

Pre-Project Planning with Virtual Construction Tools

“To Do More with Less”

Stephanie Tovar

Texas A&M University

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ABSTRACT

The construction process has a historically weak productivity growth rate. Currently, market conditions and increasing client demands give constructors every incentive to strive for improvement. Project managers can make improvements in construction time, cost, and quality standards by intelligently selecting and utilizing virtual construction tools for pre-project planning. Examples from industry professionals illustrate how this has been achieved and, comprehensive research provides evidence of benefits being realized. If builders begin to embrace the use of tools that promote collaboration and efficiency, they will begin to exceed expectations and ultimately be able to do more with less.

INTRODUCTION

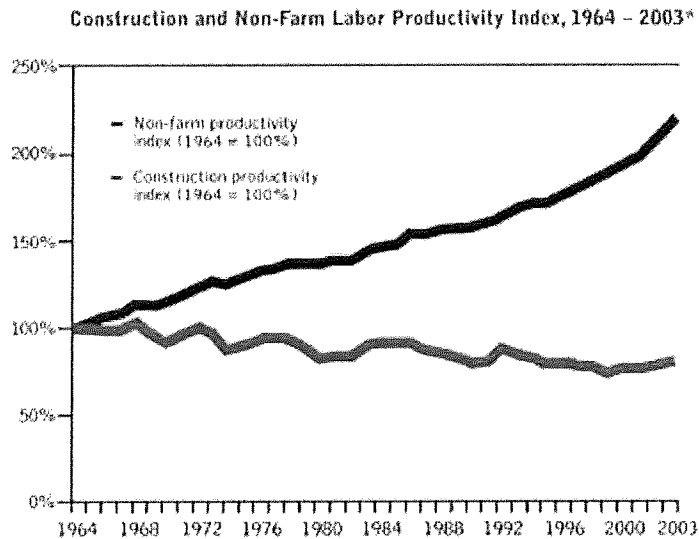
Not long ago, I was exposed to real responsibility on a commercial construction project for the first time. I encountered long work hours, a diminishing social life, weight gain, and hair loss; and, I was only an intern. I was excited to do more than make coffee and copies on a multimillion dollar higher education renovation because I wanted my contributions to make a difference. I was working for a general contracting firm that paired me with a young project engineer who did his best to show me the ropes on a fast-paced project. Looking back, my responsibilities were not much more important than the coffee and copies, but my responsibilities felt especially real on the days that I was on my own in the job-site trailer. Those were the days that my new mentor was not available because he managed our project's Building Information Modeling (BIM) process. My internship experience allowed me to observe, first-hand, both victories and setbacks due to virtual construction tools. Even though I felt like virtual construction tools were responsible for the regular hijacking of my mentor, and even though I saw that these tools are not perfect, I plan to embrace the use of virtual construction tools because of the benefits they provide to project planning.

Pre-project planning is exceptionally important because it lays the foundation for all of the activities and processes that will encompass a construction project. Syal, Grobler, Willenbrock, and Parafitt published in the *Journal of Construction Engineering and Management* also emphasize the significance of construction project planning. They state, "One main prerequisite that ensures the successful completion of a construction project is accurate project planning," and, "despite its importance, many construction firms go through this [planning] stage in an arbitrary fashion" (Syal et al. 652). There are many ways construction managers can use virtual construction tools for pre-project planning to creatively and

collaboratively contribute to the success of their projects. By not incorporating virtual construction tools or by using them inefficiently, project managers may be approaching the planning stage in an arbitrary fashion.

BACKGROUND

Technology innovations have substantially changed the way all sectors of the economy work. The field of construction is not immune to these developments, but breakthroughs and innovations are not as tangible in the construction sector according to the US Department of Commerce Bureau of Labor Statistics. (Savage) Figure 1 illustrates that “since the 1960s, the productivity growth rate for the construction and building industry has averaged – 0.59 percent, while all other industries combined have an average productivity growth rate of 1.77 percent.”



Source: Paul Testoltz, 2004

Figure 1 – From Savage

*Constant cost of contracts/work hours of hourly workers

In the past, the construction industry as a whole has been known for a culture that is resistant to change and hesitant to adopt the latest technology tools. I believe this is about to change and it has begun to change with the use of virtual construction tools.

Virtual construction tools are computer programs that allow a user to design and manipulate multi-dimensional models of a construction deliverable. Virtual construction tools are sometimes referred to as BIM, although the two terms are not synonymous. Building Information Modeling (BIM) is an intelligent model, meaning: the model is more than shapes represented in space. According to information published by *Graphisoft*, a multinational software corporation, BIM is basically explained as the virtual equivalent of actual building parts and pieces used to build a structure. With BIM, digital building elements such as walls, columns, windows, etc. can be collected and organized into a database that can be queried in both a visual and numerical way (BIM Explained in Laymen's Terms). This data can include not only information about the structure's physical properties but cost and schedule implications as well. There are numerous virtual construction and BIM tools, as well as numerous task and benefits associated with these tools. The 2012 McGraw-Hill Construction *SmartMarket Report* indicates BIM is being used for preconstruction activities most frequently for spatial coordination, quantity take-off, preliminary design phase budgeting, constructability analysis, and jobsite logistics planning. BIM is also being used for 4D modeling for relocations/moves, 5D modeling for labor and cost estimating, construction phasing and scheduling, and project management software integration (Bernstein 48, 49). Personal experience and accounts by current professionals advocate the use of these tools.

EXPERIENCE AND EXAMPLES

My internship project team mainly used the software *Navisworks* for coordination, clash detection, and for verifying specific quantities or dimensions. *Navisworks* is a virtual construction tool that helps teams plan projects before construction by reviewing integrated models and data. Because of the complexity of construction projects, construction deliverables,

such as structural steel or plumbing systems, are typically modeled separately by a trade specialist. The virtual deliverables are then combined into a single model. On my project, models from six or seven subcontractors were combined weekly for pre-project planning coordination. *Navisworks* provided a clear, agreed upon avenue for our subcontractors to plan as a team. In the coordination process, trade contractors agreed to organize and prioritize how systems would be designed.

After the project models were created and integrated, clash detection began. Identifying intersections, or conflicts, in an integrated model is known as clash detection. Most of our clash detection changes were typical. We rerouted MEP systems and adjusted structural penetrations. Identifying conflicts before an issue existed in the field usually enabled our team to save time and material. Clash detection allowed our team to address several conflicts at once and select the most cost effective solution overall. *Navisworks* gave our subcontractors a visual representation of how we planned to build the structure. Each week when our plan changed our model changed. Because we always had a recently updated and reliable model, we were also able to quickly verify dimensions or quantities. I could easily check the height of a ceiling or find out how many sprinkler penetrations were in a hallway. Previously, I have only been able to taste the low hanging fruit of virtual construction tools. Fortunately, many construction technology experts are willing to share their knowledge.

I recently had the opportunity to meet Stewart Carroll, the Chief Operating Officer for Beck Technology, when he presented this year for the Lean Construction Institute. Carroll spoke about working with *DProfiler* and *Revit* on an array of tasks including constructability reviews and conceptual cost loading. *DProfiler* is a macro BIM tool. It facilitates rapid model creation and real-time analysis with a simplified model. Using *DProfiler*, a complicated project can be

conceptually modeled in a matter of hours. Carroll demonstrated how intelligent formulas relate to a real-time cost database. As a user draws, costs begin to calculate. Conceptual cost loading helps users to see the cost implications of design scenarios. Quickly creating a model has helped Carroll in pre-project planning by rapidly furnishing him with data that was used to validate or dispute a proposed project budget. *DProfiler* constructability reviews enhance design by assigning meaning to conceptual decisions. Users can make better overall decisions with easy access to estimated cost, schedule, energy efficiency, and other areas of unified data.

Luis Berumen, the BIM Manager for Bartlett Cocke, the largest commercial construction company in San Antonio, Texas, shared with me that he is currently utilizing all of the software programs listed above along with various other tools. Berumen uses *Autodesk Design Review* for quantity take-off and cost estimating, as well as, *Navisworks* with *Trimble SketchUp* for site logistics and phase planning. Berumen uses *Trimble SketchUp* with *Google Earth* to place a model in a real world setting in order to plan out site logistics. The model becomes a valuable part of site logistics decision making. Berumen can accurately identify the location of access to and from the site. He can plan laydown and staging areas, or the locations of job trailers and temporary equipment. I watched Berumen place a hypothetical crane in a model to determine if any existing structures would be in his way or if the crane's swing radius would be adequate. Berumen also takes site logistics planning to another level with *Navisworks*. By tying the model to a project timeline or schedule, Berumen creates a 4D phasing plan. A 4D phasing plan allows Berumen to communicate the project approach visually to all project stake holders, so that all the stake holders are on the same page.

It would be a challenge to comprehensively express all of the tasks and tools utilized by only the two professionals I have mentioned above. I have touched on a short list of specific

virtual construction tools that can be used for pre-project planning and, I have included a few specific tasks for which these tools were used. If I have taken the time to mention a handful of tools and tasks, and you have taken the time to read them, why do we care?

BENEFITS

Anyone associated with the construction industry may know the answer. As architects, engineers, and constructors, together we are facing practically the same challenge every day. The marketplace and our clients are demanding more services at lower costs, while maintaining high levels of quality. We are having to find a way to deliver projects by doing more with less (Doing More with Less). We care about the tools I have mentioned because of their anticipated benefits. Successful implementation of virtual construction tools has the ability to affect many improvements to the services we are able to provide. We can reduce errors, costs, and the overall duration of a project. We can save money with successful planning to increase productivity and decrease the personnel required on a job site. We can improve the quality of our projects by reviewing and directing the constructability of our projects. Our site logistics planning can streamline workflows and efficiencies. The performance level achieved with virtual construction tools can lead to repeat business and an increase in profits.

Perhaps one of the largest benefits to using virtual construction tools for pre-project planning is enhanced collaboration. Using these tools allowed the subcontractors on my project to work as a team. Our goals and processes became more transparent to the individuals that participated and a level of trust was achieved. The collaboration involved in pre-project planning helped subcontractors understand that we valued their input. Virtual construction tools frequently opened the lines of communication on my project. Because our drywall subcontractor asked the structural steel subcontractor about a possible issue, a dialog was created that involved everyone

from the intern to the architect. We caught a potential problem before it became an expensive complicated problem. Using the virtual construction tools in pre-project planning also streamlines the exchange of information. Enhanced collaboration with better communication and more information can pay dividends in the future when unavoidable issues arise or on the project that will be completed twenty years from now. Virtual construction tools used for pre-project planning are heavily insulated with benefits. However, like insulation, some benefits are tangible and immediate, and other benefits are more equivalent to the benefits that are realized years down the road when the value of your cost efficiency and energy savings finally outweigh your investment.

EDUCATIONAL PREPARATION

Like many of my peers, I feel my educational experience has prepared me to use virtual construction tools for pre-project planning. I have been able to study and use these tools for many of my classes and team projects. But my education experiences have also prepared me to overcome the limitations of these tools. I have been prepared in a fashion that will never suffer due to low connectivity, software updates, or a computer virus. I am prepared because I have learned the importance of planning. I know that it is better to be proactive rather than reactive. I have learned the importance of relationships. I genuinely believe that collaboration and respect for people will always take precedence over software or technical skills. I have learned to accept challenges to try and figure things out on my own. I am not satisfied with meeting the minimum standards and I do not give up easily. If I can enter the industry as a proactive, relationship-oriented, flexible, ambitious, and resilient professional, using virtual construction tools for pre-project planning should be as easy as swinging a hammer.

CONCLUSION

I did not mind accepting challenges during my internship because I wanted my contributions to make a difference. As a professional construction manager, I also want to effect change for the betterment of my industry. After my internship, around the time my weight was back under control and my friends had forgiven me for my absence, I listened to a TED Talk given by Andrew McAfee, the associate director of the Center for Digital Business at the MIT. In the TED Talk, McAfee related our current technology situation to the technological impact of the industrial revolution. Citing historian Ian Morris, McAfee considers the most important developments in human history. Morris analyzed how things like empires, religion, philosophy, the arts and sciences, mathematical discoveries, plagues, or the age of exploration affected social development and advancement. According to Morris, none of these things mattered much because they did not affect the data. The one thing that did affect the data was a technological development. The steam engine and the associated technologies of the industrial revolution changed the world because they enabled humans to overcome the limitations of our muscles. Morris wrote that this technology changed the world so much that it “made a mockery of all that had gone before.” McAfee states that instead of overcoming the limitations of our muscles, today’s technologies are allowing us to overcome the limitations of our minds. Selectively using virtual construction tools for pre-project planning can provide countless benefits to a construction management team. I believe if we embrace our current technologies and apply them to construction, we will be able to do more with less. We also open up the possibility to effect change in a way that will make a mockery of everything that has come before.

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