# MULTI-TRADE PREFABRICATION

## Improving efficiency, economy and adaptability in complex healthcare facilities

By Tim Fishking and Ryan Hullinger

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## Why prefabrication

Our interest in prefabrication was sparked by a desire to bring efficiency and quality into a complex process, which we knew would bring value to our health-care clients. We sought to lower construction costs and decrease construction time, while at the same time increasing the performance of intricate building systems. We know that through prefabrication we can improve functionality and aesthetics, and ultimately we can bring order to what has historically been a chaotic process.

Specific to sustainability, we have found that prefabrication offers a number of advantages over conventional construction because it significantly reduces construction waste. In addition, it allows for increased adaptability throughout a hospital's lifespan, which reduces lifecycle disruption, demolition and waste.

## Why healthcare is an ideal fit for modular construction

### Market-driven movement toward increased efficiency

We are finding that in the US, downward pressures on healthcare spending are driving a need for efficiency and cost reduction. This is compounded by increased demands on healthcare facilities due to deferred construction as well as a potential influx of new patients resulting from the Affordable Care Act. Likewise in Canada, we are seeing continued demand for new facilities that are designed and built with increased speed and efficiency.

All of these dynamics require innovative solutions. Our experience shows that the component-based construction approach addresses cost and speed-to-market concerns without sacrificing quality: in fact, it enhances quality

### Owner-driven movement toward standardization

The hospitals we work with are consistently moving toward more systematic practice models and more standardized care environments. For instance, the Miami Valley Hospital Heart and Orthopedic Center [MVH] bed tower contains 178 identical rooms on five identical floors. This degree of standardization provides flexibility, allowing functions to shift from floor to floor and reducing the need for patient transfers.

The inpatient room dimensions, infrastructure and environmental attributes are designed to support the broadest possible range of patient types and clinical activities, making each room capable of flexing from low-acuity use for general Med-Surg functions, to maximum-acuity use for Cardiac ICU.

Prefabrication becomes an increasingly logical approach as more and more projects are driven by this kind of standardized, flexible model.

## WEB exclusive!

Almost a century ago, the Modern Movement began with a strong social agenda and the belief that the new technology of mass production could be harnessed to improve the circumstances of ordinary people. For the last several decades, technology in architecture has become an end in itself.

However, we are beginning to see a resurgence of interest in prefabrication as a means to realizing the artistic and social ambitions of architects. This time around, much attention is being given to prefabrication in wood. Many of the new six storey wood-frame buildings under construction in BC are turning to prefabrication for reasons of economy, speed and quality control. However, some architects have rediscovered prefabrication as a way to improve the quality of life for urban apartment dwellers.

In Vancouver, LWPAC has completed a prototype urban infill project called MONAD; while in Winnipeg 5468796 Architects have used similar methods to reinvent the market-driven condominium.

➔ SEE HOW IN OUR EXCLUSIVE ONLINE ARTICLE FOUND IN THE SPRING, 2014 ISSUE AT WWW.SABMAGAZINE.COM

JIM TAGGART, EDITOR

### Construction complexity

Few, if any, building types compare to healthcare in terms of construction complexity. Regardless of the degree of coordination prior to construction, when highly complex architectural and engineering systems are conventionally installed in the field, the organization is often lost, wasting time and material. Even more costly, the resulting web of interwoven ductwork, piping, conduit and hangers inhibits future maintenance and modification.

This is not the case with our prefabricated approach, in which a coordinated layering of engineering systems is resolved digitally in the Building Information Model [BIM] and construction in the shop mirrors this model accurately. As a result, system clashes are eliminated and service routing is optimized.

In addition, the precise relationship between the BIM model and the fabricated components provides the building owner with a high-fidelity understanding of what is inside the walls and ceilings, which streamlines future modification.

### Adaptability

Healthcare today is changing like never before – practice models are evolving radically, medical technology is advancing at an unprecedented pace, and healthcare's financial infrastructure has become extremely volatile. Each of these issues has the potential to significantly affect how a new healthcare facility will be used in the future, and too often these drastic changes in use have led to premature obsolescence in hospital design.

Once a healthcare facility becomes obsolete, it will either be overhauled, demolished, or worse, left in place for decades as an underperforming workplace that frustrates staff, diminishes patient care, and squanders resources. These are not sustainable outcomes.

In order to prevent obsolescence and ensure that a facility's value will endure, we are developing prefabrication strategies that maximize a hospital's ability to accommodate unforeseen change. By developing a prefabricated component logic that is highly standardized and multifunctional, key areas can be repurposed, reconfigured or replaced as requirements evolve. This reduces the likelihood of future disruption and waste, and increases the potential lifespan of the entire project.

One example of this approach can be seen in the design of the overhead MEP racks at Miami Valley, in which continuous "no fly zones" were designed to remain unobstructed in every rack. These clear zones allow for straightforward maintenance access, as well as the ability to accommodate entirely new building systems in the future.

Another example of component-based adaptability at Miami Valley can be seen in the design of caregiver workstations. Millwork and sheetrock are typical solutions for workstation and equipment enclosures, but here the design team focused instead on a systems furniture approach for both the caregiver stations and equipment storage.

These modular units are designed to respond ergonomically to the near-term needs of nurses and physicians, and their component-based flexibility ensures that they will remain highly functional even as staff needs evolve. The systems furniture was cost-competitive to millwork, but it is more flexible and easier for the facility staff to relocate and reconfigure without major renovation and associated disruption.

PREFABRICATION SIGNIFICANTLY REDUCES CONSTRUCTION WASTE AND, PARTICULARLY IN THE CASE OF HOSPITALS SUCH AS THE MIAMI VALLEY HOSPITAL, HEART AND ORTHOPEDIC CENTER, IT ALLOWS FOR INCREASED ADAPTABILITY THROUGHOUT A BUILDING'S LIFESPAN, MEANING LESS LIFECYCLE DISRUPTION, DEMOLITION, AND WASTE [1]. THE PATIENT ROOMS AND UTILITY RACKS STARTED CONSTRUCTION IN THE SHOP SHORTLY AFTER THE FOUNDATIONS AND FIRST SERIES OF COLUMNS WERE PLACED. PREFABRICATED UNITS ARE WAREHOUSED UNTIL TIME TO MOVE THEM TO THE SITE FOR INSTALLATION [2, 3, 4]. ONE OF THE 178 IDENTICAL ROOMS ON FIVE IDENTICAL FLOORS OF THE MIAMI VALLEY HOSPITAL HEART AND ORTHOPEDIC CENTER [5].

## Identifying healthcare components that are most suited for prefabrication

Our experience has shown us that multi-trade prefabrication makes the most sense for components that are highly repetitive or highly complex [or both].

At Miami Valley we focused on spaces and systems that were highly repeatable: patient rooms, and patient-unit overhead utilities. For our current prefabrication project, the OhioHealth Riverside Methodist Hospital Neuroscience Center, we are prefabricating the patient rooms and overhead racks as well as exam rooms, perioperative spaces, prep and holding bays.

Also for Riverside, highly complex – but not necessarily highly repeatable – components are being shop-fabricated. This includes the ceiling systems in the Neuro and Cardiac ORs as well as a series of technology walls.

## Prefabrication and its relationship to architectural aesthetics

Historically there have indeed been some unfortunate associations with prefabricated architecture, because prefabricated projects were often executed in a low-quality manner. There is no reason that this must remain the case. Our work focuses on not only reducing these negative associations, but completely reversing them, so that prefabrication becomes widely understood as a way to improve the quality of the construction.

The key is to treat prefabrication as a means to achieving a design, not as a replacement for it: prefabrication must be in service to the design itself. By standardizing components, we are actually able to exert more control over the process and ensure adherence to the design vision, which creates greater aesthetic value.

Ultimately, we strive to create high-performance environments that empower the patients and staff who use them. Standardized components streamline clinicians' work—because each room is laid out identically, staff know what to expect and how to work—and when clinician performance improves, patient outcomes and satisfaction improve as well.


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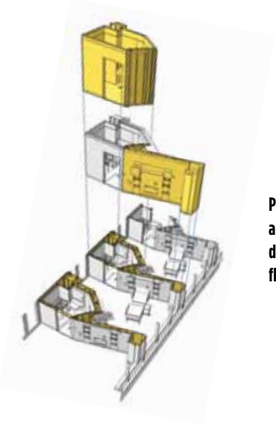
## Case Study 1: Miami Valley Hospital, Heart and Orthopedic Center

MVH opened in January, 2011 and is performing incredibly well for our client. The most noteworthy modular systems included a temporary pedestrian bridge, the patient room, and patient unit overhead utility racks.

The temporary bridge was a critical elevated corridor that connected buildings across the campus during construction. Traditional construction for this walkway was pricing out around $2.1M. The modular version, which was manufactured by the FMC jetway company, took advantage of their streamlined manufacturing processes and came to a price of $980,000, a significant cost savings. Instead of a four-month construction timeframe, the walkway was erected in three days.

The patient rooms and utility racks started construction in the shop shortly after the foundations and first series of columns were placed. This was several months earlier than work could have begun in the field using conventional construction.

The lessons we took away from this experience are numerous, and we have applied them to our current work. Most significant are lessons related to the fabrication schedule and a better understanding of how quickly the work in the shop can progress. Wringing waste out of the design and construction process was one of our initial motivators, and continually re-evaluating this process for additional waste reduction is crucial.



**Prefabrication is an increasingly logical approach as more and more projects are driven by the need for a standardized flexible design and construction model.**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## ***Case Study 2:*** OhioHealth Riverside Methodist Hospital Neuroscience Center

Our current prefabrication project is the OhioHealth Riverside Methodist Hospital Neuroscience Center. For this project we spent a great deal of time with our Design/Build partner, Whiting-Turner, reviewing the process and results from Miami Valley, and planning a process that would leverage our earlier lessons and experience. In many ways, the Riverside project can be thought of as Prefabrication 2.0.

### Expanded prefabrication scope

On Riverside, the scope of prefabricated room types and components is greatly expanded from the previous project. In addition to the elements prefabricated at Miami Valley, we are currently prefabricating exam rooms, perioperative spaces, holding bays and toilet rooms. In addition to the fabrication of repetitive rooms and spaces, there is a long list of complex, multi-system components throughout the 410,000-square-foot tower being prefabricated: the inpatient headwalls, as well as the above-ceiling engineering racks in the inpatient wings and ORs.

### Improved prefabrication processes: Just-in-time delivery of components

We planned shop fabrication in a just-in-time manner in order to minimize the size of the fabrication shop, and the length of time needed to lease it. At Miami Valley, the prefabrication process went so quickly that the modular units began filling up the off-site shop, as the on-site structure was not yet ready to install them. That was the first time a process like this was employed to such an extent, so the logistics decisions could not be based on any known precedent. This led to additional cost in leasing a second fabrication site. We have worked through a more precisely managed timeframe with the Riverside sub-contractors in order to avoid this issue.

### Team integration through co-location

During the Riverside predesign, design and documentation phases, we co-located the construction team with the design team. Every day for two years designers, engineers and builders sat alongside one another in an open studio environment. This face-to-face adjacency allowed for daily integration of design with logistics, cost and schedule.

Another benefit of this co-located relationship is a building information model developed on a single platform, which is shared amongst the designers, engineers, construction manager and sub-contractors. The same model used in design is the model used by the sub-contractors today. This degree of integration was another lesson we took from Miami Valley.

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FOR THE OHIOHEALTH RIVERSIDE METHODIST HOSPITAL NEUROSCIENCE CENTER THE SCOPE OF PREFABRICATED ROOM TYPES AND COMPONENTS WAS GREATLY EXPANDED FROM THE MIAMI VALLEY HOSPITAL PROJECT [6]. JUST-IN-TIME SHOP FABRICATION MINIMIZED THE SIZE OF THE FABRICATION SHOP AND THE LENGTH OF TIME NEEDED TO LEASE IT [7]. DESIGN AND CONSTRUCTION WERE COMPLETELY INTEGRATED WHICH HELPED GREATLY WITH LOGISTICS, COST AND SCHEDULE [8]. PREFABRICATION WILL BRING VALUE TO NEARLY EVERY BUILDING TYPE, ESPECIALLY TO THOSE WHICH ARE HIGHLY REPETITIVE AND COMPLEX [9].

Likewise during construction, the co-location of multiple subcontractors in the prefabrication shop led to better cross-trade integration because the subcontractors were working in a more coordinated way, and were not forced to compete for limited resources on the jobsite.

## Opportunities for the future

Miami Valley was the first hospital in the U.S. to extensively use multi-trade prefabrication, but the employment of this process has grown since then—that was precisely our goal in sharing the story. In our opinion, the value will increase when designers and constructors adopt the approach as the new standard for healthcare construction practice. The more experience we have in fabricating shop-built components, the more overall efficiency will increase, further driving down costs and improving building performance.

We are currently exploring opportunities for translating the advancements from our prefabricated healthcare projects to other building types. It's especially interesting to consider how component-based prefabrication could revolutionize the way we design and build our research labs because, as with hospitals, these are systems-intensive facilities that require a high degree of adaptability.

We are convinced that prefabrication is eventually going to bring value to nearly every building type, but will be particularly beneficial to those which are highly repetitive and highly complex. ◀

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**PHOTOS COURTESY NBBJ.**


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