

# Intranet Internet Applications for the Construction Industry

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Intranets offer contractors a method to manage construction project information more effectively and efficiently utilizing low-cost hardware and software. The current infrastructure of the Internet can provide the backbone for these project Intranets. Intranets can improve project communications, save personnel time, and reduce paper requirements. Security requirements, Intranet structure, content updates, and various disadvantages must be given due consideration by contractors

**Key Words:** Cost benefits, construction applications, consultants, hardware, information, Internet, intranet, security, software, and transaction costs.

## Introduction

There has been a significant amount of coverage in the media about the Internet and the so-called "Information Superhighway." To be sure, the popularity of the Internet is an important trend. It is one that many businesses including those from the construction industry are racing to use as a technique for marketing from business to consumer. One large homebuilder has a prototype Internet site where prospective purchasers can view subdivisions, model house plans within subdivisions, and further look at pictures of a typical room by further searches (Pulte, 1996). Overlooked by many contractors in this frenzy is the potential for inside business or Intranets utilizing the Internet as a communications backbone. The construction industry can realize that there will typically be much more impact through this Intranet model on improving the business operations of construction organizations. Construction organizations are typically conservative and have been amongst the latter adopters of new technologies such as computer and information technology. The revolution in computer technology with processing power, memory, disk capacity, and constantly-lower costs that all continue to improve seemingly without any scientific limits means both practicality and affordability for the typical construction organization. When it comes to the Internet, the popular press has focused on such issues as security and personal abuse which perhaps is an immediate impediment to construction organizations in adopting these intranet tools. The goal of this paper is cover applications along with the practicality of the technology, cost savings, hardware issues, software issues, and security topics. Progressive construction organizations that have adopted Intranet strategies have achieved significant benefits. There are no lengthy histories of successful implementations, of course, since the enabling features such as commonly available high data transmission rate hardware and software ease-of-use are such recent innovations. While contractors are not information technology wizards, they don't have to be to successfully implement Intranets for construction project sites.

## **Intranet Definition**

Those familiar with computers and networks are conversant with the idea of client-server architecture. The client-server model serves as a starting point in that Intranets are a client-server platform with universal clients, servers, and protocols. The client is universal and browsers can access all servers. The same face, in essence, is presented to the world and the universal client browser can talk to all applications.

The importance of the Intranet concept is perhaps best illustrated by some brief history of personal computer applications. Ten years ago, documents from personal computers were stand-alone documents. Therefore, if one wanted to have a spreadsheet attached to a word processing document they utilized a stapler to attach the two documents together. Five years ago, OLE (object linking and embedding) technology began to enable compound documents. Therefore a spreadsheet could be embedded in a word processing document. The linking feature meant that when information in the spreadsheet changed, these changes flowed automatically to the word processing document as well. These compound documents with their varying content types point the way for the power of the Intranet. The typical construction organization has a vast array of information including documents plus images that make up their files for any given construction project. As an example, a given estimate work package line item finds representation in schedules, cost reports, and purchase orders. This data is locked in desks, file cabinets, and heads of employees. The contractor's data must be accessed by employees in far-flung locations, subcontractors, and suppliers. Intranets are basically taking Internet standards and bringing them down to firm standards.

These documents can't be considered as independent entities but instead as a single unit and therefore changes or updates to one item should update everything else in tandem. Certain construction projects are developed on a fast-track basis in that portions of the project are under construction while design is still underway or is not yet started on other project elements. The benefit of the fast-track process is a shorter cycle time for the client in terms of project delivery. The inherent fast-track problem is, due to poor communications, re-work and scrap costs can significantly reduce savings. Improved construction site-fabricator-designer communications through the Intranet can produce substantial benefits. Two large design-constructors were separately commissioned by a chemical company to construct two plants both on a fast-track basis. Plant A was for \$60 million and Plant B was for \$150 million. Plant A was built by a firm with Intranet communications links between the design-construction-fabrication entities. Plant A ended up with \$30,000 in leftover/scrap material whereas Plant B ended up with \$1.2 million in leftover/scrap material (Marquardt, 1995). The cost savings accrued from faster and more accurate communications in these situations through Intranets by avoiding materials procurement mistakes.

## **Intranet Cost Rationale**

Construction organizations are almost by definition, paper-based organizations. Field construction people must translate lines on drawings and words in specifications into the reality of a constructed project. To accomplish this, other paper in the form of estimates, shop drawings,

sketches, memos, purchase orders, punch lists, meeting minutes, and other data are in part the tools of this process. The cost on a manual basis to locate this information or repair mistakes due to ignorance of already-available information can be staggering. One construction firm surveyed its project managers and found 15% of their workday was spent on searching for information (Bronken, 1996).

What makes the Intranet so compelling from a cost standpoint is that:

- Intranets are easy to deploy in that web browsers (software programs that enables system use) are easily distributed
- Web browsers are easy to utilize requiring no real training
- Low or no acquisition cost for web browsers
- Inexpensive data connection transmission rates

Consider a construction organization with 25 cellular phones and an annual cell phone bill of \$50,000 or more. If effective Intranets through enabling systems such as e-mail can reduce this cellular messaging traffic by 50%, the cost savings are important. Similarly, what are the actual transaction costs to process a change order or a purchase order through an organization? One contractor tracked the costs of purchase orders from inception and found the paperwork costs to average slightly over \$100 per purchase order (Barton, 1996). Intranet implementation reduced the cost per purchase order to less than \$1.

This cost per purchase order can be multiplied by the number of P.O.'s on a typical project to extrapolate the potential savings from just this one item. The cost of passing paper around a construction company is one of those hidden costs that tend to become absorbed in general overhead. Even though these transaction costs may not show up in executive reports, they are still real costs.

Intranets provide a strategic weapon for contractors. What is the time value of information to the project? Intranets help contractors manage things more efficiently and effectively. Intranets enable contractors to manage information and access information in an easier fashion. They can improve the quality and reduce the costs of the contractor's internal infrastructure.

IDC Corp. in a survey of corporations that adopted intranets found that the return on investment was 1000% that meant the payback period for this tool was less than one quarter (IDC, 1996). Thus the actual cost to develop and deploy these Intranet solutions is very low.

### **Hardware Considerations**

Software is one part of the Intranet with hardware, of course, being the other half. Some contractors considering Intranets may feel that these applications are only for larger contractors. However, many hardware vendors are making available web platform servers that are implemented in relatively inexpensive and uncomplicated manner. One firm has what they term a "shrink-wrapped Internet server" that they claim can be set up in an hour on site (Morris, 14). An important consideration in hardware selection is that of availability and reliability. A

contractor can not have project business stop because the server site is out of commission. Security considerations from both a hardware and software perspective are essential.

Hardware configuration is important in the sense that an Intranet differs from many typical web sites. The standard web site is a relatively static site and essentially only displays information. Construction projects comprise substantial amounts of data and personnel need to search through large amounts of data to be productive. Data base mining takes a large amount of central processing unit (CPU) power as can be attested to by those familiar with data base and spreadsheet applications. A 150 megahertz-plus Pentium Pro box (or equal) with 24-32 megabytes of random-access memory and a hard drive sufficient to contain the project data should suffice for most contractor intranets. These Intranets are random-access memory-intensive applications. Given the cost-tradeoff choice between faster processor speed above the 150 megahertz threshold or more random-access memory, the decision should be for more memory. A Fortune 500 firm web site requires the power inherent in 64-bit specialty servers since they may receive 100,000 to 1,000,000 hits per day. These large web sites need significant computing capacity to deliver information to people simultaneously. A construction Intranet would never generate this amount of traffic volume therefore computing capacity requirements are not nearly as severe.

Higher-level personnel such as a project manager or operations manager obviously need to access more than one project. If a set of projects outgrows the capacity of one box, other boxes can be added on a low-cost basis to take care of this. This is transparent to the user. They tie into the intranet site and choose a search path for a certain project and they may be switched to another box. As projects are completed, space on servers can be freed up for additional projects with the outdated project's files saved in an archival state.

### **Client Relations**

Intranets not only provide direct benefits to the contractor but subsidiary benefits to client relations. Intranets level the playing field enabling a small and medium-sized contractors to have the same high-tech profile as larger contractors. This can improve client satisfaction with the benefit of possible repeat projects. Currently, contractors utilizing Intranets to help keep clients and their resident project staffs informed can project a more progressive image than most of the competition. Client questions can often consume project staff time better devoted to more productive project issues. The project Intranet allows the client to access this information and reduces the burden of this task on the contractor's personnel. Thus an Intranet can be both an information tool and a marketing tool.

The decision-making process for a client selecting a contractor is a complicated process and can be an emotional one. Clients using an Intranet connection to get immediate answers to their questions can tend to have a more favorable view of the particular contractor. There also tend to be barriers created between contractor and client which Intranets can assist in overcoming.

A non-construction example of better client relations is Federal Express or FedEx. FedEx has placed a front-end on its databases that enables customers to track their packages around the

world, day and night, every step of the way. This customer Intranet gets information to FedEx customers in a secure way while providing a means of differentiation and competitive advantage for FedEx (Gerstner, 1995).

### **Consultants**

There are also a number of consulting organizations which for a nominal fee will assist in setting up Intranets and initial programming for contractors. Ultimately, the goal is to have a system that requires no consultants and can be updated by the contractor's employees. The best way to evaluate a consultant is to have an actual demonstration of what they have done for other companies. If the contractor has the necessary computer expertise in-house, consultants may not be necessary. However, this is usually the exception rather than the rule. What consultants bring to the table is expertise gained from the installation of many systems plus special expertise in areas such as Intranet security. Security protections, as detailed in due course, can not be ignored in Intranet implementation. Creating a sound Intranet means a strong focus on content. The consultant can help assist in this content creation process.

A caveat with consultants is that they have to be educated to the construction project model. Many consultants have substantial business experience but not with construction organizations. In order for the Intranet to deliver value to construction project personnel, consultants must be educated as to what are the information requirements. To achieve full value, the Intranet site must be seen as a valuable tool and a comprehensive information source by project users. Contractors and consultants need to collaborate on a content perspective from the project user viewpoint rather than how the contractor may be organized internally.

### **Contractor Intranet Possibilities**

Already discussed have been certain applications for the contractor's project Intranet. Essentially all information about a project can be posted to a project Intranet with proper password protections. Any item on a project that involves paper can be converted to use on an Intranet. Items such as safety plans, project schedules, field change orders, and project meeting minutes can all have an Intranet presence. Tool box safety talks are required by contractors and these safety contacts are mandated by law in some states. A carpenter supervisor starting a scaffolding project could with a web browser set the search engine to find the talk on scaffolding safety for the crew. This example of a carpenter supervisor utilizing a web browser on a computer may seem unrealistic. However, if user-friendly Intranet design is implemented with understandable point-and-click interfaces along with adequate training this concept is possible. Similarly, a superintendent remembers that about two months ago, there was some discussion on curtain walls for the project. Utilizing the browser and a key word search through the search engine, the superintendent could easily find the reference information related to curtain walls.

Other information contractors should consider postings to an Intranet include the company personnel policy manual, safety manual, benefits information, and general company information. Methods' improvements or a problem solution with a concrete forming system can be quickly

sent company-wide. When a contractor gets new projects or other newsworthy events occur, employees generally want to know this information. A contractor's Intranet makes this possible in a very low cost fashion. Newsletters can be costly to produce, become outdated, or lost by employees. Intranet information can be posted, readily available, and continually updated. One of the management trends is to make employees feel they are a part of the company. Intranets, through providing relevant information, can foster this.

Training is a key issue in the construction industry. Particularly problematic is employees working at remote locations. A contractor Intranet can provide for on-line training. Project personnel can share various ideas on issues they encounter on projects which is another training methodology. Intranets can make experience easier to learn, to use, and to maintain.

### **Disadvantages**

There are certain potential and real disadvantages to the use of Intranets. In general it is a sound concept but there is still a requirement for improvements. One area is in terms of web authoring tools that allow non-programmers to be able to create applications without programming. A project engineer may want to create a hyperlinks to related information such as costs and schedules. The lack of practical web authoring software is one of the most critical factors in the enhancement and advancement of Intranets (Machrone, 1996). Continuing advances in web-page authoring software are making it easier for non-programmers. Code-based web tools are giving way to graphics-based editors much as the way graphical user interfaces have done in other software areas (Mendelson, 1997).

Intranets also need constant updating. Intranets are about information and for that information to be useful, it must be kept current on a continual basis. How often should a project Intranet be updated is one question asked by contractors. The answer is that updating should occur when new information becomes available. Those contractors who decide to update a project Intranet like their network schedules on a once a month basis will not derive the advantages that this tool can offer. A contractor can not realistically expect someone who has a full-time job doing something else to manage this because it will not happen. Either one of the jobs or the other will suffer from time constraints. It could certainly be part-time such as a quarter-time allocation but the contractor has to book this time into the person's job. Maintenance of project Intranet databases just as with project schedules currently requires a significant time commitment by the contractor.

The advent of powerful browsers allows information viewing in a very user-friendly way. What is needed is a way to update and create content in a very user-friendly way. Intranets are not the whole solution. Those contractors employing various groupware software packages in proprietary client-server configurations should still retain it but attempt to retarget it to the Intranet. Groupware applications that strongly support Intranets still require further development (Mitchell, 1996).

To achieve full cost and time advantages with the Intranet tool, there should be an avoidance of dual information streams, paper and electronic. Even signatures can be captured electronically

for such items as authorizations and change orders. Having a separate paper-based system concurrent with the electronic system will only partially realize the true benefits. Contractors in a paper-based world usually never have to worry about document editing. A document in two-column format has to move to one-column format for obvious scrolling reasons. Documents on paper can look different on a computer screen. This may require a simple change such as with a color palette selection due to monitor viewing problems or a more substantial change.

All information about a project may not be suitable for a project Intranet. Drawings constitute a significant amount of project information yet data transmission rates for this type of graphic information may not be practicable for Intranet application. Even with transmission rate improvements through faster modems, the viewing an “E-size” (thirty-six inches by forty-eight inches) drawing on the typical computer screen is difficult. A \$2 million project may be comprised of twenty primary drawings. Often project personnel view these drawings together such as referencing a section view from one sheet to a general arrangements floor plan on another sheet. Scrolling between these drawings on a computer screen may not make sense. Therefore, certain documents such as large format plans should probably remain in hard copy form at present. Small drawings such as “A-size” (eight-and-one-half inches by eleven inches) shop drawings and sketches would be more practical for Intranet posting. Yet graphical information still requires significant downloading time.

Two other problems are transaction processing time due to translation and fidelity loss. Moving information between different-branded like applications requires translations that slow Intranet traffic down. Moreover there can be a loss of fidelity meaning that gibberish will show up at times in these translated documents. The loss of speed and/or the loss of fidelity hampers effective Intranet application. At present there is movement towards open standards that can be supported seamlessly over Intranets but problems still remain. Construction project personnel need to have the ability to share all data seamlessly rather than having “islands of data” that currently comprise most projects.

Some training is necessary for project personnel to show them how to find project information on the Intranet. With intelligent search engines available through web browsers, trained Intranet users can delegate information gathering tasks to these tools. However, users have to know and understand the applicability of these tools. Additionally, information posted to a project Intranet must be reliable. Information is only as valuable as it is reliable. Bad information follows the old cliché of “garbage-in, garbage-out.”

There has been a great deal of attention regarding the advent of network computers (Gerstner, 1995). These are essentially the reincarnation of “dumb terminals” that used to be for access to mainframes and mini-computers. The argument for network computers is that with Intranets, it doesn't matter to users where processing, storage, data movement, and other factors take place whether on the network or in their own computer. The supposed benefit with network computers is that acquisition, use, and updating costs will be less than with personal computers. Contractors considering the utilization of network computers need to be skeptical of true cost savings given constantly lower prices for personal computers. One key factor that has led to the widespread acceptance of personal computers is their ready availability to individuals in various locations.

Intranets should be viewed as a supplement to rather than a substitute for personal computers in field and office locations.

A final potential disadvantage to Intranets is that construction is essentially a people business. In addition, contractor personnel need to get out on sites and personally view the work activity. Reported data by the time it becomes compiled tends to be filtered in sometimes unintended ways. Some contractor personnel tend to try to manage projects by remote control and avoid interaction with the work actually taking place. It is hoped that Intranets will not be a crutch to promote these remote control management styles. Instead, the potential of Intranets should enable project personnel to avoid being buried in paper and spend more time interacting with project activities.

### **Personnel Abuse**

Contractors may be reticent to distribute web browsers and adopt Intranets because of the stories about employees abusing the Internet for web surfing and other time-wasting activity. Certainly there is the potential for employee abuse. Despite the best controls, it will still occur with Intranets. Any tool can be abused by employees from copiers to computers with a golf software game to company pickup trucks. Because employees abuse these items doesn't mean that a contractor eliminates them. The advantages and time savings of Intranets are so powerful that even if some abuse occurs, the contractor will still realize important savings. Contractors do not eliminate copy machines simply because they might be used by employees for personal business.

### **Security**

Security is a very common concern about the Internet and thus it follows that Intranets create the same concern. A number of true and dramatization-type stories have been publicized by the media about the potential for abuse (Brancato, 1995, Shimomura, 1996). No one wants unauthorized individuals accessing sensitive data. The typical construction project creates additional cautions. Due to the fragmented nature of a typical project, a number of subcontractors and suppliers are participants. They need access to at least a portion of the project database. Security concerns can not be minimized with Intranets. Security systems with firewalls that prohibit unauthorized entry are essential. Firewall software has been more prevalent for larger web sites. Lower-cost firewall packages costing a few thousand dollars make this solution practical for contractors. The Internet was developed to make communications easy and not with security considerations a concern. If someone gains unauthorized access, what information is available? Due to the proliferation of paper at a job site with little or no security, there is some exaggeration of security problems with an Intranet. Sensitive project information should be kept off of the project Intranet.

One potential scenario is to create a commonly available web site about a project. The commonly available information might entail project owner, designers, and contractors along with general project information such as general floor plan, square footage's, completion time frame, along with features including covered parking, fountains, and finishes. These files would be read-only-



uploadable to prevent hackers from altering the project information. A web server could be set up for all of the projects that a developer or general contractor has in progress. A developer with completed projects still needing leasing tenants or having upcoming vacancies could also place these on the web server along with lease rates. Onto this web server that is actually Internet available could also be a guest log. Those desiring more specific information on lease areas can sign the guest log for further follow-up by the marketing segment of the developer's organization.

A separate web server would be set up for sensitive information on various projects. Access to this web server would be password restricted with various levels of access depending on password. A contractor's project engineer could function as the "web master" who would be in charge of all documents for the project. Commonly available information such as project meeting minutes and project schedule would be available at the lowest password level. To get to certain areas such as unit costs might be restricted only to the superintendent-project manager level.

Password encryption programs commercially available at low cost mean that Intranets can be protected easily. These encryption keys mean that due to their length, even the world's best intelligence agencies with supercomputers could not gain access by cracking the encryption code in anything resembling a timely fashion.

Security threats to Intranets come essentially in three forms:

- unauthorized access to Intranet transactions
- unauthorized access by outside hackers to the Intranet server
- unauthorized access by inside hackers to the Intranet server

The Federal Bureau of Investigation (FBI) has stated that 80% of unauthorized access cases are from inside hackers that are overstepping their bounds or using their access privileges illegally (Summers, 1996). There are a number of architectures to choose from in configuring a system. Users from web browsers travel over the Internet to the project Intranet. Before they can get into the web server and Intranet they must pass through filtering router and firewall security software (refer to Figure 1). These systems check for user authentication before allowing access to the system. The primary concern in security is user authentication. Is the person who they say they are to allow access at the particular Intranet desired level? Security concerns raised by firms have meant that software authentication tools are available with most widely available web browsers on the market. Between hardware and software, a project Intranet can keep out even determined hackers. Suffice to say that Intranet security solutions at relatively low cost are available. Monitoring software can also point to unauthorized cases of access.

Another sensitive security concern for contractors should not be outside hackers or inside hackers trying to subvert an Intranet but instead what happens inside the contractor's organization. A mistake by a clerical staffer for the business development manager could result in a document such as a client lead list or strategic marketing plan being sent out for anyone to view on the network.

The issue of security is somewhat of a non-starter in many cases. Most information on an Intranet came off a piece of paper or is easily converted to a piece of paper. Virtually all contractors have facsimile machines in their offices. A fax machine can transmit all project information to anyone. Copiers can reproduce information just as well and be carried out by employees. The same example could be used with people who will give their credit card number to a perfect stranger over the phone but avoid electronic commerce on the Internet. What happens to a contractor when an estimator quits and takes cost data out the door? The only caveat with an Intranet is that the transmission of information is made much easier.

### **Impetus for Implementing Intranets**

Construction organizations as aforementioned are traditionally slow adopters of new technology. There are many examples of new technology common to the construction project such as lasers, hydraulic cranes, and improved materials. The important key to these technologies is that they came from vendors developing products to sell into the industry in more of a “supply-push” function. This technology adoption did not typically result in a “demand-pull” function from contractors. Lasers, as an example, took a number of years before they became a common sight on construction projects.

The cost savings from Intranet application are obvious. Like many innovations, conservative contractors tend to be suspicious of promised benefits. The slow adoption of critical path method scheduling techniques was only accelerated by owners making this a requirement of their specifications. A demand by increasingly sophisticated owners for more project information may lead to project specifications requiring that a project be displayed on its own Intranet. Some far-sighted owners have required contractors to implement document-tracking contract administration software on certain projects (Kern, 1987) and the next step up would be a project Intranet.

Construction program graduates schooled in Intranet techniques can provide an internal impetus for implementation of these systems (Walsh, 1996). In part contractors have adopted computerized cost estimating and other systems due to the fact that college-educated construction graduates were familiar with these tools.

The project cycle in construction is constant based on the familiar steps of planning, organizing, staffing, directing, and controlling (Barrie, Paulson, 1992). The essential element in every step is internal information and external information. Internal information integrated with external information. The growing merger of computers and communications capabilities affords direct access to construction personnel who heretofore depended on chains of human intermediaries.

### **Summary**

Continual decreases in the price of communications and personal computers with very high speed data transmission rates combined with decentralized construction operations make Intranets a sound solution for the construction industry. Work flow on a construction project not

only depends on tools, personnel, and materials but information. Intranets allow contractors to break down the barriers between itself, clients, vendors, and subcontractors. Construction projects are a team effort. With Intranets providing all information in an readily-viewable form, cross-firm collaboration is fostered on the project. The return on investment from Intranets makes it one of the soundest investments that contractors can make in today's competitive marketplace.

Contractors avoiding Intranets should consider the debate about telephones back in 1915. In 1915 many saw the telephone as just a gadget or toy with no practical value. The telephone is obviously an important communications tool and so too with Intranets. The computer revolution was supposed to usher in the era of the paperless office. Thus far it has not happened in construction due to the many separate systems controlled by project participants. Intranets offer a solution to help reduce the paperwork burden inherent in construction projects. Project personnel can then use their time where it has the most value.

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