

ELECTRI International Contract No. 11-02
Innovative Uses of Native CAD Files
Progress Report August 2011

Principle Investigator: Cindy Menches, Ph.D., P.E.

Research Assistant: Stephen M. Kleps

Progress Update on the Environmental Scan and Research Interviews

Between December 2010 and June 2011, Steve Kleps (research assistant) conducted a total of 22 interviews with the major parties involved in electrical design and construction. Because our travel budget is extremely limited, all of these interviews were conducted in Illinois. Nearly all of these interviews were conducted in person, but a few were conducted over the phone when meeting in person proved too difficult for the participant. The breakdown of the parties interviewed is as follows (please note that they do not add up to 22 because we interviewed three of the companies twice as the research progressed):

- Electrical Contractors (EC's): 8
- General Contractors (GC's): 2
- Architects/Engineers (A/E's): 4
- Large or Repeat Owners: 3
- Other Industry Experts: 2

Based on these interviews, we have developed a few preliminary findings. Although these findings were initially presented in the June 2011 Progress Report, they are again presented below because the findings directly evolved from the interviews conducted with the 22 participants. A summary of each of the interviews is presented following our presentation of the findings.

1. Technology in the electrical design and construction industry and the company protocols that accompany this technology are changing fast. For example, when Steve first starting making initial contacts with electrical contractors in the late summer and early fall of 2010, a number of them were unhappy that owners were still issuing paper drawings as opposed to PDF drawings. This made their estimating more time-consuming, especially if they were using on-screen estimating software. Of the people interviewed more recently, we have not encountered anyone still providing paper-only drawings and some owners have deliberately switched to PDF documents. Furthermore, most of the ECs have purchased a Total Station Trimble device within the last 18 months. The electrical contractors have been very pleased with this device because it saves them time in the field for their layout, but it does require that they get the DWG files from the designer post-bid thus making this part of the sharing process even more critical.
2. One surprising finding is that there is not a big demand for native DWG files during the pre-bid stage. Rather, the demand for DWGs appears stronger during the post-award stage or during design-assist efforts. We asked contractors how they were currently using native DWG files during estimating, AND how they would use them if they could get them from the owner or designer. Most contractors reported that they were estimating satisfactorily by hand using paper documents or by employing on-screen estimating software using PDF

documents. The contractors that estimate by hand indicated that they can use the PDF to print whatever size sheet they would like to estimate with and don't have to deal with any potentially confusing layers that might be in a DWG format. Contractors that use on-screen estimating software have only used the versions that require PDF as opposed to DWG. They are satisfied using the on-screen estimating software without the 'auto count' feature that would be enabled if they had a DWG file. *Consequently, one of the largest barriers to receiving the native files is the lack of demand for such files from ECs.*

On a typical job this would likely mean that ECs are issued a PDF pre-bid and they get the DWG files post-bid. The rare exception to this is when the designer does not share the DWG files post-bid because the owner didn't contractually require them to do so.

3. There is a surprising juxtaposition in the use of the most current software in the electrical contracting industry. On one side, ECs are embracing the BIM concept, appreciating both the 3D coordination and the prefabrication possibilities that it can provide them and in turn willfully providing the large amount of technical manpower that BIM requires. In contrast, often at the very same company, many of the ECs are still estimating by hand either because they aren't aware of the benefits of on-screen estimating software or because they have evaluated the software and have decided against it. This was a very surprising finding.
4. The designers' views on sharing or not sharing native files vary significantly based on the type of job (public vs. private, highway v. commercial, etc.), the concerns of the lead designers within the company, and company policy (although this was harder to tease out of the interview). On one end of the spectrum are the designers that are very willing to share and/or will defer to the opinion of the owner. On the other end are the designers that do not want to share their files at all. Most of these designers consistently verbalized their concern about liability for errors and omissions as one of the primary reasons for not wanting to share native files. However, when required by the owner, all designers expressed a willingness to share (because they were contractually required to do so). We are currently searching for patterns in the sharing/non-sharing behaviors learned about in our early research and will likely focus more on this aspect in the next phase of the research.

INTERVIEW SUMMARIES

Interviewer: Steve Kelps, Ph.D. students, Illinois Institute of Technology

Electrical Contractor #1

This electrical contractor does a large volume of tenant build-out work where each job looks almost identical to the previous job and feels that often times a square foot estimate with special attention paid to switch gear rooms is sufficient for many of their tenant build-out estimates. In addition this electrical contractor allows for great autonomy amongst their approximately 30 project managers, allowing them to estimate, bid, and manage their own jobs, almost as if each person was their own company. This organizational method works very well for them, but it does make having a unified estimating structure for the company difficult to implement. In addition, the top management is concerned that having too automated of a computer estimating system might be problematic for their estimators, who may lose the 'feel' of the job. For these reasons, they are satisfied doing their estimates by hand and do not use any on-screen estimating software. They are satisfied with pdf's pre-bid and they generally do not want the CAD files pre-bid. They are monitoring the advancement of BIM and believe it will play an even greater role in construction in the future. An interesting note is that the lead

estimator noted a correlation between those designers that are initially reluctant to share files and problems with the design and/or change orders down the road.

Electrical Contractor #2

This electrical contractor does a lot of heavy industrial work in addition to straight forward building work. They employ a dedicated estimator that does not become the project managers if they are awarded the job. They currently do not use on screen estimating software, but on a semi-annual basis have been debating the merits of the latest versions of the software. They like that the software can take some of the ‘grunt work’ out of the estimate, but are concerned the ‘feel’ of the job may be lost and that the estimator may not fully think through the job. In addition, they don’t feel that the software would have many benefits for the industrial work that they do. This electrical contractor was displeased with some of the municipal owners still issuing paper sets of plans and instead greatly prefers the pdf’s for estimating purposes.

Electrical Contractor #3

This electrical contractor does a lot of tenant build-outs for private owners. The size of the jobs they do is generally smaller than many of the other electrical contractors I interviewed. They also do a lot of square foot pricing and/or unit pricing as one job is very similar to the next. They do not use on-screen estimating software and don’t believe that it would be useful to them. They are concerned about the accuracy of the software, but their biggest issue is with the estimates that they do in general. Often times they will bid a job for a private owner only to get told that they can have the job for say 10% less than they bid it at. The electrical contractor then has to internally determine if they want to get ‘beat down’ and take the job or walk away. They cited this as a reason that taking a large amount of time to do a detailed estimate is often not worth it, because they often do jobs for less than they estimated anyway. They are satisfied with pdf’s for now. They only have limited experience with BIM, but are skeptical that it would have applications outside of data centers or hospitals.

Electrical Contractor #4

This electrical contractor is does almost every type of electrical work imaginable and is one of the largest I interviewed. They do perform different types of estimates depending on the type of job they are bidding. This electrical contractor does use onscreen estimating software and really likes it. It appears that from the top down, this company places a high premium and very detailed and accurate estimates. They want as accurate an estimate as possible, so that on very tightly bid jobs they can confidently decide down to even the half a percent profit on a job. Their on screen estimators are very proficient and also like the software. In addition, their lead estimator actively stays on top of current technologies. This electrical contractor says they got the onscreen software before most, but also realized that they the designers weren’t going to release the CAD files pre-bid, so they should invest in software that just worked off of the pdf’s. For that reason, they like the pdf’s. They noted that they still get a lot of paper plans from government owners, but that they can just scan the drawings and convert them into pdf’s. This company was the only company that I interviewed that said that if their personnel had the time during the estimating stage, they would invest a little time into accurately detailing their internal shop drawings. They typically did this within the pdf’s that they got. They indicated that it might be a little easier to do this directly in the CAD file, but that it wasn’t really necessary and

that they didn't do this often. For this reason they said they would like to get the CAD file pre-bid, but that it wasn't critical to them.

Electrical Contractor #5

This electrical contractor is on the smaller size of the electrical contractors I interviewed. They do all their estimates by hand and don't see that changing any time soon. They do not trust the software and do not want to spend too much time on estimates in general. They are very pleased with pdf's pre-bid. They have used BIM on a number of projects for clash detection and really like it. They are currently not doing any prefabrication.

Electrical Contractor #6

This electrical contractor is one of the larger one's in the area and does about 90% building work, 10% civil work, and no IDOT or Tollway work. They are one of a number of electrical contractors that are very proficient in utilizing BIM for 3D clash detection, but do not use on screen estimating software. They indicated that they love the pdf's and furthermore said that they don't want the CAD files pre-bid. Often times the project managers did their estimates on the run and they CAD files were either too cluttered or error prone, so they preferred just pdf's. They do some prefab work now and will likely increase that as more of their jobs utilized BIM for 3D coordination.

Electrical Contractor #7

This electrical contractor is one of the largest in the area. They are also very proficient in BIM, but don't use any onscreen estimating software. Furthermore they haven't even considered it and don't plan to. They don't want the CAD files pre-bid because there is nothing they would do with them anyway, but rather they just prefer the pdf's. Their focus is on becoming even more BIM savvy since they say that close to 100% of their jobs have been BIM. They indicated that typically the BIM model they work with has been either generated by the general contractor or a consultant hired by the general contractor. He said that the A/E's either don't have a useful BIM model or more often, the A/E is not willing to share the BIM model with the general contractor. While this electrical contractor prides itself on doing a large amount of prefab and innovation, they noted that the whole Chicago electrical contractor market was behind what other electrical contractors in other areas such as that cluster of large electrical contractors in northern California.

Electrical Contractor #8

This electrical contractor is one of the largest in the area as well. They do use on screen estimating software that works off pdf's and they really like it. Even though the software reading off of the pdf's has an 'auto count' function, it is generally not useful because of the non-standardized symbology in the market today. If the CAD files were standardized they might want them pre-bid, but for now pdf's are fine. They have done a lot of work with BIM for 3D coordination and have seen that it is generally either general contractor initiated or even just the mechanical contractors initiate it. They have done as much prefab as they can to flatten out the construction schedule, but generally have only done it when someone has already created the BIM model for the job. The owner of this company sees much room for improvement in the industry with respect to more sharing and better coordination.

General Contractor #1

This general contractor is a midsized general contractor that does primarily buildings. They also do a lot of construction management work that they find to be more enjoyable and profitable than hard-bid general contractor work. They have been using a version of a pdf based on screen estimating software for almost 10 years now and they love it. They understand that there is a learning curve getting into the software, but say that they can definitely do estimates faster onscreen than by hand. The biggest benefit to them though as a general contractor is that they can pull their estimate up in 'real time' in front of the clients and make changes to the design in order to instantly show the client what the design change might potentially save them in cost. They indicated that this approach has pleased many clients. They describe the software as an 'editable estimate'. They do not use the software for all levels of estimates, for example a schematic estimate is obviously still done by hand. They do not have a need for the CAD files and they haven't had subcontractors of theirs requesting the CAD files either. They do foresee future estimating happening by extracting quantities out of BIM and linking it to an internal library of BIM pricing.

General Contractor #2

This general contractor is one of the 3 largest in the Chicago metro area. They noted that their estimates were a split between by hand and pdf-based on-screen estimating software. The choice to use which depended on the type of the job and how long they had to estimate it. They noted that the on screen software took longer to estimate with. Also depending on the job and time constraints they would sometimes estimate the electrical portions themselves and other times solicit bids from electrical contractors for them to estimate the job. They indicated they didn't have much use for the CAD files pre-bid because so much of the cost of an electrical estimate is in the specs and the details, for which pdf's are quite adequate for conveying this information.

Architect / Engineer #1

This A/E is a global company with a large office in Chicago. They believe the reason that there isn't more sharing by A/E's is quite simple; in sharing they are only accepting more liability with no real benefit to them. They aren't concerned about the CAD files being stolen or altered because there are solid laws on the books to protect them and give them recourse on that issue; it is merely the liability issue with no additional compensation given for it. Thus for their company it is very simple; they don't share CAD files unless the contract specifies that they are required to. They clearly see BIM as the present and future, but also say that its full potential will not be unlocked until the risk issues and the trust issues are worked out between parties. They noted that in design build situations, there is often more sharing, but still many obstacles. They noted that they worked on a number of IPD (Integrated Project Delivery) or 'close to IPD' projects in which there was a lot of sharing and collaboration. However, he felt these job arrangements are relatively rare right now. He said that often time's owners aren't aware of these risk sharing structures and/or aren't interested in utilizing them. He also noted that some firms do not want to limit the pool of potential bidders on a job by requiring them to be completely BIM savvy and requiring that the contract take an IPD approach. He indicated that depending on the owner and the size and type of job, it may not make sense for them at this point to limit the pool of potential bidders in either case. There are many great contractors out there with great prices that don't know BIM and are nervous about an IPD approach.

Architect / Engineer #2

This A/E is a midsized civil engineering firm in Chicago. They have taken a position that they share just about everything. They have elected to do this for a number of reasons: The first is that since they mainly do civil work and municipal civil work, there is not much proprietary information in their drawings. Often times their symbols came right off of a governmental website. The second is that the co-owner is frustrated with arguing with contractors about sharing or not. He has found it easier to give them what they want and have them sign a large liability waiver sign off form. Lastly he has found that his openness in sharing his files has generated some goodwill in the clients that they work for that might pay off in repeat business in the future. One ironic part of this companies approach, is that more than other A/E's that I interviewed, their files have been altered or stolen. After much aggravation, the issues were resolved with existing laws. Despite these pains of sharing, they still feel that it is more of a benefit than a problem. Lastly, this company has taken the position that BIM is going to require that people share more extensively in the future, so one might as well start now.

Architect / Engineer #3

This A/E is a midsized civil/structural firm that has offices across the country. This firm also wasn't very concerned about sharing due to the nonproprietary nature of their work. Their work was often very common work items found in civil engineering. He noted that for much of the work they did, the drawings were not required to be done to scale, so the contractors knew not to scale off of them anyway. That also gave him peace of mind to share the CAD files. One thing that they did always do though, it to get the owner's permission to share the design CAD files with the contractor. He noted that some municipal owners didn't like sharing while some didn't mind.

Architect / Engineer #4

This A/E is a small architectural firm in Chicago. They were very opposed to sharing, most often citing the issue of additional liability with no compensation. He said that whenever possible they only shared pdf's. They did not want to 'lose control' of their CAD files. Often times, only sharing pdf's is not an issue for anyone. He noted that in nearly 100% of their designs they put the MEP portions out as a design build, so that the individual contractor is responsible for completing their portion. The owner is highly skeptical of the usefulness of BIM for the average building simply because of the time required to generate the models and also because he has never build a building the way it was designed. He noted that something always changes due to client changes, unknown conditions, designer mistakes, or contractor mistakes.

Municipal Owner #1

This municipal owner does the majority of their own design work, but does sub contract some of it out. They give out only pdf's pre-bid and the CAD files to the contractor that has been awarded the job. Due to their security concerns they only give the CAD files on a CD instead of on some 'ftp' website that could potentially be hacked by an outside party unrelated to any of the construction team. They haven't heard any complaints with their approach to sharing. They also noted that even their CAD files wouldn't be useful to a contractor trying to implement automated onscreen estimating software because they don't pay attention to line weights and the through labeling of the lines. One reason that this owner does share the CAD files with the

contractor post bid is that they would like to get back quality as-built drawings for their long term files. Over all they are not very concerned about sharing their CAD files post-bid.

Municipal Owner #2

This municipal owner does some design work, but generally subcontracts out most of the design work. They indicated a great fear of CAD files being stole, misused, and/or altered. However, despite that, in the end, their sharing policy is the same as the owner list above. Like the previous owner, they only give the CAD files post-bid and on a CD. They are concerned about contractors potentially 'over using' their CAD files were they to be given out pre-bid. It should be noted that one of the interviewees thought that their organization should be a lot more transparent than they were, since they were a public entity. He felt that mistakes in drawings happen and it shouldn't be something to hide from. Lastly, the three people that I met with did not understand why the contractors would potentially want more sharing because the employees of this municipal owner were not even familiar with the concept of on screen estimating software or with BIM.

Private Owner #1

This private owner is a large company that engages in a lot of construction on an annual basis. In prior years, they used to do a lot more construction management and design in-house, but as their volume of building has decreased, they subcontract most of this work out now. They only have project managers on staff now. In general, this owner shares pdf's pre-bid if requested, but generally issues paper drawings and then gives the CAD files out post- bid. They were not concerned with giving out the CAD files post-bid. They also have not seen a demand for CAD files pre-bid. One reason they do not have many security concerns is that the contractors are allowed to bid by invitation only and in addition to that, they have worked with many of them previously. They post the files to a server and then the contractor can download what they need. The owner did note that one security feature that they do have is that the contractor cannot upload drawings back to the server. This is done in part to ensure that the contractor doesn't alter a drawing and then post it back to the site as if it was the original drawing. Lastly, they have not done a BIM job yet, but upper management would like them to try one in the future for the potential cost savings and time savings.

Industry Expert #1

This industry expert feels that in general the on screen estimating software is too expensive for the majority of electrical contractors in the Chicago land area to afford. He certainly sees how larger companies can afford the software and how that software would then pay for itself. However, smaller contractors can't afford to invest the time and money into it. He speculates that if smaller electrical contractors where given outdated software for free, they would learn it and potentially buy the newer software in the future. With respect to file sharing, he has seen that the designers don't want to lose control of their intellectual property and they feel that they are losing control once they give the CAD file to a contractor. He doesn't see a way around that now or in the future.

Industry Expert #2

This industry expert feels that there is no question that on screen estimating software is better than doing estimates by hand. He notes that a competent contractor (once familiar with

the software) should be able to do an estimate on screen just as fast as by hand. He said the big difference is that with on screen the estimate is editable, more organized, and better linked to a data base. In addition with on screen you can look at areas room by room or floor by floor and make decisions right there with your client. He can appreciate the liability concerns of the A/E, but also hopes this may change down the road with more IPD like projects. He has been involved in one that worked well.

NEXT STEPS

As this research continues, we will be focusing on interviewing many more designers and large owners to gain additional insight into why some are sharing native files and others are not. We believe this is a profoundly perplexing question that needs much further exploration and getting to a plausible explanation will help us develop strategies for movement toward greater information sharing in the construction industry.

References

- Deutsch, M. 1949. A theory of cooperation and competition. *Human Relations*, 2: 129-152.
- Ghoshal, S., & Moran, P. 1996. Bad for practice: A critique of transaction cost theory. *Academy of Management Review*, 21: 13-47.
- Johnson, D. W. 2003. Social Interdependence: Interrelationships Among Theory, Research, and Practice. *American Psychologist*, 58(11): 934-945.
- Johnson, D. W., & Johnson, R. T. 2005. New Developments in Social Interdependence Theory. *Genetic, Social, and General Psychology Monographs*, 131(4): 285-358.
- Johnson, M. D., Hollenbeck, J. R., Humphrey, S. E., Ilgen, D. R., Jundt, D., & Meyer, C. J. 2006. Cutthroat Cooperation: Asymmetrical adaptation to changes in team reward structures. *Academy of Management Journal*, 49(1): 103-119.
- Malhotra, D., & Murnighan, J. 2002. The effects of contracts on interpersonal trust. *Administrative Science Quarterly*, 47: 534-560.
- Weber, L., & Mayer, K. J. 2011. Designing effective contracts: Exploring the influence of framing and expectations. *Academy of Management Review*, 36(1): 53-75.