IPRO 338

Sponsor: Electrical Contractors association

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Executive Summary

The Electrical Contractors' Association of Chicago (ECA) is the sponsor of this IPRO. ECA works to provide leadership for the electrical contracting companies in the Chicago area, and to improve communication between them by providing workshops and training opportunities. IPRO 338's objective is to forward ECA's goal by finding a way to assist ECA member companies in improving their efficiency on the job through the use of Building Information Modeling software (BIM). BIM incorporates 3d modeling of all aspects of a building, project scheduling, costs, and energy simulations to create a working model of the building before construction begins. This allows improved coordination between the construction trades working on the project and vastly improves the efficiency of a job.

It is becoming more and more common for owners to require BIM on their jobs, but taking the step to upgrade from traditional AutoCAD designs is difficult for many contracting companies. IPRO 338's goal for Fall 2009 was to develop a user guide aimed at electrical contracting companies that have never used BIM before in an effort to facilitate their transition to the new technology, avoiding common pitfalls in the process.

The IPRO team did research about the benefits and prevalence of the software in the electrical contracting industry, interviewed BIM users and non-BIM users, studied the operation of BIM software, researched costs of acquiring the software and training employees, contacted Autodesk sales representatives, and finally brought the collected information together into the user guide and created a presentation about the technology for the ECA. By sorting through and compiling the wealth of information available about BIM and interviewing companies that have transitioned to BIM, IPRO 338 created an accessible user guide and a presentation about BIM that can be used by the ECA to inform and assist their member companies in their transitions to the new technology.

Background

The sponsor for this IPRO is the Electrical Contractors' Association of Chicago (ECA). ECA helps developers find the right contractor for their needs, provides information for members about training opportunities, Labor Relations services, and information on Codes and Standards. Its members work in a wide variety of contracting fields, from industrial plants, hospitals, and schools to apartment buildings, condominiums, and single-family homes.

The user problem being faced in this IPRO is the problem of inefficiency in the electrical contracting field. Inefficiency is clearly an important issue facing the field: in a 2005 survey by Electrical Construction & Maintenance magazine, developers and property owners stated that their biggest cost concern was general inefficiencies in the construction process rather than materials and labor, and between 40% and 50% of construction projects run behind schedule ("Getting Inside an Owner's Head" 10). Preliminary research points to poor communication, paperwork error, delay in decision making, and the standard design-build-bid method as key concerns for contractors in getting jobs done quickly and profitably.

The key technology this IPRO has studied as a possible aid to increasing efficiency in electrical contracting is Building Information Modeling, or BIM. BIM is a building modeling program that incorporates all aspects of the building design, from the architectural frame to the systems and equipment in the building. It can be used to simulate the building's actual performance, and allows designers to pinpoint clashes between systems before construction begins. It also incorporates the dimension of time into the program, allowing scheduling information to be added to the design. Cost and price considerations can be added as well as a fifth dimension of modeling. In addition, energy modeling, acoustic and thermal data, sustainability information, and Green building considerations can be added to the program. The model can also be updated as construction progresses, recording changes to design and schedule, so that all members of the construction/design process are able to see in near-real time the progress of all aspects of the building (Bremer 128). BIM has the potential to vastly improve communication between the different areas of a construction project, prevent during-construction conflicts, and improve prediction of systems operations prior to completing the building.

3D Interior View of a BIM Project Building [1]

This is the first IPRO with the objective of improving efficiency in the electrical contracting industry, so the team has no previous experience of successes and failures to build on. However, there are considerations about past innovations in the electrical industry to be considered. When computer-aided design software first came onto the market in the late 1980s there were high expectations that it would revolutionize the industry. While CAD software's did have significant effects on many areas of construction and design, they served to primarily convert what once were paper designs to electronic form without changing the nature of design and management of the project ("BIM: A New Dimension For Buildings" 1). The team should consider the history and success of other CAD programs when assessing BIM's likelihood to be incorporated by contractors into their everyday operations.

The business-related costs of the current inefficiency in the industry are obvious: loss of time means loss of money, delays in the overall construction project, and dissatisfaction from the developer. However, it must be considered that though in the long run implementing a solution like BIM might increase profitability, in the short term it would require a number of expenditures including the purchase of the program and training of operators for the program. The problem has a clear economic cost, but the solution will also carry a cost.

The most effective way of communicating the team's results to a large number of electrical contractors is one of the topics to be studied during the IPRO. However, a tentative plan for sharing the team's recommendations includes: an easily navigated website explaining the IPRO's purpose, research, results, and a comprehensive tutorial on any technologies selected as solutions; a presentation of the team's results to the Electrical Contractors Association of Chicago (ECA), the IPRO sponsor; and easily readable pamphlets to be given to ECA for distribution among their members.

This IPRO is facing a new challenge, as there has not been a concerted effort to improve efficiency in electrical contracting in the past. The advent of computer design programs such as AutoCAD can be seen as a similar situation to the more recent development of BIM software; however, since this IPRO's goal is not only to find a solution to inefficiencies in electrical contracting, but also to share the team's proposed solution with electrical contractors, the team faces the challenge of finding a way to motivate contractors to try to learn and incorporate new technology into their everyday work.

Objectives

As described in the background section, the team's goal was to identify ways to improve the efficiency of electrical contracting projects through new software and technology, communications, and project management techniques, especially through Building Information Modeling (BIM) utilization. The team set out four specific project objectives and four team objectives to help focus efforts in the completion of the goal.

The team objectives were: to avoid procrastination; to be responsive and accountable; to have everyone in the IPRO contribute to the project; and to have good interactions with and to satisfy our sponsor.

The specific goals set out for the project were: to summarize the main sources of inefficiency in the electrical contracting field; to assess possible solutions to inefficiencies, especially Building Information Modeling (BIM); to gain an understanding of technologies such as BIM, with the goal of teaching them to electrical contractors; and to devise and implement a plan for distributing the team's recommendations for improving efficiency to electrical contractors.

Methodology

The team's approach to the project can be summarized in four stages. The first stage was to research the electrical contracting industry, visit build sites, and interview contractors and our ECA contact to summarize the main sources of inefficiency in the business and assess which inefficiencies could be addressed by this IPRO. We accomplished this within the first few weeks of the semester and came to the conclusion that while there are myriad sources of inefficiency in the contracting business, many of them can be addressed by improving communication and planning with Building Information Modeling. Some of the sources of inefficiency cited were poor communication, paperwork error, and delays in decision making by owners. Building Information Modeling addresses each of these inefficiencies by necessitating a high level of coordination to put together the model before the build even begins, facilitating communication throughout the project since all trades work from the same building model, and to some extent helping the owner make decisions in a timelier manner by providing more information about the final product of the build at the outset.

The second stage of the project was to assess how the IPRO could help electrical contractors implement BIM. Because BIM can only be used to good effect if all members of a project are involved, from the owner, the architects, and the engineers down to every trade working on the construction, the IPRO could not simply encourage contractors to use BIM on every project. We learned from our research and interviews that the most difficult step for contractors was inevitably the first BIM project. Every contractor we spoke to listed things they wished they had known on their first BIM project; it seemed that every contractor went through a difficult learning curve before becoming comfortable with the technology and its impact on the company. We came to the conclusion that an electrical contractor-friendly user guide aimed at first-time BIM users explaining the advantages and possible disadvantages of BIM, the logistics of acquiring the technology and incorporating it into a company, and suggestions from ECA member companies about how to make a BIM project successful would be a good approach to help ECA members improve inefficiency and become comfortable with an up-and-coming technology.

The third stage involved intensive research and compilation of the user guide, including contacting Autodesk representatives, researching schools offering BIM instruction courses, more

interviews with ECA companies, and in-depth research about how BIM works from a technical side. The Benefits team focused on compiling data about the benefits of implementing BIM as well as the possible detriments, and studying the actual operation of the program. The Implementation team researched the expenses associated with acquiring the program, the best approach to switching over to BIM in a traditional AutoCAD-based company, and schools and training courses for the program. During this stage the Content team split up between the two research teams to assist them in addition to keeping track of deliverables for the IPRO office.

The final stage is the editing and completion of the user guide, a presentation to the ECA about our project, and brainstorming of additional ways to get our information across to electrical contractors, including videos, informational CDs, and additional presentations.

Results

The product of this IPRO is a short informational booklet aimed at electrical contractors who are first-time or potential BIM users. The bulk of the IPRO consisted of research and information gathering about BIM technology, common pitfalls of switching to BIM, and the costs and benefits of the technology. The results of this research are summarized in this section, and the BIM booklet is attached as Appendix D of this report.

BIM technology is becoming commonplace throughout the construction industry. According to surveys by McGraw-Hill, 45% of current BIM users will be using it on 60% of their projects in the next year (McGraw-Hill Companies 2). Its usage has jumped over the last few years: 96% of companies surveyed by a division of Reed Construction Data said that they had begun using BIM within the last 12 months. The same survey indicated that small firms tended to benefit the most from BIM, with ¼ of the smaller firms interviewed estimating a 25% increase in productivity. Large firms indicated increases half that large (Cummings 1). The McGraw-Hill survey noted that 82% of all users who consider themselves experts with BIM technology, and 61% of contractors surveyed, believe it has had a positive impact on their company's productivity (McGraw-Hill Companies 2). Figure 1 shows a pie chart quantifying data from a McGraw-Hill survey.

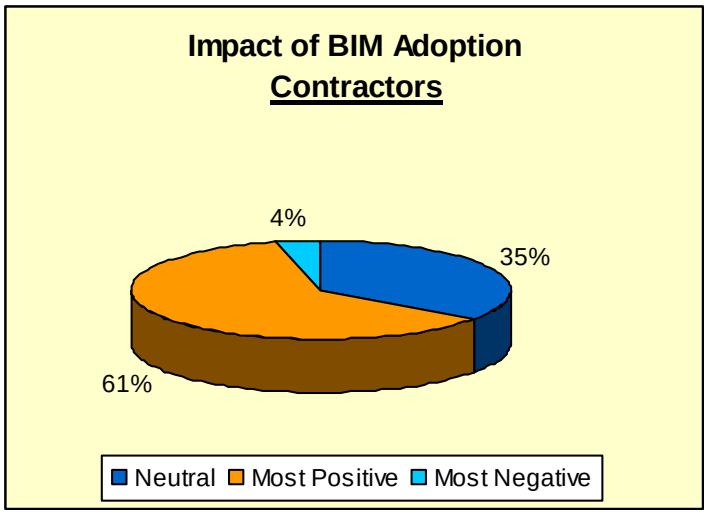

Figure 1:Impact of BIM on Productivity as Perceived by Contractors [2]

Adopting BIM is clearly a smart business move, and may soon become a necessity. The state of Texas already has a law in effect requiring that any project built with state funds must be a BIM project (Blackwell). Contractors interviewed by the team indicated that developers are increasingly requiring BIM for their new projects, particularly large-scale projects. (Block 17 Sept).

For these reasons IPRO 338 composed an informational booklet for the members of ECA Chicago. The booklet contains the information above and more, providing electrical contractors with enough information to choose whether to implement BIM, and giving them the first steps to take if they do decide that BIM is the right choice for them. The booklet can be obtained through the IIT IPRO Office's online iNuggets application by selecting IPRO 338, or by contacting Dr. Dan Tomal, the faculty advisor for this project.

Recommendations

Since BIM is a fairly new product with few, if any, competitors, we don't see many options for the immediate future, when it comes to IPRO projects. It is possible for the next semester team members to consider the usage of BIM by other trades, aside from electrical contractors. Also, during our research, we found that efficiency and time limits was a major problem for electrical contractors. Therefore, IPRO 338 has much potential to turn into an EnPro by implementing business concepts into improving efficiency in the work place

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Image Credits

[1] Image 13582955. Autodesk. <http://usa.autodesk.com/adsk/servlet/item?siteID=123112&id=13572250&linkID=10326920>. Accessed on Dec 1, 2009. Image courtesty of Mortenson Construction.

[2] Image created by Yoosuk Kim of IPRO 338, based on McGraw-Hill data cited above.

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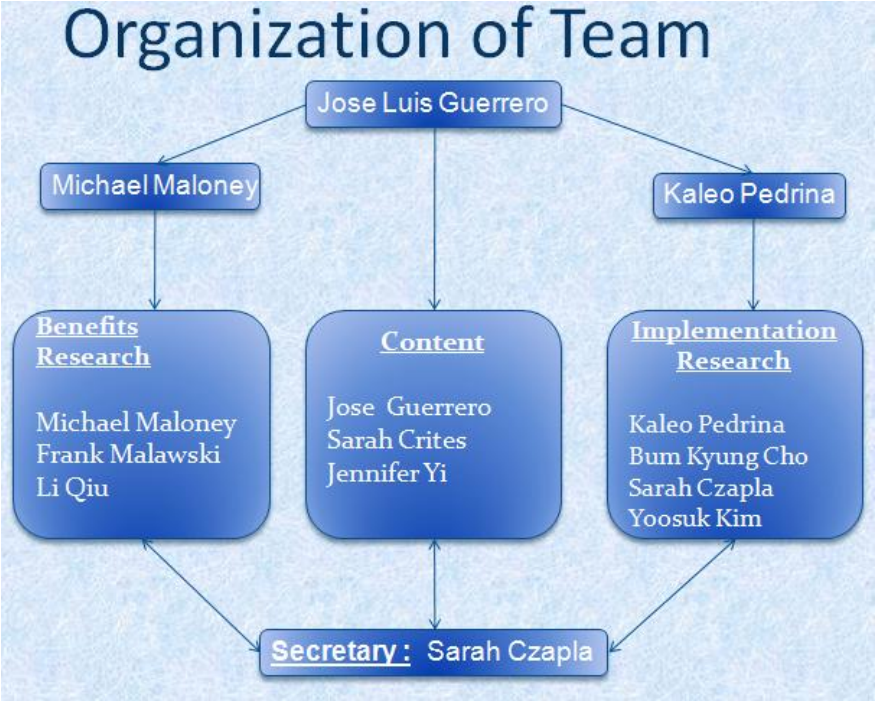
Appendix A: Team Structure and Assignments



The team was split into three sub-teams; Content, Implementation, and Benefits. A project manager was chosen to delegate responsibilities and oversea that the project was running smoothly. Each team had its own leader that divided the work throughout the members of his team. The team leaders were also responsible of working with the other team leaders to ensure good communication among the teams. A secretary was established to keep a record of minutes and any other important documents. The Content team was responsible of all the IPRO deliverables as well as putting our final project, the BIM guide book, together. The Benefits team was responsible for researching how BIM benefited electrical contractors. Finally the Implementation team was responsible for finding out how electrical contractors can go about purchasing the required programs and accommodating their workers to the new software. The individual assignments are shown below in a bullet point format:

CONTENT TEAM

Jose Luis Guerrero – (Aerospace and Mechanical Engineering)

- Project manager – Responsible for delegating and ensuring each team was working on their respective task. Project manager met with other team leaders to keep a good communication among the teams.
- Content team leader – Responsible for making sure the content team turns in any IPRO deliverables on time.
- In charge of making the Gantt chart and preparing background information for the project plan.

- Constructed the team structure, acknowledgements, and the code of ethics section of the final report.

Sarah Crites – (Electrical Engineering)

- Acted as the stand in secretary whenever the secretary was unable to attend a meeting
- Compiled the initial project plan
- Worked on and presented the midterm presentation
- Worked on the abstract and introduction sections of the BIM guide book.
- Wrote the executive summary, background, objectives, and methodology for the rough draft of the final report.

Jennifer Yi – (Business)

- Researched the business aspect of electrical contractors, including operations and management, and how BIM can improve the business.
- Interviewed electrical contractors
- Helped construct the power point for the midterm presentation

BENEFITS TEAM

Michael Maloney – (Industrial Technology and Management)

- Benefits team leader – Coordinate responsibilities for the benefits team as well as met with other team leaders
- Provided background information on BIM and electrical contractors based on previous experience.
- Delegate at meetings in conjunction with the project manager
- Worked with the benefits team to develop the BIM guide book.

Frank Malawski – (Architecture)

- Provided previous experience based on his work with BIM.
- Designed, constructed and edited the BIM guide book.
- Will be presenting for the final presentation as well as for the Electrical Contractors' Association

Li Qiu – (Electrical Engineering)

- Researched the variety of software associated with BIM
- Check the statues of BIM in the construction industry
- Find implementation or integration solutions for potential BIM users
- Worked on the final BIM hand book for electrical contractors

IMPLEMENTATION TEAM

Kaleo Pedrina – (Electrical Engineering)

- Implementation Team leader – Delegated responsibilities for the implementation team. Conducted the meetings when the project manager was unable to attend.
- Researched how electrical contractors should implement BIM into their companies
- Called various Autodesk Sales representatives to get information on where to purchase the software as well as places that teach how to use the software
- Worked on the brochure and presentation poster

Bum Kyung Cho – (Mechanical Engineering)

- Conducted Research on the cost analysis and articles regarding BIM. Looked at the pros and cons of implementing BIM. Lastly, researched LEED certification and what part of it affects the electrical contractors
- Responsible for the bibliography of the final report
- Responsible for the conclusion of the BIM guide book

Sarah Czapla – (Electrical and Computer Engineering)

- Secretary – Recorded minutes at every meeting and promptly updated them to the igroups system. In charge of sending reminder e-mails to the team with upcoming events and deliverables.
- Researched cost and training of implementing BIM as well as what LEED certification is and how it pertains to electrical contractors.
- Helped with the editing of the BIM guide book.

Yoosuk Kim (Electrical Engineering)

- Researched information about training and transitioning to using BIM.
- Prepared interview questions and interviewed various companies and workers.
- Researched current information on BIM with a focus on the marketing side of it.
- Recorded a video while visiting a construction site (Children's Memorial Hospital)

Appendix B: Budget

We did not need any transportation coverage because the site visits were very close to campus and many of us had U-passes. The only monetary expense of this IPRO was the printing of our final BIM booklets for distribution at IPRO day and to ECA Chicago at our final sponsor meeting. The total cost of these prints summed to $80.00.

Appendix C: Code of Ethics

Refer to "The Seven Layers of Integrity" by June Ferrill

Overarching principle:

Our team is responsible for researching BIM's application to Electrical Contractors. The team is required to find ways in which this new cutting edge technology can reduce time and cost of construction therefore achieving greater project efficiency. Our second objective is to find ways in which Electrical Contractors can go about purchasing the required software and how to go about accommodating their workers into a new work environment.

1) Law and Regulations:

Canon: We will comply with all intellectual property and regulatory laws to the best of our abilities.

Pressure: To make a product that does not infringe on other intellectual property.

Risk: Not doing enough research of the software and the cost and benefits.

Measure: The research being disregarded because it is unusable and/or unprofitable to the sponsor.

Pressure: To complete the work and provide promising results on time.

Risk: Exposing the project to unnecessary liabilities due to the legal research being insufficient because of time restrictions.

2) Contracts:

No Contracts were signed for this project

3) Professional Codes:

Canon: We will abide by the industry professional codes as pertaining to safety.

Pressure: Needed to tour companies to learn of the product in question but some members did not have the proper safety clothes required for the tour.

Risk: The product not providing any real value in the end due to lack of knowledge from tours and research.

Measure: Sponsor and companies may no longer provide tours that are essential to completing the project.

4) Community

Canon: The team will strive to generate results that will provide value to everyone involved, from the producer to the worker.

Pressure: To design a product that provides benefit only to the producer.

Risk: Decreasing productivity of workers due to improper research of the product.

Measure: Failure to successfully inform both the owner and the workers of the pros and cons of switching to BIM

5) Personal Relations:

Canon: The team will respect each other's opinions and completed work.

Pressure: To have a team and sub teams with a significant amount of autonomy.

Risk: Sub teams not understanding each other's work.

Risk: Project being delayed due to lengthened discussions and team member conflict.

Pressure: To complete a large, varied amount of work in a short amount of time, such as weekly deliverables

Risk: Team members taking credit for other work.

Risk: Team members not shouldering a similar amount of work.

Measure: Peer review at end of project

6) Moral Values;

Canon: No team member will be required to do anything that violates their own personal, religious, moral, or ethical beliefs.

Pressure: The need to work outside of class.

Risk: Working on days that some consider religious holidays.

Pressure: To complete all assigned work on time.

Risk: Forcing a member to violate personal morals or values to meet deadlines.

Measure: Member brings up situation to team publicly or privately to the proper hierarchical person, possibly the team leader.