Modularization and Prefabrication – Role Development and Evolution

The National Institute of Standards and Technology recently addressed ways to improve the competiveness and productivity of the construction industry in the United States. “Greater use of prefabrication, preassembly, modularization and off-site fabrication techniques and processes . . .” was viewed as one of the primary ways that the construction industry could improve productivity and become more efficient over the next 20 years. FMI’s experience confirms this view.

When many people think of modularization, they think of double-wide site trailers or temporary buildings at educational facilities. Those are indeed modular buildings, able to be relocated as needs change. However, modularization has also influenced more permanent structures, from power plants to hospitals to local office buildings. FMI has followed the evolution of modularization and prefabrication for some time. In 2010 FMI conducted several surveys related to modularization and prefabrication. In its 2010 Fourth Quarter Nonresidential Construction Index Report, FMI asked panelists to estimate their expectations of growth for prefabrication and modularization in construction. Only 11% expected growth for the next three years to be less than 1%, or less than expected GDP growth. Thirty-seven percent expected growth to be between 1% and 5%, and 49% fully expected growth in this area to exceed 5%. FMI also surveyed more than 1,000 mechanical and electrical contractors and found that 80% of respondents saved more than 5% in labor in the prior year due to the use of prefabrication, and 93% expected they could save more than 16% in labor costs in the coming years. These are significant growth and cost-savings expectations.

Prefabrication and modularization are concepts that have been in use for years. FMI predicts that in the coming years modularization and prefabrication will play an increasingly vital role in improving the productivity of the entire construction value chain – on par with lean construction techniques, alternative project delivery methodologies, and 3D and 4D modeling. Architects, engineers and contractors all use modularization and prefabrication in their work. Most agree that prefabrication and modularization can lead to significant decreases in project schedules, a reduction in project budgets and significantly less construction-site waste.

How does this happen? Due to the repetitive nature of fabrication, more work can be done by cheaper, lower-skilled labor. This labor pool can be made more efficient with specialized tools and equipment, and field equipment needs can be reduced as modules are fabricated off-site. Materials and completed modules can be stored off-site in controlled environments, and waste material can

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be used on subsequent projects or recycled. Work sites can be made safer with fewer weather-related complications, less work at heights and fewer conflicts among various trades. Safety also is enhanced by prefabrication facilities that provide a uniform, efficient manufacturing environment – one in which layout areas and schedules are optimized to provide for proper sequencing and sufficient room for people, equipment and materials. Manufacturing environments can also result in fewer supervisors overseeing a larger volume of work. Importantly, prefabrication allows site development, utility and foundation work to proceed at the same time that modules or prefabricated components are being manufactured. Finally, manufactured modules can be installed over periods that are significantly shorter than traditional stick-built or site-built construction, resulting in less environmental impact on-site and quicker site restoration.

Two examples serve to illustrate the potential range of projects that can utilize prefabrication and modularization. In May 2006 The Shaw Group delivered the Astoria Power Plant in Queens, N.Y. The project was completed in only 21 months. Shaw used modular construction and pre-fabrication to construct the air-cooled condenser off-site and also constructed modularized pipe racks and equipment skids at facilities in Louisiana. Perhaps most impressive was that two fully constructed heat-recovery steam generators were built in Indonesia and shipped more than 12,000 miles to the plant site. In preparation for the 2010 Winter Olympic Games, Britco, a Canadian company, designed and manufactured a 100-room lodge and a 20-unit townhome complex in the athletes village. The projects were delivered on budget to tight deadlines, and the buildings were designed to LEED™ Silver standards. The lodge was selected as the best modular building in North America in 2010 by the Modular Building Institute, which cited its architectural excellence, technical innovation and energy efficiency. In addition, Britco designed and manufactured temporary housing used by almost 600 athletes and officials of the games. These temporary modular units were later disassembled and relocated to six different cities where they now are being used as permanent housing.

Significant cost, schedule, safety and environmental benefits accrue to the users of prefabrication and modularization. These techniques can be applied to a wide range of project types. Why, then, do prefabricated and modular buildings make up only $5 billion of the approximately $800 billion of annual put-in-place construction? We think that the reasons relate to mind-set. Modularization and prefabrication are not easily used in traditional design-bid-build projects, where each phase of the project is executed separately and apart from the following phase. Prefabrication and modularization are much more easily used in projects that use integrated project delivery or in design-build projects, where design and construction decisions are made with a view toward maximizing cost and schedule efficiencies and where all participants share in the risks and the rewards of project execution. Project participants must work together and be open to new approaches to realize the full benefits of modularization and prefabrication.

Better. Faster. Cheaper. The construction industry is being pressed like never before to create and

find value for clients and owners. Building Information Modeling (BIM) in the vertical design and construction world and other three- and four-dimension modeling used in the heavy civil world are changing the way projects are conceived and delivered. As these software systems see broader adoption, it will be more and more common to have the same multidimensional project model used by planners, designers, engineers, fabricators, quantity surveyors, construction managers, and general and specialty contractors. These programs allow for precision that was impossible to achieve in the past. This precision, carried through to module fabrication and manufacturing, materials management, scheduling and conflict identification ultimately results in significant savings in time and materials and also produces less construction waste.

It is essential that owners are convinced of the benefits of modularization and prefabrication. Whether it is the architect, engineer, construction management firm or contractor that has the primary relationship with the owner, great effort must go into showing owners that they can end up with a project delivered at less cost and in less time with higher quality. Proving this to owners can be accomplished best by showing them similar projects on which savings and quality were well-documented.

How do you start? Start with the owners. Convince them of the benefits of a modular approach. Then, make sure architects are aware of the possibilities of prefabricated modules. Introduce architects to engineers who have worked with prefabricated modules as well as to the manufacturers of these modules. Have them tour the plant and other projects that are using prefabricated modules. Prefabricated modules often can only be used in a project if they are designed and included from the start. This is a crucial point in the entire value chain – make sure the use of prefabricated modules is explored early in the process so that your options are not limited right from the start of the project.

Get the engineers involved in designing the modules. With the right materials and design, it is often possible to use lighter materials that are more easily transported and installed. Engineers are in the best position to extol the structural benefits of modules manufactured to precise tolerances in controlled environments. Walls, roofs, floors, concrete spans, superstructures – all of these are being prefabricated, and engineers are in the best place to evaluate their applicability to specific projects.

Early collaboration between engineers and architects allows for the highest chance that significant cost and schedule savings will be derived from prefabricated modules. Architects and engineers need to be evangelists and extol the virtues of using prefabricated modules with both the owners and with the other parties involved in project delivery. The more architects and engineers are convinced of the benefits, the more likely it is that owners will be comfortable using prefabricated materials and contractors will embrace new installation methods and new project delivery schedules. Architects and engineers will need to take on a greater coordination role in the overall construction process. Since design and material choices must be made early, with little room for adjustment at

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later points in the process, and because these choices will dictate how and when much of the subsequent manufacturing and installation work will take place, engineers and architects need to bring all parties together early in the process to get buy-in and alignment around these choices. Finally, engineers and architects will need to design projects and systems as they have always done, but also will need to broaden their role to evaluate and integrate components, modules and materials designed and manufactured by others.

Where architects and engineers are interested in overall design and the best application of materials, contractors and construction managers are interested in project delivery – time and money. In fact, contractors and construction managers are probably in the best position to benefit from the use of prefabricated modules. Since manufactured modules do not lend themselves well to construction site modification, they have to be conceived well and designed and manufactured to tight tolerances. In many cases, this requires additional design time and expense to ensure that modules are designed and fabricated correctly. The big payoff of this early effort is often realized in the concurrent work that can be accomplished at the construction site while the modules are being fabricated at a nearby facility. This concurrent work, coupled with the ability to erect and connect modules on-site in an expedited manner, leads to significant schedule compression. Contractors who use a modular approach to construction can also save significant costs associated with site labor and equipment rental.

Perhaps more than other contractors, specialty contractors have already embraced prefabrication for mechanical and electrical systems. Their experience base can help them to remain competitive and differentiate themselves from competitors who are not using prefabricated components. In addition, specialty contractors can help speed the adoption of prefabricated modular methodologies in other parts of the project, by being vocal about the benefits they have experienced with prefabricated systems. Said another way, their positive experiences with pre-fabrication and modularization in the context of mechanical and electrical systems can help shape the way owners, general contractors and construction managers implement prefabricated components in the broader project context.

Contractors should work to gain experience with prefabrication and modular construction. Small jobs lead to bigger jobs. Familiarity and experience with the use of modular construction will allow contractors to build the advantages of these approaches into their bids and allow them to incorporate the benefits into schedule and pre-construction planning sessions. Time and money. A project delivered faster through the use of prefabricated modules is not exposed to as many weather delays, can be of higher quality, can result in significantly less construction waste and can allow the ultimate owner to begin utilizing the project sooner.

Better. Faster. Cheaper. The pace at which modularization will be adopted by players in the con-

struction value chain will accelerate, as knowledge of the benefits becomes more widespread and as more players seek to differentiate themselves in today's hypercompetitive market.

There is a growing base of successful projects that demonstrate the benefits of modular construction – benefits that argue for this approach in a wide range of projects. However, to recognize the full benefits of modular construction, industry players will need to alter their mind-set. They will need to be open to new approaches to designing, scheduling and constructing projects. Collaboration and partnering skills will be paramount. Owners will need to be convinced of the benefits of this approach. Architects will need to embrace the possibilities and the constraints of modular construction. Engineers will need to become familiar with the possibilities and manufacturing processes associated with various prefabricated components. Manufacturers will need to become involved in project discussions at the outset, and contractors and the specialty trades should use prefabrication and modularization to reduce project schedules, improve safety and reduce waste. The benefits of prefabrication and modular construction are most apparent in projects that utilize integrated project delivery or in design-build projects where design and construction decisions are made with a view toward maximizing cost and schedule efficiencies, and where all participants share in the risks and the rewards of project execution.

Because FMI works across the industry with architects, engineers, contractors and the specialty trades, we are in a unique position to see the positive impact that modular construction and prefabricated components are having on the construction value chain. We are convinced that managed correctly, prefabrication and modularization will improve productivity. The risks and rewards of modular construction will need to be shared among all parties that contribute to value creation. This will call for better coordination and alignment among owners, designers, manufacturers and contractors.

For more information on how FMI can help you tackle the acute challenges facing your firm, please contact:

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