The Impact of Information Technology and Internet in the Construction Industry

AMAURY A. CABALLERO
Dept. of Construction Management

KANG K. YEN
Dept. of Electrical Engineering

Florida International University
10555 W. Flagler St.
Miami, FL. 33174
USA

Abstract: - The wide implementation of Information Technology and Communications (ITC) in construction has proven to be a difficult task due to the inherent characteristics of the construction industry. The introduction of computers, telecommunications and automation is changing the way the different parties relate to each other in the whole construction process. Important opportunities for improving performance on engineering and construction projects may be obtained through the integration of design, planning, and construction. The only way of obtaining these results is through the rational use of information systems, including Internet. This paper analyzes the level of utilization of these techniques in the construction industry and the impact on the flow of information between the contracting parties. From the realized research a model is proposed that fits better the actual relationships that have appeared with the wide use of the Information Technology and Communications in the construction industry.

Key words: Construction, Information Technology, Computers, Communications, Internet.

1 Introduction

Factory-based manufacturing industries have long been enjoying increasing economic, safety, and quality control benefits from automated data collection and from the process control of production operations using automated machines, including robots. However, field-oriented industries like construction, with frequently reconfigured operations and often-severe environmental conditions, have been slower to adopt the information and automation technologies.

There exist at least four characteristics referred in the literature [1] in the construction process that complicates the introduction of Information Technology and Communications (ITC). These are Complexity of Building Process, Distinctive Nature of Projects, Dispersion of Construction Activity, and Divided Authority.

As is known, every building project contains inputs from several factors that in many cases act independently of each other: sponsor, designer, and contractor. Divided authority reduces the overall efficiency of a solution. For improving efficiency it is necessary to use a decision-making strategy that includes [2]:

a) Define and communicate the goals for and concerns about the project.
b) Identify areas and levels of performance that are critical to these goals
c) Establish value frameworks against which to assess the solutions.
d) Translate stakeholders' requirements to terms that can be more readily dealt with.
e) Raise and assess potential solutions in terms of their relative values.
f) Communicate and coordinate the "product" description during the project's life cycle.

To attend the observed needs in a) through f), it will be necessary to clarify:

i. What decisions will be made and when?
ii. What information is needed and in what form?
iii. Who should contribute to these decisions?
iv. Who should communicate them to whom?

The objectives of the paper are twofold:
First, to analyze the effect of information technology and Internet in the way the different participants in the construction process interact, and second, to present a model for the interchange of information that better fits to the actual state and tendency of the communications in the industry.

2 New Computer Based Relations in the Construction Industry

It is well known that computers increasingly and successfully support design and construction. From this seems logical to support their communication with computers also. With the introduction of computers and computer applications, a big quantity of information has been generated, related to projects, company, and in general with all of the construction process. Unfortunately, the communication between project participants has not been developed at the same trend. For this to be possible, it is imperative to have hardware and software implementations conforming a body of standards that permit free and easy access to multiple vendor solutions. This means, to make use of open systems.

The general means used for solving tasks in the construction industry are not suitable for open-systems communications and it is necessary to introduce software permitting this high-level computer communication. This will be possible when the reasoning behind the design and construction choices is made explicit in the message. To realize this, application needs information with more explicitly defined meaning, which is related with information at a higher semantic level.

Important opportunities for improving performance on engineering and construction projects may be obtained through the integration of design, planning, and construction. With the construction integration process, suppliers have a growing influence on the design, which results in designs that better fit the construction needs. This process has been defined as the continuous and interdisciplinary sharing of goals, knowledge, and information among all project participants [3].

The recent efforts of rationalizing the industry reached the point to integrate planning, design, fabricating, and assembly process like manufacturing industry. The previous separated design information and construction process planning are combined and integrated as a big construction system. That conceptual progress is considered [4] as the trigger of construction automation.

There exists a wide tendency towards the integration of diverse managerial functions: engineering, contract administration, quality control, accounting, commercial transactions, and reporting. Unfortunately, no satisfactory general solution has emerged so far due to the complexity of the interactions and the differences in the methods used by diverse groups on different projects. As stated by Hannus [5], “at this moment, one of the effects of ITC has been to fragment the construction industry, because different organizations are at different stages of IT implementation and simply will not “talk” to each other. The reason is that the software architecture has thus far been designed primarily to perform individual business functions, such as scheduling, cost estimation, purchasing, inventory management, or financial accounting. In many construction companies such function-oriented applications gave rise to an unmanageable maze of system components, and data could not be easily transmitted to other partners. For solving this situation, interfaces have to be developed to link the various applications. This problem becomes more complicated by the fact that, once instituted, function-oriented structures could not be transformed into process-oriented structures; as a result, companies sacrificed flexibility and the ability to introduce changes. This phenomenon, which is characterized by a high degree of internal integration with very loose or non-existent connections, is called *islands of automation*”.

Among the changes that ITC has introduced in the traditional relationships between designers and constructors is the possibility of working like a team, which has the ability to communicate faster, so

decisions can be made quickly. The traditional flow of information between owner-designer-contractors is shown in Figure 1. This model could be viewed somewhat like representing adversarial positions, with the project construction people on one side and the design people on the other, with the owner in the middle like a referee. In a modern approach, with concepts as partnering and construction management risk, the building process becomes much more collaborative. Now that most construction firms are relying on computers and communication technology to perform office functions and project work, these systems are influencing how the different parties in the construction process interchange information and work together. "The connectivity afforded by digital tools makes possible new levels of coordination and management control in single-project associations, more formal joint ventures, and permanent partnership created by mergers or acquisitions" [6]. This implies that the process can be changed interactively and accordingly to the needs. It is very important for the different parties to define at the early stages of the project all the basic issues, like setting, which standards will apply to the project documents, and what will be the communication channel the different parties will use for interacting with each other.

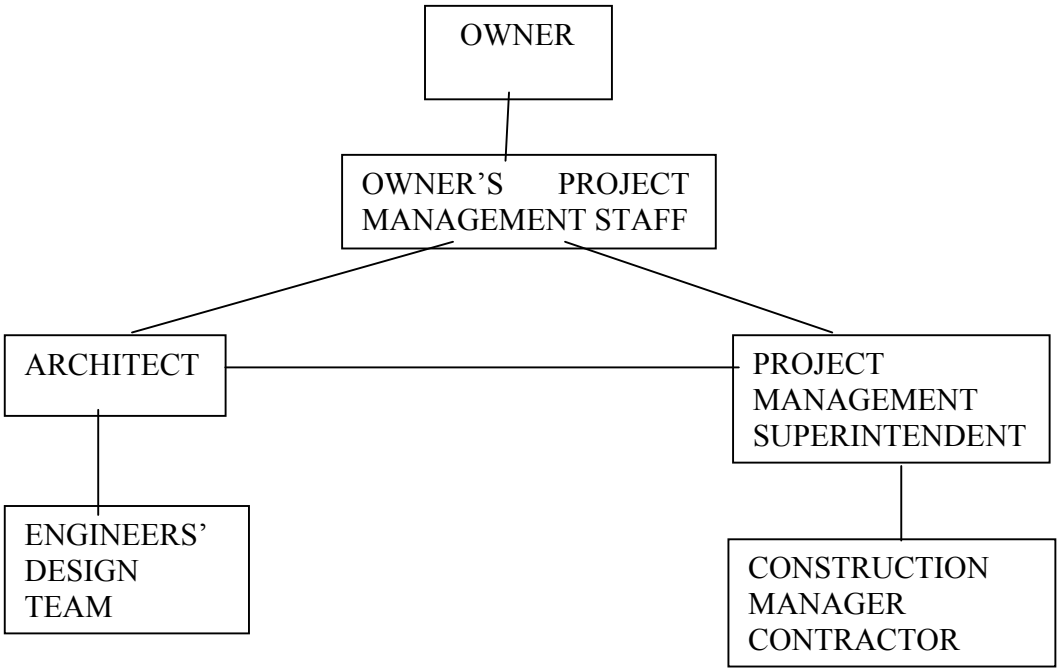

Figure 1. Owner-Designer-Contractor Flow of Information Representation.

3 The impact of Internet

Internet has emerged in the last few years as a real possibility for the implementation of Information Systems at the highest level. One of the advantages that Internet brings to the users is that they don't need to be in a specific location. It is possible to access the resources anywhere there is a PC and Internet browser. Collaboration became a reality when e-mail and Internet evolved to the point that professionals could routinely share their ideas and actual work.

There exist many companies that act as "Application Service Providers (ASP)", allowing the customer to access their software over the Internet for a monthly subscription fee at affordable prices [7]. A step further is the use of a "Management Service Provider (MSP)", which manages Information Technology (IT) operations for multiple business, running and

monitoring computer networks and software, hosting web sites, as well as providing web access and e-mail [8].

Among the benefits of using ASP and MSP are [9]:

- Monitoring computer networks and software, Small and medium sized companies can compete with larger corporations without spending a lot of money or recruiting skilled IT personnel.

- Using project management software on the web, people can view the same page on the web with figures that are recalculated as they change, and the two parties can negotiate online.

- All the software is integrated. So the backend accounting software, for example, is integrated into its project management software, both as a software product and online.

- The union of scheduling to e-commerce permit, for example, tracking materials from the manufacturer to the job site.

To this might be added [10]:

- Greater access to the information.
- Increased speed and flexibility of delivery.
- Self-service capabilities to all parties are provided.
- Customer satisfaction is enhanced.

Among the more representative online services can be cited:

- Online bid transmission services business-to-business.

- Internet applications for the commercial construction industry.

- Automated Service Dispatching.

- Web-based facility monitoring.

- Use of a centralized data base management system (DBMS).

- Integration of project data and knowledge management systems

3 New Model Representation

From the previously presented situation, it is possible to conclude that the traditional model presented on Figure 1 is not the best for representing the actual and future relationships and Information flow among the different parties. A more actualized model shall comply at least with three conditions:

1.All the parties will work on the product from the early stages up to the production stage like a team. The previously separated design information and construction process planning stages have to be combined and integrated as a big construction system.

2. The process will be changed interactively and accordingly to the needs.

3. It is necessary to have standards accepted by the whole industry.

The model can be graphically represented as shown on Figure 2. The data model has to exhaustively define the building through its entire life cycle. The data will include graphic representation in four dimensions, technical and cost calculations, scheduling, etc. The goal is to form a software bridge between mathematical coding- the language that computer read- and the characters and pictures that human can see and understand.

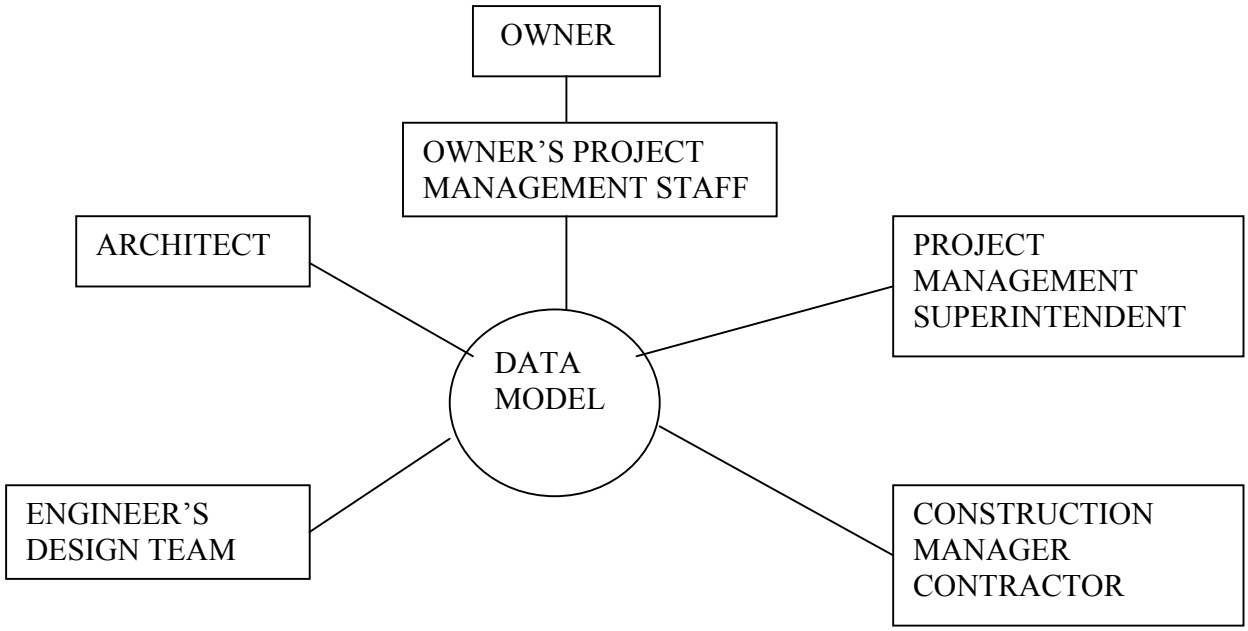

Figure 2. Actual Owner-Designer-Contractor Flow of Information Representation

Using the Internet as support, databases can be established for every aspect of a project and with monitoring and input timely information. For this model to be practical, it is necessary to have defined a set of standards. The positive experience from the manufacturing industry may be used in the construction industry. One area where manufacturing and construction are very different is in the interface between designer and constructors. In manufacturing, there is a new discipline for manufacturing engineers. They not only work on a new product at the concept and design stages, but also carry it forward through production. Consequently, the design process is heavily oriented toward optimizing the production cycle. Even with this philosophy, the most difficulty in computer integration has been at the break between design and production. Because of the difference in databases and the knowledge involved in the two processes, it has been difficult to integrate these processes. In construction, where the designers and the constructors work for different companies, this process will be more difficult. A conclusion related to this problem can be extracted: *the need for an industry standard is compelling.*

The collaboration across multiple project stages increases the complexities in the transmission of information and creates the necessity of more coordination issues.

As per Jerry Laisering [11], "the existing software packages differ at many levels, including how they name, subdivide, and classify building parts; the way they organize the attributes of those parts; and their method of linking parts and attributes. They also differ in the techniques they use to represent parts and attributes. The consequences of all this variation include lost or duplicated information, inaccurately transferred or converted files, and multiple databases of redundant information. Plus, much time and effort are wasted in checking these possible sources of error. Everyone would benefit if these communication problems were eliminated".

4 Conclusions

One effect of the construction integration process is that suppliers will have more influence on the design, which results in designs that better fit the construction needs. The recent efforts of rationalizing the industry reached the point to integrate planning, design, fabricating, and assembly process like manufacturing industry. Managerial functions like engineering, management control, contract administration, and others, move towards the integration.

Among the changes that ITC has introduced in the traditional relationships between designers and constructors is the possibility of working like a team, which has the ability to communicate faster, so decisions can be made quickly. The new available digital communication channels make possible a higher level of coordination and management control in single-project associations, increasing the necessary feedback that improves the quality of the project, and permitting the creation of permanent partnership formed by mergers or acquisitions.

At the present time, there are many companies on the web that act as "Application Service Providers (ASP)", allowing the customer to access their software over the Internet for a monthly subscription fee at affordable prices. A step further is the use of a "Management Service Provider (MSP)", which manages Information Technology (IT) operations for multiple business, running and monitoring computer networks and software, hosting web sites, as well as providing web access and e-mail.

There is a need for construction companies to move at Internet speeds. The traditionally paper-intensive world of construction is becoming more electronic and construction companies are forced to transform the way they manage their business by installing the usage of Internet. The use of wireless Internet increases the possibilities for its utilization due to the inherent mobility offered by this technique. All this increases the possibilities of information exchange at all the project stages, with the consequent enhancement in the quality of the project.

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