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Design-Build Leading the Way to a New Era of Productivity Gains

By William H. Dean

Design-build may prove to be the impetus that provides a long-needed leap forward in construction productivity.

Delivering Much More Construction for the Money Through Design-Build

Construction productivity is such a problem that the Business Roundtable formally took up the issue in 1969 and published a compilation of findings in 1983. They studied productivity in our industry and determined that productivity often actually *declined* and that of the 11 major economic sectors they tracked, construction was by far the worst in terms of productivity improvement. I doubt they had to study productivity in television or textile manufacturing, much less personal computers, semiconductors, or storage devices, as firms in these industries do not last a day without recurring productivity breakthroughs.

Construction may be the world's largest industry, representing \$1 trillion+ annually in the U.S. alone. Imagine if productivity increased by 10 percent per year. That would be a doubling of output every seven years. How many more schools could be built, how many hospitals, how many research facilities? In seven years we would free \$500 billion annually for whatever use we choose. (Some would argue less given the productivity gains in housing in the past 20 years but, even in the worst case, there would be hundreds of billions saved.) Given the size of the industry, productivity improvement in construction presents a greater opportunity to change the quality of life for all of us than productivity improvement in any other industry in the world. The bad news — we've gained little ground; the good news — the opportunity's there for the taking.

How do other industries increase productivity and improve their products? Key aspects of productivity advancement in any industry are efficient work breakdown, which thus permits specialization and collaboration amongst specialists (horizontal integration, supply chain management) and development of repeatable processes for most, if not all, work activities. Since the primary measure of client satisfaction is fulfillment of their needs, performance driven design-build has the potential — possibly the unique potential — to tie together client needs and production processes in ways that have not been done in construction.

Design-Build Evolves from a New Paradigm in Risk Mitigation to a New Paradigm in Productivity

Design-build construction of electrical, telecommunications, and low voltage systems has become so widespread that it could be argued that design-build, in some form or another, is the preferred method of delivery for complex requirements. On most projects, design-build construction of specialty systems takes one of three forms (usually as a subcontractor to a general contractor or construction manager at risk):

1. Integrated design-builder of specialty systems
2. Specialty contractor-led team of specialty contractor/engineer
3. Architect/engineer-led team of general contractor/A/E with specialty contractor in a design assist role

All three methods of delivery accomplish one of the primary objectives for the owner: shifting performance risk to the contractor team.

This is the first wave in design-build for specialty systems. The next wave, which is now upon us, is to build on the foresight of our innovator and early adopter clients and create a significant improvement in productivity on their behalf but also so this might make design-build indispensable (i.e., bring the late adopter clients into the fold). Although my background is in electrical and low voltage systems, I suspect the same could apply to mechanical, structural, fire protection, etc. Improve productivity at the trade level, where most of the costs occur, and you will have the greatest impact on its improvement at all levels.

How Can the Delivery Method Foster or Inhibit Productivity Improvements?

In typical design-bid-build projects (from the perspective of a specialty contractor), the design is provided in detail and client program issues are conveyed to the specialty contractor based on these details. Here is an example from a project currently being performed by M.C. Dean, Inc.: A particular fire alarm system is specified, not exactly by brand name, but using system requirements and specifications that are so detailed and particular that that only one or two manufacturers will comply. At the same time, we are provided very little information about the actual fire detection and alarm performance requirements of the client (i.e., what they need in terms of detection and alarm performance), just what we know from the specifications. The specs require the building automation system (BAS) to interface with the fire alarm system, again with little insight as to why and to what effect, other than to "interface." The BAS is selected by the mechanical contractor, likely dealing with the same conditions. As the electrical contractor, we negotiate the best deal we can for the fire alarm system with price, likelihood of approval, and interface to BAS as our primary considerations. We also strongly consider past performance, specifically, our working relationship and familiarity with the products, which actually has a big impact on our view of price. But these are all secondary to meeting the specifications. There is likely no effort or, at best a severely hampered effort, to align performance requirements with production on the part of the specialty contractor.

It is possible, and in this case actually true, that we could have very little experience installing this particular system (and we install hundreds of fire alarm systems annually and has a dedicated fire alarm systems operation). We therefore have to learn the nuances of installing and commissioning this particular system while actually installing it, which is never a particularly productive method. We may never install this system again, meaning there is no significant development of repeatable processes.

Then the time comes to make the system work with the overall BAS. Hopefully, the specification is tight enough that the mechanical contractor has selected a completely compatible BAS. The integration obligations are clearly on the BAS specialty contractor, who simply ties in to the fire alarm system. Three firms are involved in this process, reading through a specification that is a *translation* of the actual requirement. Productivity improvement is the least of anyone's concern.

After the project is completed, the mechanical and electrical and BAS contractors never work together again. Or perhaps they will work together again, even frequently, but never with the same specifications. Or maybe they will work together again once or twice with the same set of circumstances, but since makes and models of equipment change substantially over time, the specifications will change. After all, a major project will often last two or three years, so a team can gather for large scale projects with the same circumstances at most just a few times in a 30-year career. This severely impedes supply chain management and horizontal integration, as is so prevalent in the personal computer business, not to mention iterative improvement of repeatable processes.

Contrast this with the way almost everything else is produced:

A client requirement set (a.k.a. program), often prioritized, is established and conveyed to the producer. The entire process is driven around the client's needs and everything is on the table to increase value and reduce cost while fulfilling those needs. Design derives from client needs and couples efficiently to production. In fact, production planning is a major component of the design process for any industry that values productivity, such as automobiles or computers. Nothing is properly designed without considering production impacts or improvements. Furthermore, client requirements may be discarded in favor of productivity if their value is determined to be less than that of the reduced cost to the client.

For example, when I purchase a car Ford doesn't ask me to tell them what type of cable to run to my halogen fog lights. In fact I can't even make that selection. If I don't like their cable type, I must buy the car and change the cable afterward. If Ford permitted otherwise, they wouldn't have advanced the manufacturing process to the degree they have, lowering the unit cost per automobile to the extent that we now have more cars than we do people in the United States. I am fine if Ford makes the decision on my lamp cables so long as I reap the benefit in terms of lower a price for the car or additional features that have greater value to me.

But aren't there other paths to construction productivity? Haven't the information revolution and the advent of digital media improved the average electrical and low voltage firm's productivity? An example of the typical application of this technology provides the less-than-satisfying answer. Many vendors are offering to "improve supply chains" on behalf of construction companies by automating their bid request and purchase request processes. While this very limited application of the information revolution could improve some processes, the construction industry could use a larger dose of the *industrial revolution* for the information revolution to maximize its impact.

It's not that these processes don't provide value, but if you want anecdotal analyses of the productivity gains since these tools became widely available, ask any developer or plant builder if their construction dollar is buying more. I suspect their responses will not be resoundingly affirmative.

Every day we receive e-mails from dozens of general contractors on dozens of projects, all of which are generated by bid process automation tools. I assume one day someone will expect an automated response, and perhaps this will go full cycle and create an online reverse auction, as has been tried by some industrial owners. Yeah, that'll solve the productivity problem and beat the tar out of contractor's prices because contractors are too greedy or non-innovative to reduce their prices. Study electrical contracting and the margins and you'll find that neither is true. It is likely that if you took all the net earnings from the industry you'd temporarily save about four percent on the cost of the electrical and low voltage portions of construction — not much of an improvement. In fact, it is amazing that despite the talent and innovation in our industry, which has made pre-fabrication processes, materials management processes, and measurement and productivity analysis processes routine in the top firms, we can barely dent first-cost and labor productivity issues. Most of the information technology is focused on improving job and bid administration rather than production. This is useful but does not go the root of the problem, which is the need for systematic productivity improvement.

One cause of the productivity problem is that in design-bid-build, the client's actual requirement is separated from the production engineering and planning process, so that production is never focused completely on the client requirement, but rather on an interpretation of the client requirement that varies without consideration of production impacts. So we build as we are told to build, free to choose methods and processes within the constraints of the plans and specs, which change from client to client and project to project as any component in the program changes, be it the client, the creator of the specification, the products selected, the other contractors, etc. The supply chain does its best, but will never develop the synergies needed to improve production at all levels while focusing on the client requirements.

Another cause is that the production design process improvement iterations that normally occur as a result of substantial industry productivity improvements do not occur in the electrical construction industry when the connection between production and design is stifled. Furthermore, engaging the supply chain in productivity improvement only meaningfully occurs when there are continuous iterations driving down cost and satisfying client needs. This is stymied when responsibility for client need is separated from the source of production and production engineering.

Here is a glaring example from a recent project. My firm was the electrical subcontractor on a large headquarters core and shell project. The plans and specifications were like most and left means and methods up to us, but disallowed the use of metal clad cable, specifying the use of steel conduit. We were subsequently successful in being awarded the tenant fit-out portion of the project in addition to the work we were already performing. The specifications for the tenant-fit out, because they were created by someone other than the creator of the core and shell specs, permitted the use of metal clad cable to all branch devices. Both metal clad cable and steel conduit are completely acceptable per the National Electric Code and all relevant design criteria, but metal clad cable was only permissible where the covering requirement was the fit-out specification. The use of metal clad cable versus steel conduit could not have mattered to the client since both were run to branch circuits in the same location, as core and shell and tenant fit out activities often overlap. Nonetheless, our costs were impacted by not being able to select an approach that best suited us, but made no difference to the client.

How Will Design-Build Help Remedy This Type of Situation and Improve Production in This Delivery Challenged Industry?

Design-build, of course, puts all of the onus for design deficiency and impact on the project cost on the shoulders of one entity, rather than separating responsibility for design, management, and production. However, there is absolutely no requirement for one entity to perform both design and construction, just that there be one consistent point of responsibility for both. In fact, design-build might logically create long-term engineering-construction partnerships, since once two firms have been through multiple iterative production-design cycles they will create a competitive advantage to working together and further the advantage of their respective specializations. M.C. Dean, Inc., although a self-performing designer and constructor, is currently establishing long term design partnerships in just this fashion. This shifts risk quite well.

Is there a cost? Certainly there is a lack of adequate contractor oversight. Who will protect the owner's interest? Certainly not the same greedy electrical contractor who causes costs to stay so high as described above. (Remember the four percent impact to cost from electrical contractor earnings.)

Our experience has been the exact opposite. Once we are aware of the owner's actual requirements and know we cannot separate ourselves from them by simply complying with the plans and specs, there is not nearly the incentive to obtain the lowest initial price products, because we are now responsible for their performance, not some third party who wrote the specifications. For example, on a large-scale design-build mission critical power plant we had no specified generator or switchgear manufacturers, yet in the end we actually selected the most expensive products. Our reason for doing so was that the facility was an 18MW plant designed to have 99.997 percent reliability. If it were to falter, we would be responsible.

We have had the same experience on large-scale low voltage systems. On these systems, it is difficult to assess product and performance differences until problems occur. On a recent design-build systems project for a major airport, we were given wide latitude with regard to equipment selection, with the only constraint being that we had to meet stringent performance specifications for the airport's controlling authority and construction manager. The component and subsystem selection criteria we employed as designers gave serious consideration to those items operating very successfully in the airport already, such as the digital sound electronics and programmable electronic signage in use in other terminals. Ninety percent of the time they were integrated into our design. No one had to try to write a specification that hinted at these manufacturers without violating most institutions' procurement policies by creating a sole-source specification. (Always a fun way to build a job — contractors love to substitute, engineers love their specified manufacturers, and purchasing agents want competition.) We have a great incentive to select these vendors, for when we design and build and, in some instances, warrant for many years, we own a very similar problem to the owner's.

So What's This Next Wave of Productivity That Design-Build Can Take Us to as Specialty Contractors?

Focusing directly on client requirements allows the producer to understand what is considered valuable. Once we know this, we can design a solution that maximizes value to the client, not execute a translation, however good it may be, in the form of a specification. Furthermore, we learn to create commonalities among user requirements such that we can rapidly develop responses and gradations based on what we learn from common sets of users. Here's an oversimplified example — we learn that all data centers have critical power infrastructure and stringent grounding needs and client requirements might include several variations of data center specific electrical configurations, such as full system level redundancy, component level redundancy, or combinations thereof to achieve a certain level of reliability based on the planned use of the center.

Once we begin the design-build process at risk, based on true performance requirements, we then initiate the necessary feedback loop for major productivity enhancement. Once a project in a genre of service is performed, the ups and downs of the approach are assessed and improvements made to enhance cost effectiveness without impacting client value drivers. While the value drivers are sacred, everything else is on the table.

For example, when designing a complex critical power system, the main issue is reliability. Almost everything takes a back seat as a value driver to reliability. All performance criteria must be measured in terms of improvement to or detracting from reliability. A mission critical power plant design will include large generators, high quality switchgear, etc., but most importantly, it will include a highly skilled design that focuses on reliability and the ergonomics of supporting reliability. A skilled design-builder will have the latitude to deploy the conveyances, lighting, fire alarm systems, etc., that most suit his comfort so long as they meet the functional and architectural requirements and above all else support the reliability needs.

Over time, this design-builder develops improvements, as they will necessarily afford an advantage in providing the client ultimate value. These improvements might lower cost, or might improve power reliability, or both. By being at risk in the design-build process repeatedly, the design-builder can establish repeatable processes with maximum effect to meet the project requirements. On a recent project involving design-build of approximately 40 mini-data centers, the client had attempted to design-bid-build unsuccessfully over an 18-month period. Our team was given six months to complete these facilities using design-build. We placed production planning just behind reliability in the design process. We developed standard service configurations that were assembled and tested in a controlled environment, then disassembled, containerized, and delivered. Concurrently, engineers designed locale and facility specific elements of the electrical system such as life safety, lighting, and utility feeds. These specific elements could be constructed independently of the service equipment and, once the service equipment arrived, it was reassembled and the site commissioned. All 40 sites were completed within six months to very exacting performance constraints.

On design-build of large facilities, we first identify the value drivers and optimize our design-build solution around these drivers. For the rest of the work, i.e., everything to which the client says "give me quality and reli-

ability, but I have no specific requirements otherwise" (remember the metal clad cable and steel conduit), so long as we meet expected standards of quality both internally and with the client, we design the solution with emphasis on productivity. Roughly 25 to 33 percent of most electrical projects are like this. For example, M.C. Dean, Inc., has developed a catalogue of some 60 items that we specially design and fabricate to both improve quality and reduce costs. These items are built using a pre-selected list of products, with which we are extremely familiar and adept at deploying (i.e., highly repeatable). As we discover new means and methods, they are incorporated into the design process. These assemblies, many of which are simple, are engineered into our design, their parts are assembled and tracked much like a manufacturer would. They are delivered and installed as if they were manufactured independently. The series of photographs and details below shows one item in our current catalog of 60+ components for design-build.

Once we are successful in fully establishing this as standard operating procedure within our company, productivity process improvements so prevalent in other industries can truly be applied to ours. While this is just the beginning, it has indeed begun. The more performance based design-build becomes the delivery method, the more M.C. Dean, Inc., and companies like us will do our best to make a dent in the half trillion dollars that can be saved by our industry.

M.C. Dean, Inc., headquartered in Dulles, VA, is a leader in the design, installation, and integration of complex power, electronics, homeland security, and telecommunications systems. The firm, with more than 1,400 employees and offices throughout the world, has extensive experience in providing services to public sector clients and institutional and large commercial customers throughout the MidAtlantic, Southeast, and worldwide.

William H. Dean is President and CEO of M.C. Dean, Inc. Mr. Dean has a Bachelor of Science degree in Electrical Engineering from North Carolina State University. He has been the President of M.C. Dean, Inc. since 1998 and has spent his 25-year career in the field of power, telecommunications, and electronics systems engineering and construction.