THE BROAD DIMENSION

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tbd consultants

Construction Management Specialists

111 Pine Street, Suite 1315
San Francisco, CA 94111
(415) 981-9430 (San Francisco office)

6518 Lonetree Blvd., Suite 164
Rocklin, CA 95765
(916) 742-1770 (Sacramento office)

600 B Street, San Diego, CA 92101
(619) 814-6793 (San Diego office)

8538 173rd Avenue NE, Redmond, WA 98052
(206) 571-0128 (Seattle office)

2063 Grant Road, Los Altos, CA 94024
(650) 386-1728 (South Bay office)

7083 Hollywood Blvd, 4th floor
Los Angeles, CA 90028
(424) 343-2652 (Los Angeles, CA, office)

1a Zoe House, Church Road, Greystones
Wicklow, A63 WK40, Ireland
+353 86-600-1352 (Europe office)

www.TBDconsultants.com

Lean but not Mean

Studies have shown that over 50% of the effort expended on a construction project does not contribute to the value that the building owner is looking for. About 10% of materials are estimated to be wasted, but waste extends far beyond that, including rework regarding defects, time spent by workers waiting to be able to do their work, and production of reports that are never read or acted on, amongst others. It has also been shown that over 50% of scheduled targets are not met. Lean Construction aims to correct these problems.

No one is going to argue with the ideas that waste is bad and that schedules should be realistic and achievable. Isn't that what project management techniques are working towards anyway? So what is special about Lean Construction and where did it come from? Answering the last part first: Lean Construction emerged out of the attempt to apply lean manufacturing techniques, developed by Toyota after WWII, to the construction industry.

One major difference between construction and manufacturing is that manufacturing generally involves producing multiple copies of the same thing, whereas a

construction project is normally a prototype that will likely not be repeated exactly the same anywhere else. BIM is a technology that gets around the prototype aspect to some extent, because the model can become a virtual prototype of the proposed building, testing the sequence of construction, etc. Construction can also get closer to traditional manufacturing by utilizing modularization/prefabrication technology. Neither BIM nor prefabrication are specifically related to Lean Construction, but they can be a part of it.

Another difference is that factories manufacture products for a mass market, whereas a construction project is for a specific owner. Getting the owner's and end-users' involvement is therefore essential, not only establishing initially what is required, but also *why* it is required. That way, what the owner sees as value from the project is clear from day one to the design team. What constitutes value to all participants is important, because maximizing value and minimizing waste are primary goals of Lean Construction. Naturally, the owner's concept of value takes precedence because they are the customer. The owner's involvement throughout the process is also essential, to ensure that problems can be resolved expeditiously.

IPD (Integrated Project Delivery) is another technique that works well with Lean Construction. Getting input at an early stage from the main contractor and subcontractors can lead to a more constructible project with fewer RFIs and change orders, meaning less rework and therefore reducing waste. The main contractor and subcontractors are also the ones with the best knowledge of how long activities are going to take, so their input should lead to better initial scheduling and setting of milestone dates.

From what we have discussed so far, there might not seem to be much that is new about Lean Construction, and it is true that many techniques and technologies can be incorporated into it. One technique that has been pioneered by the Lean Construction Institute (in fact they hold the Copyright on its idea and its materials, and the Trademark on the name) is the Last Planner System.

The Last Planner System includes the review of activities that are coming up over the next few weeks, and getting reliable input on the activity durations. Alongside each activity is also listed the make-ready work that needs to be completed before that activity can commence. The contractor and subcontractors are involved in these scheduling meetings, and with short daily work huddles, to

ensure things are keeping on track and they commit to the target dates. Updated project information is prominently displayed on site, including information on what percentage of target dates are met and what are not, in order to encourage better adherence to the schedule. Everyone needs to know what is going on, and transparency and collaboration are encouraged. That includes identifying the reasons why tasks may be ending up late, which then helps show how everyone's work affects everyone else.

The encouragement to constantly do better is also a major feature of Lean Construction. Continuous Improvement is the aim, so learning from things that have gone wrong and from those that went right is important, and then passing that knowledge on for future projects. The goal of Continuous Improvement also means that everything that may contribute towards Lean Construction does not have to be implemented in one go. To do so might be considered disruptive. Instead, implementing one or more aspects of Lean Construction that are expected to accrue benefits can be a good way to introduce Lean Construction, and then building on that start.

Traditionally, projects have been bid on the basis of lowest price, but cost is less of a consideration with Lean Construction. That said, Lean Construction does produce savings, thanks to the reduction in wasteful activities and better coordination. Cost reductions of up to 30% have been reported from the use of Lean Construction practices.

Big Data in Construction

Construction projects have always produced voluminous quantities of data in the form of drawings and specifications, contracts, RFIs, bulletins, reports, etc., etc., but traditionally the data has ended up in filing cabinets or storage rooms and their contents effectively lost. As these documents moved into digital formats it became easier to search for relevant information, but even digital documents have normally been stored locally, maybe on someone's personal computer or, at best, on a company network, and sharing that information with others has been somewhat problematic. Another challenge has been that the growing mountain of digital data has made it hard to search through. Having a lot of data, assuming that it is realistic in its content, is good, but how to find the needle you are looking for in what may be multiple haystacks has been the problem.

The term Big Data relates to extremely large data sets that are being generated continuously, and we are seeing that in construction. That data may be structured, like drawing sets and RFIs, or unstructured, as with emails. The other part of the Big Data definition is that the data can be analyzed to reveal patterns and insights that can improve decision making.

Thankfully, modern software, often cloud-based, is making the sharing and analysis of the data feasible and effective. At the same time, the mountain of data is growing exponentially as new technologies, such as drones and 3-D laser scans, are making increasing volumes of data available. Fortunately, AI systems thrive on masses of data, so they can be utilized in carrying out the required searching an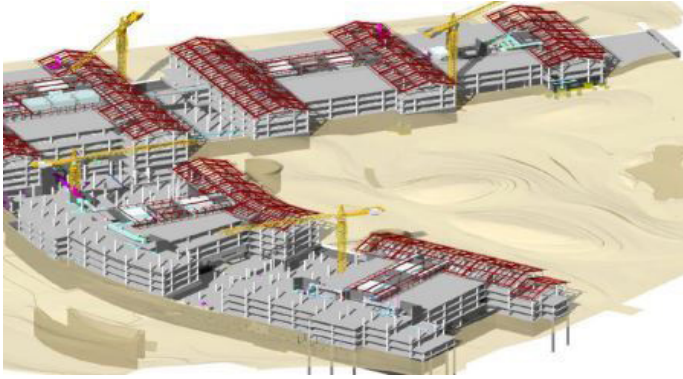d analysis. As data gets shared among the parties involved in a construction project, the more potentially useful it becomes. If each company keeps its data in its own silos, it is less likely to be found by the person who can use it, who may be in another part of the design or construction team.

At the conception of a project, the building owner and his/her advisors can utilize data on their customer or user preferences, along with traffic and environment data, to determine the best type of building to erect and help locate it in the most advantageous spot. Designers can assist by utilizing data from the planning authorities to see what massing it can have in different locations, and records of similar projects can help flesh-out the concept and provide preliminary cost information to compare with the owner's budget. Utilizing AR (Augmented Reality) to display the potential project can let the owner see what the building would be like viewed against the actual surroundings.

Once it gets into design, the users' preference data, showing what is of value to them, and data from previous projects along with building codes, etc., help pull the design into shape. BIM software becomes a repository for data related to the particular project, and BIM goes well beyond just 3-D design. Schedule information makes it 4-D, and cost information grows it to 5-D, with the result that changes in design can instantly show potential effects on schedule and project cost. BIM systems can also incorporate product information, complete with maintenance requirements, that can provide useful data throughout the life of the building. The simulations such systems provide can identify risks and help work out how to mitigate them.

During the construction process data from drones and other sensors can help identify potential safety issues, and monitor actual work completed against the schedule to highlight problems. Such real-time data can also show how the construction site is being utilized and lead to suggestions for making the site more efficient and less wasteful of materials and plant and labor resources. This results in reductions in schedule and costs. Contractors can also analyze results from past projects to see which types of projects have produced the best profit margins for them, helping them decide which jobs to bid on.

Once the building is complete, sensors within the building, along with maintenance records and the BIM data, can identify potential areas of concern that may need maintenance or possibly training for the users in the operation of building features, such as HVAC controls.
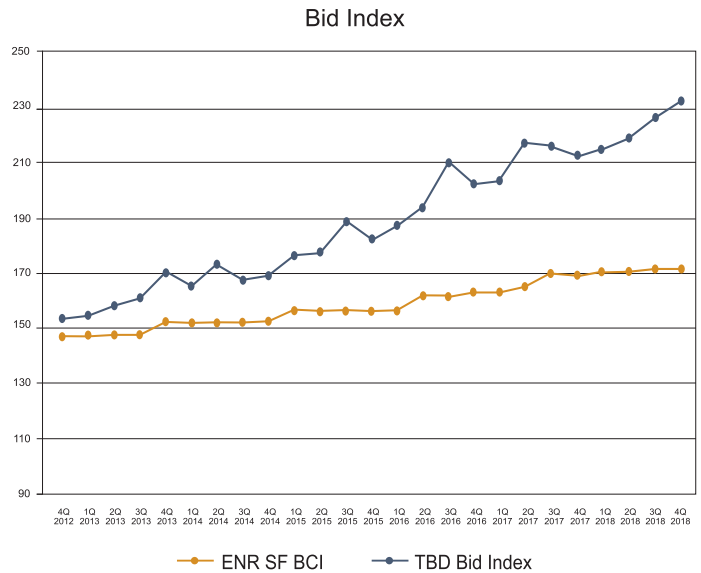
In short: Big Data means that the decisions needed at every stage in the building's life-cycle can be based on solid information rather than something close to guesswork.

Prediction Problems

The stock markets don't seem to know which way they want to move, with the result that businesses are becoming concerned about the possibility of a recession. As a consequence, we saw US construction-starts dropping by 10% in December 2018, mostly due to the non-residential sector, although starts finished the year marginally up from 2017. The AIA's Architectural Billings Index had also been dropping at the end of 2018, but has been showing a strengthening again at the beginning of 2019, with all regions of the country showing positive growth in design work which should lead to more on-site construction.

The tariff war has been one concern for markets, but at time of writing (early March) it is looking as though some form of agreement between the US and China is coming, and that should result in a reduction or removal of many tariffs. The tariffs were designed to help improve the trade gap that the US has with the rest of the world, but the trade deficit actually increased substantially in 2018 over 2017. Such increase might not be totally dependent on the tariff war. Despite a number of concerns, business in the US has been flourishing quite well, consumer confidence has remained high, and the US GDP growth rate has been continuing to follow an upward trend. Meanwhile, Europe has been showing fairly stagnant growth and China has admitted that its growth rate has been dropping. How accurate the official China growth rates are remains questionable, but, although it has been dropping, it remains impressive. The growing market here in the US means we should be buying

more, while if elsewhere growth is stunted, they won't be buying as much, so the trade deficit can expect to be hit. The question is, how much of the slowdown elsewhere is due to the tariff war or to other factors.

The Fed's interest rate increases have been another concern, although the fact that it felt it could make those increases shows that it sees the economy as strong. Rates are still at historic lows, especially considering the fact that businesses are doing well. The low levels of inflation (and we are not talking about construction cost increases here) does mean that there is little pressure on the Fed to push interest rates much higher. However, having such low rates also means that they will have weaker tools available if and when we do enter another recession and the economy needs a boost.

The bull market has just passed its tenth anniversary, which is an exceptional run when looking at recent cycles that indicate recessions happen around every nine years. But we know that there is nothing fixed about these cycles, or anything necessarily logical about the markets which are mainly driven by fear and greed. It is inevitable that another recession will come, although the next one is likely to be mild compared to the previous, and currently there is little indication that one is coming soon. Job growth remains good (despite the dip in February) and consumer spending is high, so, although there are plenty of potential problems out there, the economy seems happy to shrug them off for now.

Geoff Canham, Editor, TBD San Francisco