

Using Mobile Technology for Managing Construction Projects

“Building and Growing with Mobile Technology”

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ABSTRACT

Today's construction managers have an arsenal of mobile technologies at their disposal, all of which make managing projects vastly more organized and efficient than ever before. In this paper, I will explore in detail three different mobile technologies that the modern contractor has at his or her disposal, their benefits, potential pitfalls that they may present, and my thoughts on the future of these tools. I will share personal experience with, and research based on topics ranging from building information modeling, to RFID chip tracking of resources, to cloud based programs that streamline information flow.

From Alexander Graham Bell's first transmitted words in 1876, to Ray Tomlinson's historic "electronic mail" in 1971, and Neil Papworth's first SMS text message in 1992, the evolution of communication is a testament to the ingenuity of humankind. Today, nearly twenty years after that historic text, there exists an instantaneous exchange of ideas through mobile technology that is all but taken for granted. The construction industry is no exception. Mobile technology leads to more efficient collaboration between owners and contractors, accelerates project timelines, and allows for more efficient use of resources. This expediency comes at a price however; through an increasingly globalized and competitive market, razor thin margins, and instant price comparisons, industry members should be well aware of the risks associated with competing in the global area that is construction.

Selection of Mobile Technology

In today's construction industry, a Project Manager (PM) will use an array of mobile technology for both Pre-Construction and Construction operations. Laptops, desktop computers and smartphones are now common on most job sites. As the industry continues to advance, certain mobile technologies are becoming more prevalent. The following is a selection of mobile technologies that I have found to be particularly exciting. For Pre-Construction, tablet computers with cloud based document sharing, as well as cost and time loaded building modeling transmitted via mobile devices will help advance projects in their infancy. Once construction is under way, I believe it would be helpful to use the following devices in particular: Tablet computers with Building Modeling software, GPS enabled total stations and laser scanners, and passive RFID tags and readers.

While I did not have much experience with the pre-construction process on my internship, I was exposed to the same type of software that the preconstruction department uses. In general, it seems that project management and document control software such as Prolog can and should be more readily available on iPads with PMs moving from one job to the next. PMs need to be in constant contact with the owner and have communication with subcontractors, architects, and engineers. The mobile technology required for these interactions goes beyond cellular communications. Contractors should have access to bid summaries, plans, and specifications to know exactly what someone else is talking about and respond appropriately. Tablets and cell phones with these capabilities make for an increasingly globalized world, and one that facilitates the flow of information from one point to the next. Software like BroadVu is one example of a mobile technology that enables instant information flow and sharing. Broadvu gives users access to real time document and digital file sharing, which keeps the entire project team in sync (Wood 2013). It is applications like this that would help a preconstruction team digitally manage bids and corresponding documentation.

While mobile technologies like Prolog and BroadVu may have some benefit to pre-construction, larger benefits of mobile technology can be reaped when construction actually begins. With a variety of modern mobile technology available, it would be wise to narrow in on three major areas of construction operations that can be enhanced via mobile technology: Building Information Modeling (BIM), Scheduling, and Resource Tracking.

1. BIM

Computer aided design is not a recent invention (think 1970s for some of the first iterations), but its application to the construction industry, via BIM is starting to gain mainstream acceptance. Like nearly every other kind of technology, BIM seems to adhere to Moore's law. Moore's law actually applies to the number of transistors in a circuit, and states that every two years, the number of transistors in a circuit will double thanks to advances in micro computing technology (Intel 2014). On a more abstract level, we can take this law to mean that computers will get twice as powerful every two years. In my own experience, it seems that over that same time period the cost of the technology will be cut in half. Thus, BIM is becoming more and more accessible to companies without a large amount of financial liquidity.

BIM has shown a tremendous potential in field applications, particularly with Mechanical-Electrical-Plumbing (MEP) and structural coordination. This tool for crafting a digital building before a physical one, has historically been confined to a desk. The future of modeling, however, could lie in liberating the model from indoor use. Already, there are programs like BIM 360 Glue, which allow users to take an iPad into the field, hold it up to a construction project in progress, and see an augmented reality via a mobile model of the building.

Davies and Harty (2013) explore this possibility by stating that mobile BIM has been shown to be a valuable addition to the collection of tools that site workers use. Having a building model available on a mobile device allows workers to access information pertaining to design and to capture work quality and progress data on-site (Davies and Harty 2013). However, BIM is more than just getting information into the

field in a timely manner. In construction, there is an overwhelming amount of material that must be relayed between multiple parties, in multiple forms. 2D drawings, 3D models, dimensions, and costs, are all part of a vast communication flow that needs to be uniformly managed. BIM, in conjunction with mobile tablets and cell phones, has the ability to get the right information to the right people at the right time. Having a centralized place where all the moving parts of a construction project can come together, from any place (jobsite, office, abroad) is a powerful tool.

It would also be helpful to tie the computer model of the project to a wireless device that would allow for a variety of tasks to be completed in the field. Tasks such as photo documentation, inputting scheduling data, or rerouting ducts/pipes could be done more quickly and with less transcription errors. This leads to a more efficient flow of information, higher levels of collaboration, faster project turnover, and less potential for litigation.

2. Scheduling

Scheduling is another project management task that could be greatly improved by mobile devices. According to Turkan et al. (2012), progress tracking is typically dependent on foreman daily or weekly reports, and these involve intensive manual data collection, and frequent transcription errors. To address these, Turkan et al. (2012) propose to have field workers track progress digitally, on mobile devices as work is installed. In addition to this, they propose a system of laser scanners and RFID trackers to simultaneously track the building's progress digitally (Turkan et al. 2012). This system could have real value for project applications with tangible items being installed such as

masonry, structural erection or earthwork. Much of a construction manager's time is spent calculating what stage a project is at, and how much work is remaining.

Turkan et al. are not the only ones making this claim. Kim et al. (2013) also claim that there are efforts being made worldwide to apply sensing technology like total stations, GPS, digital photogrammetry and laser scanning to generate as-built drawings. For the project management team, this means less time catching up with the schedule, as-built drawings, and cost implications, and more time focusing on future coordination.

At this point, I must insert a word of caution. While this system seems to provide a much-needed service to contractors, it does have limitations. Laser scanners cannot measure minute details like paint or drywall, or highly dense areas like wood or steel framing. Beyond that, lasers are incapable of calculating geometries. They take distances at face value. If there are ramps, angles, or curves, the distance measured is put into the model as an actual, when in reality the distance measured may be a hypotenuse or chord of a circle. Then, there is the issue of the marriage of digital technology and the end user. Ideas like laser scans and RFID tracking technology sound great in a board room as ways to become a more effective company, but will the workers on the field side actually be able to interpret and utilize the data that these technologies provide?

3. Resource Tracking

Another problem hindering the construction industry is the accurate tracking of resources. From tools, to heavy machinery, to concrete trucks, keeping track of a company's physical resources is a time intensive task that should have been delegated to computers long ago. One example is the yard where a contractor's tools and equipment are stored. As different teams request machinery for their job, it is the duty of the yard

workers to keep track of every piece of equipment and which job it belongs to. RFID technology can be used to streamline this process. For example, as the yard worker checks out a piece of equipment for a project team to use, a small RFID tag can be applied to the tool, then passively scanned into the companies tracking database. When the tool reaches the jobsite, it can be scanned again as the specific project team accepts it. Costin et al. (2012) apply this technology to tracking a specific worker throughout a high-rise building to monitor productivity, but it could work just as well on the ground level. Specifically, tracking the hundreds of concrete trucks necessary to place a mat foundation consisting of thousands of cubic yards of concrete. While I was completing my internship, I was given the opportunity to track concrete trucks as a mass concrete pour was underway. After logging hundreds of individual trucks by hand, I can appreciate how much more efficient and accurate it would be to have a system of RFID tags on the truck that could be scanned as they leave the plant, and as they arrive on site. The result is a substantial amount of saved time and reduction in data entry errors.

Privacy concerns are, of course, among the disadvantages of this system. Furthermore, this tracking system is mobile in nature; it must be assembled and disassembled at each jobsite. Furthermore, the number of RFID readers required to accurately track resources might be high enough to be cost prohibitive.

Benefits of Mobile Technology

As discussed above, mobile technology will usher forth an age of building in which information can be shared faster and more efficiently. The benefits of mobile technology include increased collaboration and error detection, and devices with a “mobile model” will serve to centralize trade coordination and save time in meetings.

Consolidated document control and project management software that can be downloaded to mobile computers in the form of apps will also enhance field workers' ability to read and view plans while working. Above all, these mobile devices will lead to a more efficient worker, just so long as he/she can keep up with the technology.

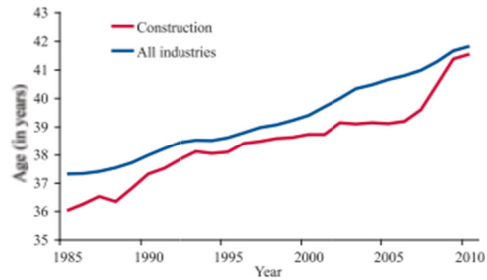
Pitfalls of Technology

The problem with mobile technology this advanced lies in its implementation. Support and troubleshooting is key, and if users don't want to bother, they will wind up using tried and true methods because people are faster at what they are good at. People will not take time to figure out a new device when they have deadlines to meet.

Another issue that is also brought up by Davies and Harty (2013) is the resistance to technology and the resistance to change in general. Davies and Harty (2013) describe a common dilemma facing contractors. What happens when technology outpaces its users? Especially when those users are field operations personnel who may not be as technically inclined as IT personnel? The answer, claims Davies and Harty (2013), lies in the *implementation* of the new technology. Instead of generating long-winded procedural manuals, site workers should adopt the necessary technical skills in the field through "*personal relationships rather than formal processes*".

While I was working on internship this summer, I saw first-hand that there is a generation of aging site workers in this industry. Using data from the latest US Census, Sue Dong (2014) stated that the average age of construction workers has risen to nearly 41 years. This is illustrated in Figure 1, which shows the rise in construction worker age over the past thirty years. Furthermore, some of the superintendents, labor foremen, and laborers in the field did not receive a college education, and also have limited knowledge

of computers. Given these, there is a generation of construction professionals that is accustomed to doing things “the old way.” Implementing something as complex as BIM on a mobile device may prove to be too much for these members of our community. While it is a sweeping generalization to state that the typical site worker in the field is technology illiterate, there is some truth to it. But this is changing, albeit slowly. No longer is it acceptable for a labor foreman to say, “I didn’t read that RFI because it was *emailed* to me.” To survive in a world where iPads and cell phones are now commonplace, the “field guys” need to start keeping up.



*Figure 1 Average Age of Construction Workers Over Time.
From: (Dong 2014)*

Changes to Traditional Project Management

I must admit that I do not have much experience in what many would consider “Traditional Project Management.” The company I worked for in 2014 is fairly advanced. That being said, I have a few ideas of how mobile technology will be changing the traditional management model. A project manager using mobile technology that I have discussed, is going to have to spend a lot of time up front with his/her team, training them on the software he/she expects them to use. After all, these mobile technologies are only as good as the person using those. A clear “standard operating procedure” should be implemented at the inception of a project and weekly updates should occur. Expectations need to be managed with subcontractors and suppliers as well. A PM in this new “mobile generation” needs to open clear lines of communication at the start that the project will be a “digital” project and that he/she expects *all* correspondence to be conveyed digitally.

My Educational Experience

College is not solely responsible for developing student's abilities to use and manipulate mobile technology. Today's students were raised in a world where it is common to see children as young as two or three years old playing on iPads and cell phones. Any student born within the last two decades has a considerable advantage with respect to technology over CM Professionals already in the industry. As a member of the Millennial generation, I am no exception to this statement.

At the institution I attend, there are no regular classes specifically designated for learning a software/technology. These programs are integrated into the classes. However, there are intensive courses offered in 6 week blocks that can help train students on CM specific software. So called "boot camps" were a tremendous asset to me, a student who had never hyperlinked an RFI in Bluebeam or applied a baseline in P6.

Conclusions

In just the past twenty-five years, digital and mobile technology has advanced at a breakneck pace. The construction industry is just one sector of a global market to benefit from mobile technology that keeps people just one click away from every bit of information they could ever need. When applied to construction, mobile technology can reduce data transcription errors, increase collaboration between all interested parties, and accurately keep track of the moving parts that comprise a construction project. As with most things, there will be growing pains that arise from implementing these new technologies. As the world of construction begins to adapt mobile technology and grow more efficient, it will allow us to focus our collective energy on new and innovative projects, which in turn will drive a new era of intelligent building.

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