Prefabircation and Modularization in Construction

2013 SURVEY RESULTS

FMI
Sixty Years
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# TABLE OF CONTENTS

FMI 2013 Prefabrication and Modularization in Construction Survey Results ........... 2

Summary of Selected Statistics From the Survey .................................................... 4

Survey Methodology ............................................................................................ 4

Survey Results ....................................................................................................... 6

Who is doing prefab now and how much? ............................................................... 6

Prefabrication and Organizational Strategy ........................................................... 8

Factors Driving Demand for Prefabrication ......................................................... 8

The Benefits of Prefabrication ............................................................................ 10

Strategic Planning: Prefabrication and Modularization ....................................... 11

Growth Rate Predictions for Prefabrication and Modularization in Construction .. 12

MakingPrefabrication Work .................................................................................. 13

Calculating ROI and Efficiency ............................................................................ 13

Improving Current Prefabrication Operations ..................................................... 14

Prefabrication: Shop Planning and Ordering ........................................................ 16

Growing Use of Prefabrication and Modularization ............................................ 20

Challenges and Opportunities for Prefabrication and Modularization ............... 22

Comments From the Survey ................................................................................ 23

Conclusions and Recommendations ..................................................................... 28
FMI 2013 Prefabrication and Modularization in Construction Survey Results

by Ethan Cowles and Philip Warner

“We do expect more use of prefab techniques. BIM is currently making it more possible or feasible to do, but the real driver will be owners seeing examples from elsewhere in the world and starting to demand it for their projects. Contractors will drive this too — by starting to use it more on projects, and working with trades to do more single-trade prefab, it will become more prevalent, even on projects where the GC is not looking at prefab opportunities.”

Big changes don’t come easy for something as large as the construction industry, and when they do happen, they don’t happen all at once industrywide. Change occurs project by project, company by company. There are the early adopters out on what is sometimes referred to as the “bleeding edge.” Sometimes they are way ahead of the game, and sometimes they fail. Then there are those who wait until the leaders have made the process work before jumping in. The change we are referring to in this report is the move to greater use of prefabrication and modularization in construction. According to our recent survey, 61% of all respondents think the use of prefabrication will grow more than 5% a year over the next three years. Currently, 81% of the mechanical and electrical contractors surveyed for this report own their own prefabrication facilities. Of those who don’t, 33% are considering starting up their own facilities.

Of course, there are those who lead, follow and struggle with new trends. The key for all is to make these decisions part of a larger market strategy. According to our report, only 40% of all contractors responding consider their capabilities in prefabrication and modular construction as a part of their company’s strategic initiative. Although the use of prefabrication for some project assemblies is not new, the amount of use and the move in some sectors to using more modular construction in a multitrade environment are growing trends. They are trends, we believe, that will continue to grow, leaving some companies scratching their heads on the bench. A few of the driving forces include:

■ The constant pressure to lower price.
■ The need to achieve a competitive edge in markets increasingly calling for the use of prefabrication and modularization, i.e., hospitals, hospitality, education.
■ The lack of, or impending lack of, skilled construction labor.
■ The use of BIM — allowing greater coordination of design with construction.
■ The need to increase productivity.
Recognizing the growing number of market forces that influence the decision to increase or obtain greater abilities to produce prefabricated and modular assemblies is just the first step in what should be an overall strategic plan. As the response to our survey will indicate, we find that even those who are working to get ahead of the curve with modern shop facilities may be struggling to make it a profitable investment. Putting up a fabrication shop is something they know they need to do, but many of those surveyed don’t spend the time calculating the ROI or the efficiency and success of the operation. They may not have enough work to keep the shop busy, because they don’t incentivize their field managers to look for opportunities to use their capabilities. They aren’t getting their money’s worth even though they expect prefabrication to grow and generally realize their costs are lower in the shop than in the field. There are a number of underlying reasons for these concerns, but we think one the most important considerations for contractors moving to greater use of prefabrication and modularization is that they need to think more like manufacturers. Analyzing ROI, planning work flow, marketing manufacturing capabilities, justifying the expense of new facilities and equipment and so on were revolutionary in the manufacturing industry decades ago. Much of the construction industry is behind that curve.

Contractors have been known for the ability to mobilize men, equipment and material to get the job done. Now they must learn how to make a profit from manufacturing facilities. It is not always an easy switch. Owning and operating prefabrication facilities isn’t for everyone. Again, that is a strategic decision. Not all markets have begun to take advantage of prefabrication and modularization. Contractors working in those markets may be better off buying what they occasionally need prefabbled from shops that do work for others. At the same time, we think the future may bring more regional prefabrication capabilities that might be performed by contractors or by manufacturing companies. It could be either a threat or a boon to construction if this prediction comes to fruition. These ideas will be considered as we analyze the results of our survey in the following pages.
Summary of Selected Statistics From the Survey:

- Forty-eight percent of mechanical and electrical contractors had more than 11% of their current project work accomplished using prefabricated assemblies. That is slightly less than what we found in our 2010 survey when the number was 52%.

- More planning for prefabricated assemblies is taking place in the design phase of construction, 35% for all mechanical electrical contractors in 2013, compared with just 11% in our 2010 survey.

- In 2010, 90% of respondents owned their own prefabrication facilities. That figure was 81% for mechanical and electrical contractors in 2013. However, in 2013, more contractors are subcontracting prefabrication, and more of those who own shops are doing subcontracting work for others.

- In 2013, of those mechanical and electrical contractors that do not own prefabrication facilities, 17% are considering it, compared with just 5% in 2010. However, only 33% have plans to start up their own prefabrication shops, compared to 57% in 2013.

- On average, for mechanical and electrical contractors, 12% of their total annual labor hours were committed to prefabrication. In five years, they would like that number to rise to 32%.

- On average, 26% of mechanical and electrical contractors surveyed have never analyzed the efficiency of their prefabrication efforts, while only 23% reported that they did that for every project.

- Thirty-one percent of mechanical and electrical contractors reported they saved more than 11% on labor last year attributable to prefabrication efforts. In 2010 that number was 37%.

- Sixty-one percent of all respondents think the use of prefabrication will grow more than 5% a year over the next three years.

- Forty percent of all contractors responding consider their capabilities in prefabrication and modular construction a part of their company's strategic initiative.

Survey Methodology

The survey was sent by email and regular mail to a selected list of electrical and mechanical contractors. For the 2013 survey, we also included general contractors and CM firms. This is a change compared with our 2010 survey. As expected, we found some differences between GC/CMs and MEP contractors in the use of prefabrication. While there are some GCs and CMs that have self-perform capabilities in HVAC and electrical work, the numbers are few. We have added GC and CMs to the survey participants, because they are involved in project planning and influence the use of prefabrication and modular construction. Therefore, for much of our discussion, analysis and graphs in this report, we will either segregate this population or not show that group other than in comments. For some questions, we will compare the results with our 2010 survey results. In 2010 we had only a few GCs and/or CMs responding. While the comparison between surveys is interesting and useful in some instances, we can't claim that we have a full picture of all the contractors in the U.S., as the samples are different and biased toward those who have experience with prefabrication, as we expect those respondents were the most interested in participating in the survey.
Survey Results

Who is doing prefab now and how much?

When compared with the numbers from our 2010 survey, it doesn’t appear that the use of prefabrication is growing at the rate we expected. While there is growth on the low end and the high end, the growth in usage of prefabricated assemblies seems to have stalled for most respondents. We do not think this signifies that we will not see more growth in the next few years; however, it might show that some are getting better at finding work that can be accomplished in the shop than others are. When we compare these results with the results for those who now own prefabrication facilities and those who are considering it, we get a picture that suggests more contractors will subcontract prefabrication work (19% for 2013 compared with just 5% in 2010). In the latest survey, we found 5% more shops taking on outside fabrication work than in 2010.

While a few years ago, more MEP contractors were considering adding prefabrication facilities, we think those decisions have been put on hold or changed due to the slow growth of the economy and the difficulties finding investment capital. Many MEP contractors have diminished working capital, taking work at lower margins and trying to stay solvent during the recession. The same holds for GCs, where only 12% said they are considering adding fabrication facilities. This changes their approach to prefabrication facilities. On the other hand, there are those that made the investments during the downturn to be ready for the upturn. As they get more experience, some will excel at producing more prefabrication work and learn to keep their shops full with outside work. Of course, there are already independent shops that don’t have their own construction crews. One can assume that those shops are working harder to capture market share.

As we will discuss further below, this apparent trend not to rush into adding prefabrication facilities may be a good idea, especially for those who haven’t considered prefabrication and modularization as part of their strategic plans. In other words, it is important to “do the math” before leaping into prefabrication. There are risks involved in such large investment decisions, and some will be able to take on that risk and obtain a competitive advantage, while others will do best to avoid it and subcontract as needed.

<table>
<thead>
<tr>
<th>What percentage of your project work is currently accomplished using prefabricated assemblies?</th>
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</thead>
<tbody>
<tr>
<td>2010 Survey</td>
</tr>
<tr>
<td>0% 0%</td>
</tr>
<tr>
<td>1% to 5%</td>
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<tr>
<td>6% to 10%</td>
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<tr>
<td>11% to 20%</td>
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<tr>
<td>21% to 25%</td>
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<tr>
<td>&gt;25%</td>
</tr>
</tbody>
</table>
Do you own your own prefabrication facilities?

- 6% No
- 19% No, we subcontract this work to qualified shops.
- 69% Yes
- 55% Yes, we subcontract work for others.

If you do not own your own prefabrication facilities, do you plan to add this capacity in the near future?

- 33% No
- 17% No, but we are considering it.
- 33% Yes
- 17% Yes, but we are not sure if it is justified.
- 5% We have not considered prefabrication.
Prefabrication and Organizational Strategy

The comment above from a general contractor responding to our survey represents some of the challenges and opportunities for prefabrication and modularization in the construction industry. The industry will not overcome those challenges or make those goals without more individual construction firms first making decisions about prefabrication and modularization part of their strategic plans. And many are, as we will indicate below.

Factors Driving Demand for Prefabrication

For mechanical and electrical contractors, the largest factor driving demand for prefabrication is to improve productivity. This is ultimately the focus point for other factors driving demand, such as improving the construction schedule, bidding competitively and finding a way to make up for a shortage of skilled labor on the jobsite. As business picks up in the industry, all of these factors, especially the shortage of skilled labor on the jobsite, will only become more critical.

A thorough understanding of the demand drivers for prefabrication and modularization is a necessity before making strategic decisions about how prefabrication and modularization fit into an individual company’s strategy. For some markets, like health care, lodging and education, the use of modularization is expected to grow faster. There also may be growing interest in other markets as experience grows and the perceptions of prefabrication and modularization as “cheap, poor-quality, temporary” solutions improve. These perceptions are held not only by the owners paying the bills, but also by field managers who influence the use of prefabrication decisions.
Who or what are the primary factors driving the demand for prefabrication?

- General contractors to improve construction schedule: 21% (23%)
- The need for productivity improvements and lean construction: 19% (27%)
- Trade/subcontractors to win bids and increase profits: 14% (15%)
- Owners indirectly due to competitive pricing pressures: 13% (15%)
- Improved technology allowing for greater use of prefabrication: 10% (9%)
- The shortage of skilled labor at the jobsite: 10% (13%)
- Architects specifying prefabrication in the design stage: 5% (3%, 6%)
- Owners by direct request: 4% (7%)
- Other: 3% (2%)

2013 Survey All Responses
2013 Mechanical/Electrical
2013 GC/CMs
The Benefits of Prefabrication

Having a better understanding of the benefits expected when increasing the use of prefabrication is another important part in creating a strategic approach to the market. We found a number of potential benefits of prefabrication. The top benefits expected were reduced time to completion and reduced construction cost. However, improvements in quality, safety and profit margins also exhibited strong expectations for benefiting from a greater use of prefabrication. For each of these categories, it is possible to estimate savings and benefits that help make the decisions to build, buy or otherwise increase or decrease the use of prefabrication.

<table>
<thead>
<tr>
<th>Benefit</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing time to project completion</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>2%</td>
<td>5%</td>
<td>11%</td>
<td>15%</td>
<td>14%</td>
<td>50%</td>
</tr>
<tr>
<td>Reducing construction cost</td>
<td>1%</td>
<td>3%</td>
<td>2%</td>
<td>3%</td>
<td>13%</td>
<td>6%</td>
<td>14%</td>
<td>18%</td>
<td>21%</td>
<td>21%</td>
</tr>
<tr>
<td>Increasing profit margins</td>
<td>1%</td>
<td>2%</td>
<td>3%</td>
<td>4%</td>
<td>10%</td>
<td>9%</td>
<td>15%</td>
<td>18%</td>
<td>23%</td>
<td>17%</td>
</tr>
<tr>
<td>Competitive advantage</td>
<td>1%</td>
<td>2%</td>
<td>3%</td>
<td>4%</td>
<td>10%</td>
<td>9%</td>
<td>15%</td>
<td>18%</td>
<td>23%</td>
<td>17%</td>
</tr>
<tr>
<td>Overall improvement to worker safety</td>
<td>2%</td>
<td>5%</td>
<td>3%</td>
<td>3%</td>
<td>15%</td>
<td>8%</td>
<td>18%</td>
<td>22%</td>
<td>11%</td>
<td>13%</td>
</tr>
<tr>
<td>Improvements in quality</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>3%</td>
<td>11%</td>
<td>8%</td>
<td>20%</td>
<td>22%</td>
<td>20%</td>
<td>13%</td>
</tr>
<tr>
<td>Reducing rework</td>
<td>3%</td>
<td>2%</td>
<td>4%</td>
<td>4%</td>
<td>16%</td>
<td>10%</td>
<td>16%</td>
<td>19%</td>
<td>16%</td>
<td>12%</td>
</tr>
<tr>
<td>Reducing material waste</td>
<td>3%</td>
<td>3%</td>
<td>5%</td>
<td>8%</td>
<td>15%</td>
<td>10%</td>
<td>12%</td>
<td>19%</td>
<td>15%</td>
<td>10%</td>
</tr>
<tr>
<td>Reducing the need for skilled labor on the job site</td>
<td>1%</td>
<td>4%</td>
<td>5%</td>
<td>5%</td>
<td>13%</td>
<td>12%</td>
<td>13%</td>
<td>21%</td>
<td>19%</td>
<td>7%</td>
</tr>
<tr>
<td>Reducing change orders</td>
<td>11%</td>
<td>6%</td>
<td>7%</td>
<td>10%</td>
<td>13%</td>
<td>13%</td>
<td>16%</td>
<td>8%</td>
<td>12%</td>
<td>4%</td>
</tr>
<tr>
<td>Ease of recruiting skilled employees for work in a shop environment</td>
<td>6%</td>
<td>10%</td>
<td>5%</td>
<td>5%</td>
<td>19%</td>
<td>14%</td>
<td>15%</td>
<td>11%</td>
<td>11%</td>
<td>3%</td>
</tr>
</tbody>
</table>
Strategic Planning: Prefabrication and Modularization

We never recommend following the crowd. If you think you need to increase the use of prefabrication and build a new facility primarily because other contractors are doing it, you may be diverting your attention and funds that could be better used elsewhere. The survey responses indicate that 10% of all respondents have considered the use of prefabrication and modularization as part of their strategic planning process but have determined that there wasn’t much competitive advantage at this time. That’s a low percentage of the response, but at least the decision was strategic rather than those 28% of respondents who haven’t even considered how prefabrication and modularization fit into their overall market strategy. The good news is that 23% expect to make prefabrication capabilities part of their next strategic planning sessions, and 40% already have and now think of prefabrication as one area where they can achieve a competitive advantage over the competition. Whether they have all achieved that advantage yet or not, we can’t say from the survey results. However, they are certain to have the jump on those who have not considered prefabrication and modularization as a potential by important part of their strategy.

For those mechanical and electrical contractors that have made prefabrication and modularization part of their strategic plans, the results align closely with the market drivers and the potential benefit factors. At the top of the list, prefabrication is thought of as part of the operations plan for productivity improvement. There is a high recognition factor that prefabrication and modularization are critical capabilities required to compete in some strategic markets. Still, for 10%, prefabrication is used only opportunistically when the project calls for it. We think some of these may be able to make more strategic use of prefabrication at some point, but at least it has been carefully considered as part of a strategy.

### What part of your strategic market planning does your approach to the use of prefabrication and modular construction play?

<table>
<thead>
<tr>
<th>Statement</th>
<th>2013 Mechanical/Electrical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prefabrication fails under our operations plans for productivity improvement</td>
<td>23%</td>
</tr>
<tr>
<td>In select markets, prefabrication and modularization are key capabilities for winning work</td>
<td>18%</td>
</tr>
<tr>
<td>Prefabrication has become an important strategic move to capture market share</td>
<td>18%</td>
</tr>
<tr>
<td>Modular construction capabilities are becoming a critical competitive edge</td>
<td>15%</td>
</tr>
<tr>
<td>Prefabrication is something we must do to keep up with the competition</td>
<td>14%</td>
</tr>
<tr>
<td>Our use of prefabrication has just been opportunistic when the project calls for it</td>
<td>10%</td>
</tr>
<tr>
<td>For our markets, prefabrication and modular construction do not play a very important role</td>
<td>2%</td>
</tr>
</tbody>
</table>
Growth Rate Predictions for Prefabrication and Modularization in Construction

As noted in our earlier discussion of current work in prefabrication, we expected more growth after our last survey; but it now seems we did not take all the potential growth inhibitors into account. Again, with 42% of mechanical and electrical respondents expecting 5% to 10% a year growth, and 11%, even more than that, we expect this area of construction to show strong growth in the next few years. GCs and CMs who also have a potential influence on the use of prefabrication and modularization have slightly lower expectations for growth, but still expect steady growth. Considering our experience and the current state of the market, we will hedge our prediction to just 1% to 5% growth in the next three years. This is not unsubstantial, and, if it grows that fast or faster, prefabrication and modular construction will in fact become a stronger trend.

How fast do you think the use of prefabrication will grow in the next three years?

<table>
<thead>
<tr>
<th>How fast do you think the use of prefabrication will grow in the next three years?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1% a Yr.</td>
</tr>
<tr>
<td>1% to 5% a Yr.</td>
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<tr>
<td>&gt;5% to 10% a Yr.</td>
</tr>
<tr>
<td>&gt;10% to 15% a Yr.</td>
</tr>
<tr>
<td>&gt;15% a Yr.</td>
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</tbody>
</table>

2013 Mechanical/Electrical

How fast do you think the use of prefabrication will grow in the next three years?

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<thead>
<tr>
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<tr>
<td>&gt;5% to 10% a Yr.</td>
</tr>
<tr>
<td>&gt;10% to 15% a Yr.</td>
</tr>
<tr>
<td>&gt;15% a Yr.</td>
</tr>
</tbody>
</table>

2013 GC/CMs
Making Prefabrication Work

Calculating ROI and Efficiency
For those making a strategic move into expanding their use of prefabrication and modularization on projects, especially when building new facilities, we would expect there would be some considerations for the expected return on investment (ROI). What we have found over the course of two surveys is that only a little more than half of the respondents have calculated their ROI before making investments in prefabrication assets. Similarly, 26% of respondents have never analyzed the efficiency of their prefabrication efforts. In a manufacturing environment, this would be unacceptable. Fortunately, nearly half of all respondents pay close attention to the ROI and efficiency of their operations.

Another important measure when considering a substantial investment in prefabrication facilities is the expected payback time frame. Fifty-three percent of all respondents expect that should be three years. It is more difficult to get a good idea of the expected payback time if you have not first calculated ROI. For small investments, a two- to three-year payback would be reasonable. For contractors making large investments, a much longer time horizon may be needed and appropriate, especially if the organization is trying to compete on a regional level.

There are a number of other factors that should be measured to track the efficiency and effectiveness of an investment in prefabrication facilities. (These measures, like design and delivery times, quality control, procurement and quantity tracking and labor relations issues, are typical in a manufacturing environment.) Some of these measures are different from what is required or done on a construction site. Prefabrication requires a different mindset than construction. That is why we think some contractors will do better than others will if they learn the sophistication and patience of manufacturers. At the same time, we also expect we may see more regional involvement in prefabrication from industrial manufacturers that already have these disciplines in place.

Before making investments in prefabrication assets, do you calculate ROI?

<table>
<thead>
<tr>
<th></th>
<th>2010 Survey</th>
<th>2013 Mechanical/Electrical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>65%</td>
<td>55%</td>
</tr>
<tr>
<td>No</td>
<td>35%</td>
<td>45%</td>
</tr>
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</table>
Improving Current Prefabrication Operations

Considering improving current prefabrication operations, our survey focused on productivity and labor savings as among the most measurable advantages of prefabrication. When comparing labor savings with expected annual labor savings, we found a significant gap between actual savings and expected savings. For some, this gap will close with experience, especially for those relatively new to the prefabrication process. For others, it will be a challenge to achieve their goals. However, it is encouraging that, at least at the lower end of savings, some have done better than expected. For instance, in 2010, 43% reported that they saved 5% to 10% in labor using prefabrication compared with 34% in 2013. However, when we look at achieving labor savings of 11% or better, we find a lot of opportunity. If these goals are realistic, it will lead to greater efficiency and productivity in prefabrication.
At this time, most of the savings in labor are due to lower hourly rates for shop labor. In 2013, 67% said prefabrication labor is less expensive than field labor, while only 7% said it was more expensive. These figures are highly dependent on where the facilities are and on union labor agreements. However, if more attention is paid to potential efficiencies in the shop, the use of prefabrication will look more attractive.
Prefabrication: Shop Planning and Ordering

One of the encouraging signs in our 2013 study of prefabrication in construction is that more planning for the use of prefabricated assemblies on the project is taking place in the design phase of the project. This helps to improve planning and workflow, both in the shop and on the jobsite. However, there are some caveats noted by our respondents, for instance:

"Design changes during construction appear to create problems with prefabrication. Field coordination of systems and building components is still critical to prefabrication working properly."

The use of BIM has also made it more effective and collaborative to incorporate the use of prefabrication and collaboration early on in the process. At this point, only 31% of mechanical and electrical contractors think of the use of BIM as “very critical to our ability to prefabricate assemblies,” while 24% have not used BIM in the prefabrication process yet.

Becoming more efficient and making productivity gains using prefabrication requires experience. Keeping the shop working near capacity not only increases experience, but also can greatly improve efficiency. Toward that end, it is important to focus on who plans or orders prefabricated assemblies in your organization. Is he or she encouraged, incentivized and confident in the shop’s abilities to deliver what is needed in the field, on time and with high quality? We found that, for the GC/CM group and the mechanical/electrical contractors, the project manager is the key field source for ordering prefabricated assemblies.

We recommend higher involvement from the field manager; however, the decrease in the involvement of the field manager is down 58% since our last survey. On the other hand, it is good to see that more prefabrication is being considered in design. This is an important trend, and we think it shows in the increased lead time for prefabricated assemblies over our survey in 2010. In 2010, 11% of respondents said lead time for prefabricated assemblies was one to three months. In 2013, that number increased to 32%. The longer lead times are indicative of larger projects and more modularization and involvement in multitrade assemblies. It takes time to plan and pull large, multitrade assemblies together.
Essentially, if there is labor savings in prefabrication as well as higher-quality work, fewer safety problems, higher productivity, etc., then we think it is more effective to involve the field manager who must work closely with the equipment and be knowledgeable of both field and shop capabilities and capacities. It may even be instructive to start new field managers in the shop to understand the capabilities and quality of the prefabrication shop. However, just as more are expecting the PM to order prefabricated assemblies, the number of respondents saying that they incentivize the field managers to find prefabrication opportunities has gone down from 37% in 2010 to just 29% in 2013. At the same time, only 13% of mechanical and electrical companies require that prefabricated assemblies be purchased internally. Nonetheless, 52% do analyze where prefabricated assemblies will be ordered on a project-by-project basis.

If prefabrication and modularization are competitive advantages in your strategic plan, then implementing that plan should involve both internal and external marketing of those capabilities. While it may not always be cost-effective to require that your own facilities do the prefabrication for a project, it is important to assure your facilities are competitive on both price and quality, and that they have the opportunity to gain experience from challenging projects.
Are field managers incentivized to find and use assemblies that can be prefabricated?

Who plans or orders prefabricated assemblies?
Do you require your company to purchase prefabricated assemblies internally?

On average, what is your lead time for prefabricated assemblies?
Growing Use of Prefabrication and Modularization

Currently, the contractors answering our survey would like to see their total hours in prefabrication nearly triple in the next five years. However, looking at the response for our 2010 survey, we can see that there has not been nearly that much progress in the last three years. The easy explanation for this is that the economy for construction has not recovered as fast as many had hoped. However, as we have discussed above, it does not appear that many companies are treating their prefabrication facilities as a profit center for gaining productivity. It is not easy to make the change even when it is apparent that prefabrication is the best approach in some markets. There are also challenges to increasing the use of prefabrication and modularization, as we will discuss below.

One of the reasons contractors may not be utilizing their prefabrication capabilities more often is that they are still working out how to make the best use of their facilities and the details of equipment needed and materials flow, etc. As noted above, these decisions require more of a manufacturing mindset, and it is likely that most contractors do not have these skills in-house. Nonetheless, we found that 53% of mechanical and electrical contractors work these things out themselves. We believe that there are alternatives that might help, including joining a peer group, hiring a manufacturing expert and bringing in a consultant. Figuring it out on your own may work for some, but it also may be an approach that introduces habits and processes that will later need to be unlearned.

<table>
<thead>
<tr>
<th>Year</th>
<th>Current Prefab Hours</th>
<th>Desired Prefab Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010 Survey</td>
<td>12%</td>
<td>29%</td>
</tr>
<tr>
<td>2013 GC/CMs</td>
<td>10%</td>
<td>26%</td>
</tr>
<tr>
<td>2013 Mech/Elec.</td>
<td>12%</td>
<td>32%</td>
</tr>
<tr>
<td>2013 All</td>
<td>13%</td>
<td>28%</td>
</tr>
</tbody>
</table>

- Current percentage of total annual labor hours in prefab
- Percentage of labor hours you would like to see in prefabrication five years from now
Where do you hear about or find out about prefabrication ideas, for instance, what can be prefabricated, what equipment is needed, what shop space is needed, how much material is needed in inventory?

- From the competition: 2010 Survey (13%), 2013 GC/CMs (16%), 2013 Survey All Responses (15%), 2013 Mechanical/Electrical (15%)
- Industrial engineers: 2010 Survey (4%), 2013 GC/CMs (6%), 2013 Survey All Responses (6%), 2013 Mechanical/Electrical (2%)
- Outside consultants: 2010 Survey (5%), 2013 GC/CMs (16%), 2013 Survey All Responses (10%), 2013 Mechanical/Electrical (15%)
- We work these things out ourselves: 2010 Survey (41%), 2013 GC/CMs (33%), 2013 Survey All Responses (52%), 2013 Mechanical/Electrical (36%)
- Trade associations: 2010 Survey (24%), 2013 GC/CMs (18%), 2013 Survey All Responses (19%), 2013 Mechanical/Electrical (18%)
- Other: 2010 Survey (7%), 2013 GC/CMs (11%), 2013 Survey All Responses (2%), 2013 Mechanical/Electrical (10%)
If your company has worked on multitrade prefabrication and/or modular construction projects, how would you characterize the experience?

Challenges and Opportunities for Prefabrication and Modularization

One area of construction that we expect will grow is the use of prefabrication in multitrade modular construction projects. This is driven by more collaborative delivery systems, including integrated project delivery (IPD) and various forms of design-build. BIM is one of the major construction tools that will help make this possible. This trend is in its early stages, but we find that more contractors are gaining experience working on multitrade modular construction projects. Of those answering our survey, around 35% said the experience was very collaborative and successful, while 65% of mechanical/electrical contractors said it was OK but could have been better. Overall, those are good results, and we hope to see the trend shift to more collaborative success in the future.

Whether working in a multitrade environment or not, there is no shortage of challenges and related opportunities for the future of prefabrication and modular construction.

Almost everyone answering our survey expects the use of prefabrication and modular construction to grow at an increasing rate in the next five years. Productivity that saves time and expense and increases profitability is the largest driver, but the potential lack of skilled tradespeople on the job is another expected challenge to overcome that can be helped with the use of more prefabrication and modularization. Projects with repetitive modules in the design, like hospital rooms, hotels, schools and multifamily units, are good candidates for more modularization. In addition, the need for and benefits of more collaborative construction delivery methods are also drivers for more prefabrication and modularization. This has been a long-growing trend in the industry; however, the focus on competitive low-bid work since the recession has slowed the benefits of more collaborative construction methods.
Increasing the use of prefabrication and modular construction is not without challenges. From the comments we received, those challenges or hurdles include:

- Proving that it works and saves time and money.
- Selecting the right types of projects for modular construction.
- Transporting, particularly states allowing large assemblies to be transported on their roads.
- Locating costs of modular assembly areas close to the construction site.
- Working collaboratively and getting involved with the design early in order to avoid changes after the work is designed and built.
- Convincing people that prefabrication and modularization can produce superior quality and not look like temporary housing units, etc.
- Assuring or reassuring that the work meets code.

All of these challenges can be overcome. However, one of the biggest challenges is getting the organization to deal with change. Getting buy-in from the field, working more collaboratively, producing the best quality in the shop and incentivizing change are all ways to get change moving in the right direction.

We have listed many selected comments concerning expectations for prefabrication and modularization and challenges below.

**Comments From the Survey**

Do you expect more use of modular construction in the construction industry? And, if so, what or who will drive this trend?

- A shortage of skilled trades is driving modular construction.
- Absolutely. It will continue to evolve rapidly over the next five years and be a standard part (at least a notable percentage) of doing business after that. Owners will indirectly drive this trend by asking for buildings faster and cheaper. The competition will directly drive this trend because promises will be made about how they can deliver these cheaper and faster requests using prefabrication.
- Anytime you can save money in the form of labor expenses or time, it will help the end user—especially if it is a specialty type of construction that gets repeated over and over for medical surgery rooms for remote locations developing nations, restaurants (pre-assembly).
- CM/GC will drive process—we have to demonstrate value with results.
- Collaboration from owners, architects and contractors.
- Cost and schedule will drive the use of modular construction, but cost advantages have not been experienced yet. We may not know the right subs, as these franchise, limited-service hotels would be ideal for this modular construction.
- Customers demanding better quality delivered faster and cheaper.
- Developers looking for better quality. Trying to be more sustainable.
Facility owners. Government regulators. Alberta provides a regulatory framework that allows movement of larger modules over public roads. This is a great benefit for designers, constructors and owners.

I believe modular construction will be used more in the commercial and residential markets where construction is repetitive and units are only semi-custom. I believe cost and quickness to erect will drive the market.

I don't think it will change much in our market.

I think we will see an increase in the use of modular construction. The drivers will be large customers, such as refineries, and customers who have space constraints.

Modular construction will be used more and more because of the tax advantages of depreciating the assets and because of speed to market.

The economy. Finding a competitive edge and still keeping up quality, profits and schedule.

The one thing that scares me is the strength of the modular builder. In one of our projects, that modular builder was 80% of the cost of the project. We got the owner to take the risk of that builder's default, but that does not add much value to the client. The job was a great success, but about a year later, the modular builder did go out of business. This is way too much risk for us for the reward of doing the job. We are looking at working on smaller chunks of the work so the credit risk is not so concentrated.

There is certainly a growing trend of prefabrication in our industry. Currently, the mechanical trades (HVAC, piping) drive it. There are also structural components, such as precast, wood and light-gauge steel, that are catching up.

Time restraints and expensive labor cost (Davis Bacon) will make this something everyone will be doing in five years.

To increase in Louisiana, fire marshal regulations (U.L. tests) will have to be included.

We, as the GC, will drive this trend. Owners and architects at this point do not care, as they are typically not educated about prefab and modular construction. But the benefits of modular construction, for certain projects, help us better deliver what the owners are looking for: speed to market, reduced cost of GCs due to shorter schedules and less disruption of their existing operations by reducing construction time on-site.

Yes — need to differentiate (competitive advantage)

- Improvements to safety and quality
- Reduced manpower needs on-site
- Efficiency

Yes — owners and GCs are pushing it, but subs who really embrace it find they cannot live without it.

Yes, as owners continue to drive down prices and or shorten schedules. This will increase the value of prefab. In some of our niches, we are seeing some in health care, when bedrooms or other repetitive construction is part of the design. Same holds true for higher education. Obviously, we do not expect it to come into play for a long time in interior renovations for health care or biotech and pharma outside of basic MEP and equipment prefabrication.
Yes, everyone (owners, CMs, subs) is driving this trend with compressed schedules and the need to be more productive with a less productive, skilled labor pool. Allows for fewer man-hours on the project and improved safety performance.

Yes, the growth in the oil and gas industry in North America is occurring in remote locations lacking the infrastructure to accommodate workers. This has resulted in high costs and delayed schedules. Modularization addresses many of the factors that impact the success of these projects, and we anticipate the industry will be increasingly looking towards a modularized solution.

Yes. Craft shortages, specifically welders, will lead to a move towards modular construction. Schedule, quality, safety and predictability improvements will also drive the trend.

What are the biggest challenges or hurdles that the industry (including owners) needs to overcome in order for prefabrication and modularization to become widely used and accepted practices?

1) Time and proof it works: As there are more projects that are completed using prefab and modular construction, more companies, including owners, will have proof that there are real benefits and therefore will be more likely to be willing to participate.
2) Early decision-making: Even with traditional construction methods, one of the biggest hurdles we face is timely owner decisions. With prefab/modular construction, we are now asking the owners/architects to make decisions six or more months earlier. The key is to convince them of the following: no loss in design intent, no more decisions (same decisions, just sooner) and they will receive the benefit of early decision-making through cost savings in reduced construction time. In addition, potentially the largest benefit in speed to market is the early revenue generation through their operations.

1) Conceptions (or misconceptions) on quality (mostly due to competitors that sell only on price).
2) Architects’ acceptance in the PEMB as a primary structure use (vs. conventional, might be conflicts when architects also perform engineering services).

1) Designs must be modular.
2) Subcontractors and GC collaborate and learn from one another.

Acceptance by permitting agencies and approval by inspectors.

Acceptance that quality is the same, if not better (people still think of manufactured homes). Learning how to make early decisions that cannot be changed during the fabrication stage. Planning the entire project in design and precon and picturing the outcome. BIM is helpful.

All stakeholders, designers, constructors and clients need to understand the advantages as well as disadvantages of prefabrication and modularization. Not in every instance is modular construction economical. The client needs to be educated.

Allowing the time to plan and engineer the modularization into the design and procurement.

Better education, better design options, more entities with expertise. More collaborative planning in pre-construction, comparability of prefab systems.

CM delivery model does not support the upfront project investment to reduce project cost, schedule and improve quality. Construction firms currently move construction from the site into a prefab facility. Instead of moving construction inside, they need to treat as a manufacturing and industrialized process to maximize productivity. The construction industry is resistant to change.
Competition for shop space, finding skilled labor.

Creativity limitations.

Decisions are set in stone once made to move to fabrication. It becomes a manufacturing environment not easily adjusted for changes.

Demonstrating the value and/or proving that buildings will be built cheaper and faster. Subcontractors will also have to become adaptable to various GC prefab facilities, while utilizing their prefab shops to the fullest extent. I also believe potential nonunion/union labor issues could be an early hurdle for wider adoption.

Design accuracy and coordination of trade-specific drawings.

Design and drawings are usually not 100% complete upon award of construction. Rapid project progression limits prefabrication. Overlapping trades — 'who gets there first' installs hangers, etc., preventing slower prefab parts from being installed as designed.

Design changes during construction appear to create problems with prefabrication. Field coordination of systems and building components is still critical to it working properly.

Designs will need to change to be more conducive to prefabrication.

Drawings good enough to prefab a job with minimal errors. Also, shop drawings matching with field drawings to eliminate misalignments in the field.

Every project is always so unique. Even if a previous project can be replicated, the designers and client always want tweaks or changes.

Early commitment to allow time for formal design procurement and construction, sometimes even before the construction on-site starts. Lenders willing to pay for materials and labor while in the shop. Architects willing to design within parameters that fit prefabrication.

Experience. The more prefab gets used, the more it can get recommended.

Fear of innovation.

Find skilled labor. Set up an efficient shop. Improve logistics (site layout, transportation, commissioning). Prove cost savings.

For California public works, the efforts by the unions and state to extend prevailing wage use to all off-site fabrication.

For the substructure, we attach to-be-built to exact tolerances, which is highly unusual. Being in a union environment, we also need to get better buy-in with multiple trades working on the same unit.

Getting engineers to design cookie-cutter modules to fit different capacities, where not everything has to be designed from zero when new orders come in.

We own a facility in Japan but not in U.S.

Having all the answers so we can prefab!

I think that it is already widely used and accepted. It is just not always the right fit for a project. Conversely, it often is a great fit for a particular project. I think that it should be used where it fits and not used where it does not fit.
Integrated project delivery. The entire project team needs to be on the same page.

It needs to be flexible and look like “stick-built.” We’re seeing quite a few hospitals using completely finished bathroom pods and corridor racks. Some issues are that future renovations and additions to these prefabricated units after the fact can be quite challenging as well as maintenance (in order to save money and increase productivity these corridor racks tend to be overloaded).

Natural resistance to change, fear of the unknown, fear of investment in tools and/or training in order to develop in-house capability. In the case of the general contractor, finding trade and/or specialty contractors who will ‘get with the program’ and integrate their work with yours and all others involved.

Off-site fabrication and modularization tend to end up in conflict with some of the current design trends, such as “green,” sustainable, local content, reuse of on-site materials or using on-site waste materials, etc.

Overhead costs or a fixed-plant facility.

Prefab is limitless; modular is limited by design constraints and negative perception as cheap.

Prefablication and modularization require quality engineering to be successful. Most owners are cutting back on engineering, so this will need to change.

The numbers of upfront decisions that an owner or design team must make and stick with, because changes become more complicated and costly to deal with.

The biggest challenge I feel is the labor unions, as they feel that the work is being taken away from their respective locals. The other challenge is collaboration during prefabrication. The ideal way to do prefabrication is to have multiple trades working on assemblies and not just focus on prefabricating their scope of work.

The biggest challenge will be the need for three bids from every subcontractor in order to get the “best price.” Modular and prefab need to be part of the early design to include the producers of the work. Keeping them at bay while you produce bid documents for the traditional divisional breakdown of subs doesn’t allow the concept to truly add the value it could. The trades are blended with prefab and modular.

The industry needs to stop looking at each project as special! Once our industry creates some standardization in design, methods, materials and players on projects, then we will begin to see a huge increase in fabrication and all the benefits that go with it.

Overall improvement to worker safety — mod dropped to 55 from 97 in four years.

The label itself.

Prefabication can utilize many different trades and approaches. We have only used minimal prefab materials and installations but would be interested in hearing what other contractors have come across. Since we are often a CM to our clients, it would be interesting to see where we can direct the design approach differently.

Transportation and location to the jobsite will become the biggest hurdles, and the ability to customize modules will be needed to overcome the advantages of constructing on-site. Permitting and plan review from local jurisdictions will also contribute to challenges we face.
Understanding that the quality of the prefab product is as good or better than field fab as well as a willingness to do things in a different way.

Union jurisdiction.

As with any new approach or technology, continued utilization and creative implementation will help build a better understanding and history of typical ROIs and success or failures of its use.

Conclusions and Recommendations

We found some unexpected changes from our 2010 survey to 2013, mainly in the area of expected growth in the use of prefabrication. However, the two surveys have had many similar results, some promising and some not so promising. Among the greatest concerns is that those companies that either own prefabrication facilities now or are considering them do not spend enough time analyzing their costs, savings, productivity and other important measurements that would help justify increasing use of prefabrication or other strategic decisions. From our work in the field as well as our research, we find that those who make decisions about the use of prefabrication and modularization part of their strategic planning will fare better in the long run. Those are the companies that are less likely to take half-measures. If they find a competitive advantage in their markets for their prefabrication capabilities, they will act accordingly and get smarter on how to make the shop a profit center and advantage for getting and doing work.

As everyone in the industry realizes, prefabrication is not new. Mechanical and electrical contractors have had shops for a long time. Nevertheless, things are changing. Those shops should now be employing the best of new technologies, including BIM and automated equipment. How to organize those shops and labor for the best results should be high on the list for productivity improvements and training. Prefabrication capabilities and capacity are not just nice to have but should be strategically marketed as advantages. Then, there are some who should not start up their own prefabrication facilities. That is a strategic decision based on markets and a number of factors. Not, as we said above, a matter of following the crowd or just because “we have to be competitive.”
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