companies centered on their internal organizations—on
project approvals, employees and internal customers rather than on communication with vendors
and consultants. It is possible that some of this emphasis on internal issues might be explained
by the fact that the interviewees were top level executives. As such, it is not surprising that their
perspectives were more focused on the broader issues of managing their organizations rather
than on the more narrowly focused issues of communication in the day to day running of a
project. If managers at the next level down in each organization were interviewed perhaps they
would have expressed more concern with the pain surrounding project communications (among
vendors, consultants, sub-contractors, etc.)

Each company was evaluating and utilizing technology in construction management – but in four
out of five cases, not in the way I thought they would be. This paper set out to test the
hypothesis that, information technology could be used to build buildings faster. Research results
showed that, among these five companies, there was not proof to support a definitive conclusion.
Each of these companies had a different answer to the question “can I/T deliver buildings
faster?” Fidelity’s answer was a resounding yes. Among the others it was less clear that
technology was the priority in achieving speed in the construction of buildings. Rather,
accountability was more often the priority, with technology playing a less important role. In a
sense, I asked a question about technology, but the answers I received were overwhelmingly
about people —how to fit people more effectively into the organizational structure, how to
motivate people, how to educate people, how to cause people to manage their time more
effectively. These were seen as the priority areas to address in order to deliver buildings more
quickly.
Beyond Fast-Track: Next Steps in Speed

My thesis advisor, John D. Macomber, wrote the following paper entitled, Beyond Fast-Track: Next Steps in Speed. It was presented at Harvard University on June 25, 1998 as part of the IDRC Executive Symposium: Infrastructure Challenges for Fast-Growth Companies. The premise of the paper is that corporate owners of real estate should be looking to I/T as a tool for dealing successfully with compressed project schedules. In particular, the paper speculates that use of Web based project communication systems would help to clear up accountability issues, and by providing greater project access, organization and accountability, would speed the delivery of construction. Since the premise of his paper correlates with that of my thesis, I thought it would be instructive to analyze the paper with reference to the companies that I studied.

Macomber’s paper identifies that:

“The delivery system of the future will be about the information.” It goes on to say (that project team) “members are in the information business.”

This was a fact that proved true among the five companies in my study. Whether the issue was assigning responsibility for the breadth of information required to manage a construction project as with State Street; exchanging a large volume of complex information as with Genzyme; managing the motivations of those who control information flow as with Reebok; expanding the scope of access to information as with Children’s Hospital; or attempting to speed information processing as with Fidelity, the key component for these companies in attempting to improve efficiency in the building process was information.

Macomber’s paper advocates that the bottom line would be improved:

“By opening the flow of information, providing economic incentive to work towards the owner’s goals, by using superior capabilities of shared databases and the Internet to form a whole team, and by emphasizing the business benefits of sharing information in a planned and thoughtful way.”

Each of the five companies in my study were searching for ways to accomplish the goal of creating a whole team. All of them saw that improving project team communications (i.e. better, faster, more accurate exchange of information among project teams and/or internal customers) was the way to achieve this goal. Their initiatives showed how they each aimed to create more of a whole team by sharing more information. For example, at State Street, newly defined owners of a project would lead the whole team by having greater access to information that would give them more control and responsibility. At Children’s Hospital, internal customers would have newly acquired shared access to facilities information that would enable them to be more responsible and to contribute to the whole team. At Genzyme, policies for controlling information turnaround were really about more effective sharing of information among the whole team. Fidelity had the most obvious match with the concept of creating a whole team—they were attempting to discover ways in which I/T could bring shared information to the whole team and thereby overcome the obstacles to speed inherent in large, geographically separated project teams. Reebok’s point was to create a whole team in the sense of a boat in which (they
were) “all pulling oars--hopefully in the same cadence.” This cannot be effectively accomplished without shared information.

Whether they saw it this way or not, the interviewees’ attempts to create whole teams were always about sharing information. The end-goal might have been accountability but accountability is necessarily tied to information exchange. How do you hold someone accountable if you cannot track the critical path of information exchanged? Unless information is well organized and shared there can be no accountability—this is the point Macomber makes in his paper about organization, access and accountability. Four of five companies were focused on accountability to improve speed and efficiency, but to achieve this they were implementing strategies for improving the integration of whole teams into shared information environments. In this way, their strategic directions evidenced de facto agreement with Macomber’s premise—that improvements in the sharing of information lead to faster buildings and improved bottom line. They diverged with Macomber’s premise only by not placing I/T at the forefront of this strategic implementation (except for Fidelity.)

An example of this can be found in examining data from Children’s Hospital: Initiatives to provide internal customers at Children’s Hospital with greater shared access to facilities information were designed to cause them to become part of the whole team. The bottom line would be improved because internal customers would understand the processes and costs associated with their actions. They would be able to set realistic expectations and work in conjunction with the facilities team rather than at odds with them. In this sense, accountability would be the result of improving the scope and effectiveness of shared information. The goals and initiatives at Children’s Hospital match with Macomber’s theory that improving information organization, access and accountability will improve speed and the bottom line. Children’s Hospital diverged with Macomber’s theory in the sense that they were not looking to I/T to accomplish these goals.

The same was true for the other companies: The priority was accountability in one form or another, strategic goals included improving information exchange in one form or another and creating whole teams. This matched with Macomber’s paper – yet they were not evaluating how I/T might help them to accomplish these goals. For this reason, I believe that each of the companies would benefit from a more careful evaluation of what I/T might do for them in improving the creation of whole teams through more efficient sharing of information. If Macomber’s premise is true, that I/T can improve information sharing, thereby improving the formation of a whole team, thereby improving project speed and efficiency, thereby improving the bottom line; then I/T has a role to play for the five companies in this study, since these improvements exactly match their stated goals.

The benefits to speed would be derived from an I/T system that provided shared access to accurate, up-to-date information easily available to team members through a standard system of organization:

“Decision makers know what’s going on. Teams save time and money and work more effectively.”
The simple but powerful message is that decision-makers must have fast access to accurate information; without it there can be no accountability. At the time of my interviews for this thesis none of the interviewees had read Macomber’s paper on Next Steps in Speed. Nonetheless, his paper addresses many of their priority issues and might provide some answers for them about how to improve speed in construction management. Research showed that, in attempting to make project management more efficient, accountability was the central focus of four of the five companies. Accountability is a people issue, but it is also an information issue, and in this sense Macomber has hit upon a good point when he says that:

“Business needs require faster and faster delivery. Faster delivery means faster decisions and better information flow.”

Every one of the companies in my study would agree with this—speed was a top priority among them and speed meant faster decisions that cannot be made without faster information flow. However, they believed that faster decisions hinged more on the accountability of the decision-makers and less on the speedy delivery of information. This meant that they were focusing not on how to get information faster, but how to cause decision-makers to act on information faster; and also on the sub-set of this: who was supposed to act next. Presumably the decision-makers had to have the information before they could act on it. Once they made a decision then they also had to deliver it for execution. In this sense, whether recognized by the interviewees or not, accountability and the speedy delivery of information are interdependent.

Macomber’s point about access to information is also important in the accountability equation. An accessible information database would allow project team members to see the critical path of information. If someone were holding up a decision then the transparent database would allow the entire project team to see where the decision was delayed. There would be no room to duck accountability.

That interviewees were focused on accountability might be a precursor to the next step of turning to I/T to help improve both accountability and speed. In his paper, Macomber speculates that:

“New information technology tools, designed to help people to represent designs more completely and to work in groups more effectively, hold the promise of a new way of working.”

Although interviewees were looking to find new, more effective ways of working within project groups, with the exception of Fidelity they did not see I/T as the best tool for achieving these goals. If I/T works the way Macomber thinks it does— to improve accountability leading to improved speed leading to an improved bottom line— then all five companies should be investigating its potential more thoroughly. Perhaps if they made a more careful evaluation of currently available construction management/project communication technologies they would recognize some benefits to their stated goals. At the very least such an evaluation might yield new ideas on how I/T might be applied to solve problems of improving accountability, speed and the bottom line among whole project teams.
Beyond Fast-Track: Next Steps in Speed

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Introduction: The Need for Speed

Fast Growth companies need to preserve real estate options for as long as possible, then get to market as quickly as possible. Corporate real estate teams, and their design and construction vendors, are near the limits of the improvement that is available from speeding up physical work at the drawing boards or in the field. Strides in speed from creative allocation of risk, for example fast track, design build, and partnering, are also reaching the limits of effective acceleration.

A new generation of tools is available today to help teams to reach the next frontiers of delivery speed: better decision making and more effective use of information. These tools include technologies like groupware, 3D modeling, and the Internet, as well as contract and negotiation methods involving multi-party agreements, interest-based negotiation, and innovative financial products which reward all of the players for "team" behavior. Many of these tools have compelling benefits, but are difficult to implement across many vendors on one project. Third party outsourcing partners may be able to help corporate real estate groups improve their bottom lines, and their process, with this next generation approach.

Corporate Real Estate: Pressure at the Focal Point

Time is the enemy. Corporate real estate is in the middle.

Business pressures today force corporate users and management to defer real estate decisions as long as possible. Once the decision is made, the facility must be up almost immediately. Users have many other issues in their businesses which also drive program requirements, ability to pay, capability to make decisions, and willingness to pay attention to facility issues in the face of daily business demands.

While answering to this difficult "customer" environment, corporate real estate groups must get buildings designed and delivered through a large and hard to coordinate set of consultants, sub-consultants, contractors, sub-contractors, and vendors. The corporate real estate group is the focal point between these groups. There's pressure on results, on effectiveness, on process, on cost, and on time.

Industry Value System

The typical new corporate building project is delivered by a value system including scores of participants, and dozens of companies. The real estate department is charged with site acquisition, finance, legal and environmental input, and design and construction. The principal design firm might have 10-20 subspecialties or subconsultant firms; the constructor likely has more than 50 subcontractors and vendors in new construction.

In this value system, the physical product flows from manufacturers through distributors through subcontractors through general contractors through the "owner" - in this case, the facilities group. Money flows the other way: from the end users down the chain to labor, manufacturers, and intermediaries. On a parallel track, the intellectual product of the design team flows up to the owner, and the money flows back down.
Every link in the system is characterized by some level of contract and some level of risk. The parties negotiate who will accept which risks.

**Problems Within the Industry Value System**

Information flows in both directions in this value system. Typically it flows along the chain of contract relationships. Information is communicated piece by piece and step by step, in paper or by email, with no common organization or accountability.

Complicating the process further, the many contracts and business agreements are based on two-dimensional representations of three-dimensional space. These representations are static and contracts are based on lack of change. Consequently change creates havoc in controlling the information and the contracts. The present information handling system does not accommodate it well. Yet the business needs of corporate real estate users demand constant change.

In a manner particular to the real estate, design, and construction industries, practically all of the entities on a new building project have many other business relationships outside of one particular client project. All of the projects are of limited duration, making it hard for teams to get to know one another. All of the industry sectors in the chain are highly fragmented (with the exception of a few manufacturers and financial services firms), so no participant alone has the standing to have influence on the design and construction industry. Consequently, there is limited ability to accomplish the kinds of supply-chain management and electronic data interchange strategies pioneered by firms like Wal-Mart and Procter & Gamble to revolutionize the retail industry.

All of these factors lead to intense inefficiency around decision making, to parties with opposing financial incentives, and to inadequate handling of information on projects. This costs time and money.

For example, the author was the project manager for a condominium project with the opportunity for buyers to customize units prior to construction. However, there was a poor business model for documenting design intent of the buyers, obtaining firm change proposal pricing information from a dozen trade subcontractors over 100 condominiums in the heat of a fast-track schedule, and waiting for total approval of all changes before starting. This led to irate buyers, work done out of sequence, unreimbursed inefficiencies for the trades, and loss of money by almost all parties.

There must be a better way.

**New Tools and the Need for Speed**

Business needs require faster and faster delivery. Faster delivery means faster decisions and better information flow. New information technology tools, designed to help people to represent designs more completely and to work in groups more effectively, hold the promise of a new way of working. These tools include 3D design tied to databases, groupware, and the Internet.

At the same time, the need for efficiency and for alignment of purpose among many firms has led to advances in business relationships independent of the technology possibilities. These include multiparty agreements (some based on the field of game theory), facilitation of communication including Partnering, and innovative insurance products that reward all of the players for acting in a manner that benefits the project as a whole.

The first class of technologies are not likely to succeed on real estate projects without the second class of advancements: those which align compensation for the parties. Rational economic actors will not adopt new technologies, share information, give up leverage, or alter the existing risk relationships unless there clearly is a business benefit for them.

These potentials can be combined.

**A Vision for the Delivery System of the Future**

The delivery system of the future will be about the **information**. All of the members of the value system are in the information business: What will it cost? What are the choices? When
will it be done? Where is the piece? Has the Research Department signed off?

**Groupware and Workflow across the project**

Computer programs like Lotus Notes allow many users to collaborate through one well-organized central database. Reviews, approvals, and logs of outstanding work can be built and shared in real time to help the entire team have access to all of the information, and also access a real time log of what is owed by whom. Letters, invoices, photographs, reports, schedules, and drawings can all be posted, tracked, shared, worked on, and approved by any authorized team member, from anywhere, any time.

**3D Design - Better instructions**

The information will mirror the product: represented in three dimensional designs, just as is current practice with manufactured products like airplanes and cellular phones. The design will be dynamic and always changing - because the users will require it, and because it's possible. Three dimensional design will vastly reduce confusion around physical details and around space coordination, interferences, and visualization. Vendors like Parametric Technology and Solidworks have built major businesses in 3D modeling of design information in other industries.

**The Internet - Information at once for the whole team**

Advances on the Internet, including faster speeds and cheaper computers, mean that the entire team will be sharing all of the information in real time. The speed of connectivity - as well as the range of companies committed to working on the Internet - is growing so fast that this will cease to be a business obstacle within a very short time frame.

The team, defined very broadly to include all of the key users and all of the key consultants and vendors, will have access to information and decisions from start to finish: from initial evaluation of pro-forma alternatives, through design and construction to commissioning and operations. The team will build the project knowledge base together.

But how will the information be shared? Why should the designer invest extra effort to build information that benefits other players in the chain? How will owners avoid being taken advantage of by vendors with respect to changed information? The technologies will not be adopted if the business model does not change as well.

**Why should I share? Multiparty agreements**

Game theory suggests that multiparty agreements can be crafted that indeed give all players a distinct incentive to work for the good of the whole, because it clearly is good for them too. For example, the interests of two of the key participants in the condominium example can be analyzed and shown to have an opportunity for a win-win set of incentives:

- Buyers want a good experience. They are willing to pay for quality. They have no incentive to make fast decisions. Solution: an upfront charge for customizing, on top of actual cost, with rebates (not added charges) for timely decisions.
- Subcontractors want to do the work once, in their sequence, and don’t want to price many alternatives. Solution: upfront negotiation of many unit prices, a bonus for satisfying the buyer from a process point of view (drawn from a pool of the customizing charges), compensation for staffing the office to provide the level of service desired by the developer.

In practice, there are many more parties and many more incentives. This example illustrates a starting point for interest-based multiparty negotiation. The next generation of time saving tools and techniques must feature an appropriate new business structure with clear incentives for all of the entities to leverage new information technologies that are based on sharing, not hoarding, of information.

**The bottom line: Pulling in the same direction, using information tools**

How does this vision improve the bottom line? By opening the flow of information, providing economic incentive to work towards the owners' goals, by using the superior capabilities of shared databases and the Internet to inform the whole team, and by emphasizing the business benefits of sharing information in a planned and thoughtful way.
What Can I Do Today: How to Make it Happen

The vision is appealing, but today’s reality is different. How can corporate real estate departments get away from today’s world of fax, Fedex, faith, of airplanes and overtime, and into the world that many of their manufacturing counterparts already live in - one of effective information sharing?

The historical model of technology adoption by individual companies, acting alone, is not useful here. Companies cannot independently adopt multi-company groupware or data sharing standards; the industry is too fragmented, and each firm has too many other relationships, to expect all to learn each others’ systems. Additionally, each firm in the value chain has core skills for which it is hired by its clients. These typically do not include the firm’s shared database strategy. For example, general contractors are hired based on price, proven ability to make schedule, proven record of quality, and proven people. Few owners will place an advanced information technology, and a proprietary standard of organization and workflow, ahead of these other variables for contractor selection. Similarly, few corporate real estate organizations want to make this kind of capital investment - and then commit to maintaining and upgrading it for users inside and outside the organization.

Vertical Integration

One school of thought is that the power of a shared project database is so compelling, yet the business obstacles so daunting, that new design and construction providers will evolve. These will be highly vertically integrated, probably centered around large owners, and their business interests will be aligned by virtue of their being owned by the same parent. This approach sacrifices the benefits of the present entrepreneurial system including price competition at all levels and the ability to only purchase the resources needed at the time, rather than stockpile talent in all specialties. However it takes advantage of the compelling possibilities for saving time and money by effective sharing of information throughout the value chain.

Information Subcontractors

A second school of thought holds that third party “information subcontractors” will be formed. These firms will act as a trusted, independent third party on projects. The information subcontractor will develop software, hosting capabilities, and training and support capacities to support project teams on behalf of owners. In many cases, the information subcontractor will take the technology risk and the capital risk of the software, the programming, and the database hosting, and will also provide extensive outsourced people and support services.

This business model allows corporate real estate users to rent or subscribe to a shared database for themselves and all of the other firms whom they wish to include. For some, this is a way to outsource IT capacity during a time of intense activity with many outside parties and vendors; allowing IT to focus on the ongoing core needs of the operating business. Finally, this shared resource exists outside the corporate firewall, and has almost no impact on the corporate network or IT function - making it easy for project teams to say “yes.”

Collaborative Structures

The author’s firm, Collaborative Structures, is a leading provider of these services. This is a business solution to a business problem; adapting the new technology tools so that they can be leveraged in the special circumstances of the real estate industry. The firm employs widely available Internet technology like Microsoft Internet Explorer or Netscape Navigator to access databases built in Lotus Domino and hosted on the World Wide Web. The databases allow authorized project members from any company to see the entire database from anywhere, anytime. Documents transmitted and tracked typically include text, photos, drawings, accounting reports, and schedules; but there is almost no limit to file types supported. Since the solution is based on Internet browsers, it is instantly useable on almost any firm’s operating system and with almost any application program.

A deep commitment to training and support characterizes the best of these third party providers; success for project teams on shared databases is not about technology as much as it’s about people.

Extensive sharing of 3D CAD models and multiparty agreements is still in the future. Yet, today firms like Collaborative Structures offer shared database solutions with functions which...
provide ACCESS, ORGANIZATION, and ACCOUNTABILITY for the whole team. Corporate real estate departments can create a common knowledge base that incorporates every phase of the project, from initial concept and “what-ifs” through commissioning and operations. Corporate real estate departments can realize a standard organizing system and easy access to project information across all projects, regardless of location and with unlimited variety in end user groups served, or architects and contractors engaged on various projects.

What will this feel like? Users can go to any computer with a browser, anywhere in the world, and check in not only on their files and to-do lists, but on the outstanding work items for the whole team, regardless of what company the team member works for. A few mouse clicks show not only the log of what’s outstanding, but actually open the document. Months later, it’s easy to find documents from a common shared, unchangeable record. Decision makers know what’s going on. Teams save time and money and work more effectively.

The Bottom Line: Finding Time

Time is the common enemy. Corporate real estate teams can help their companies build competitive advantage by leveraging information across project teams. When access, organization, and accountability are established, every team member can work more effectively, make better decisions, and improve the bottom line for themselves and for the project.

Companies want their real estate departments to do more, with less, to help the organization succeed. New information technologies, coupled with thoughtful and complete attention to the people and business issues, help these teams accomplish this mandate: compress space and time.

About the Author

John D. Macomber is Founder and President of Collaborative Structures, Inc., a provider of online collaboration solutions to help building owners save time and money. Mr. Macomber is the former CEO of the George B. H. Macomber Company, a Boston-based General Contractor whose time-sensitive clients include EMC Corporation, Hewlett-Packard, and Fidelity Investments. Mr. Macomber’s graduate level class at MIT, “Strategic Management in the Design and Construction Value Chain,” covers topics including game theory, interest-based negotiation, groupware, and supply chain management in fragmented, project-based industries like real estate and construction. Mr. Macomber is a graduate of Dartmouth College and of Harvard Business School.

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Bibliography


Addendum

The following list provides the Web sites for a selection of currently available information/communication technologies for construction project management. Interested readers can find more about these products on the Web.

FirstLine by Collaborative Structures, Inc.: http://www.costructures.com
ProjectCenter by EVOLV: http://www.evolv.com
Framework Technologies Corporation: http://www.frametech.com
MP Interactive Corporation: http://www.mpinteractive.com
Advantage PCS by Emerging Solutions: http://www.emergingsolutions.com