FACING MODULAR'S TWISTS AND TURNS

Traditional building teams, trying to improve their projects, find that off-site construction disrupts 'business as usual'

By Nadine M. Post

MODULAR-BUILDING BOOSTERS, including traditional owners, developers, contractors and designers, maintain that off-site construction is faster, safer, leaner, greener, better quality and potentially less costly than site construction. But there is a big hitch, they caution: Building teams are not likely to reach modular delivery's pot of gold unless they plan and execute the off-site strategy properly. And that is no simple proposition.

"Everyone thinks it's a silver bullet," says Jeffrey M. Brown, the developer and general contractor for the Stack, a mostly factory-built seven-story residential building in Upper Manhattan that opened in May (see story, p. 24). "It really isn't unless you put the right ingredients in the bowl."

Few know that better than developer Forest City Ratner Cos. (FCRC) and its team building the world's future tallest modular tower: the 32-story B2 BKLYN residential building in Brooklyn, N.Y. Stalled at 10 stories, the B2 project at the $4.9-billion Pacific Park Brooklyn site, until recently called Atlantic Yards, is a glaring example of modular gone sour. The B2 project, designed by SHoP Architects, was going to take factory-built modular to the next level through the use of sophisticated digital tools to design, fabricate and manage assembly of the 930 modules (ENR 7/16/21 p. 24).

Instead of a poster child for improved high-rise modular, B2 has become the poster child for modular run amok. Unable to solve their differences privately over delays and cost overruns, FCRC and Skanska USA Building Inc.—B2's construction manager and FCRC's partner in a new modular plant, called FC+Sksanska Modular—are battling it out in court (ENR 9/8 p. 10).

Despite the situation, both Skanska and FCRC say they are committed to factory-built modular. "We believe in
STEEL FRAMES Delayed Brooklyn, N.Y., project (above, right, below), which could become the world’s tallest modular building, is the subject of a heated battle between the owner and the construction manager. Bronx project (left) is moving along, with four of its 64 total modules added each day.

modular as the future of the industry,” says Richard A. Kennedy, Skanska’s chief operating officer.

In a Sept. 4 letter to Kennedy, FCRC President and CEO MaryAnne Gilmartin says, “We remain resolute in modular technology’s potential and promise.”

Modular-building veterans are rattled by the B2 feud. “I’m angry because it gave this industry a black eye,” says Tom O’Hara, vice president for business development at Capsys. The factory builder is supplying modules for a 65-unit residential building in the Bronx, N.Y., called 3361 Third Avenue.

Modular is of interest to traditional builders because, in part, it has been identified as a means for improving building production. Collaborative delivery and advances in digital tools for design, coordination, clash detection, project management and fabrication support the movement, as do advances in lifting equipment.

“This is not a new process, but there is newfound interest of late,” says Tom Hardiman, executive director of the Modular Building Institute (MBI).

Until 2009, the 31-year-old MBI had no traditional contractor members. Now, there are a dozen, including Gilbane Building Co., Mortenson Construction and PCL, but not Skanska or FCRC.

Off-site construction is most appropriate for buildings with repetition, including schools, housing, hospitals, multifamily residential, hotels and dormitories. Many recent modular buildings are a mix of site-built, non-repetitive lower floors topped by assemblies.

The B2 drama is serving as a cautionary tale. The 85-member Off-Site Construction Council, formed last year by the National Institute of Building Sciences (NIBS) to advance all types of prefabrication and preassembly, “is interested in learning what works and what does not in all projects that pursue the use of off-site construction,” says Ryan Colker, the council’s director. “As the case unfolds, we will be looking to understand any role off-

PERMANENT MODULAR CONSTRUCTION, a subset of off-site construction, is a sustainable construction delivery method using off-site, lean manufacturing techniques to prefabricate single or multistory whole-building solutions in deliverable module sections. PMC buildings are manufactured in a safe, controlled setting. The modules can be integrated into site-built projects or stand alone as a turn-key solution; they can be delivered with mechanical-electrical-plumbing systems, fixtures and interior finishes.

SOURCE: NIBS OFF-SITE CONSTRUCTION COUNCIL

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OFF-SITE WORK SPEEDS HOSPITAL COMPLETION

Mortenson Construction's Bill Gregor is a big fan of off-site construction. Still, he is careful not to do prefab for prefab's sake. To nail down the contractor's component preassembly strategy for the $623-million Exempla Saint Joseph Hospital Heritage Project in Denver, Mortenson held a prefab charrette during the job's precollision and programming phase that included the owner, the contractor and the architect.

The exercise "is an analysis of what makes sense to drive cost, quality, safety and schedule," says Gregor, Mortenson's Exempla hospital construction executive.

For the 831,000-sq-ft project, a replacement for a hospital that faced a shutdown for code violations, schedule was the biggest pressure. Mortenson has to have the new hospital operational by Jan. 1, which left 29.5 months for a job that should take three years.

Over several months starting late in 2010, after a two-year hiatus prompted by the recession, the building team fine-tuned its off-site plan. Ultimately, the team elected to prefabricate 166 multi-trade overhead utility racks, nearly a mile in total length: 440 of 562 bathrooms; 346 exterior panels and 376 patient-room head walls.

Mortenson elected for site construction for the lower three floors of the seven-story building because of a lack of repetition of elements.

The only volumetric modules of the building are the bathroom pods for the 360 patient rooms and the administrative offices. Egress Modular Solutions, a division of Oldcastle, supplied them. The pods were shipped from Littleton, Mass. They contained all the finishes, down to towel bars, mirrors and toilet-paper holders.

Shipping the pods from the East Coast was not the greenest solution, but, "four years ago, there were only two experts that prefabbled bathrooms," says Maja Rosenquist, Mortenson's project director. "There are eight today, and they have multiple locations."

Workers mocked up a patient room on-site to work out all the design details. "The last thing you want to do is prefab [something] the wrong way 360 times," says Rob Davidson, a principal with architect H+L Architecture, part of hospital architect H+L/Davis, A Joint Venture, in association with design architect ZGF Architects LLP.

During the mock-up work, "we dropped the ceiling two inches to fit the largest number of pods in a standard-sized truck," says Davidson.

Mortenson rented a warehouse eight miles from the site to fabricate the exterior panels, typically 30 ft long by 15 ft tall. Crews erected 26 panels daily. Workers in the field only completed the detailing on the connections between the panels, installed the masonry on the clips set in the warehouse and added the 6-ft-by-8-ft windows.

The masonry was left off the prefab panel because of its weight. Glazing was left out because suppliers will not maintain warranties for off-site preassembly, says Gregor. Hoisting imposes different stresses on the panels. That could break the seals and shatter the glass.

The multi-trade racks, typically 25 ft by 8 ft, contain hydronic piping, single or multistory whole building solutions in deliverable module sections. PMC buildings are made in a safe, controlled setting and can be framed in wood, steel or concrete. Modules can be delivered with mechanical-electrical-plumbing systems, fixtures and interior finishes.

"The application of manufacturing principles to design and construction enables us to put buildings together in more innovative ways," says Sue Klawans, Gilbane's director of operational excellence and the council's co-chair. "Why bring 2 million individual bricks, studs and wire connectors to the site? Let's reduce that by a factor of 10 or 100."

Off-site construction leaves "many owners, architects and builders confused and sometimes put off by the process," says Ryan E. Smith, chairman of the NIBS council and director of the Integrated Technology in Architecture Center at the University of Utah. "It is not easy for those in their first rodeo."

"Not easy" is an understatement for the first residential rodeo of FCRC and Skanska. Sited up against the two-year-old Barclays Center arena, B2 is already more than a year behind its original December completion date. On Aug. 27,
The team decided to preassemble the 376 patient room head walls (left) in a warehouse four miles from the site. The heads were assembled in a warehouse eight miles from the site.

EXTERIOR PANELS
Crews installed 26 exterior panels a day (right). The panels were assembled in a warehouse eight miles from the site.

Skanska stopped work at both the site and the FC+Skanska Modular plant, furloughing more than 150 workers and raising the ire of Forest City. Lawsuits have followed.

Skanska is asking for more than $50 million in damages over its $117-million fixed-price contract to cover alleged “commercial and design issues.” Forest City, on a campaign to reopen the plant, alleges Skanska has breached its contract after “multiple failures and missteps” that led to “massive delays and cost overruns.”

John Erb, vice president of sales and marketing for Deluxe Building Systems Inc., says, “If a project goes awry, it means the team didn’t know the process. It’s like trying to perform open-heart surgery tomorrow without any training.” Deluxe supplied modules for the 90.5-ft-tall Stack, the U.S. record-holder for the tallest completed modular building.

Factory modular is “a science” and “outsiders” should not venture into the business, which is drastically different from traditional site construction, says Capsys’ O’Hara.

There are flaws in the B2 scheme, say those experienced with modular, especially the “still” construction plan developed by XSite Modular—Forest City’s modular-business partner-consultant before Skanska. Unlike an assembly line, still construction is built in place by teams, each assigned to a vertical line of identical units. The approach and the 913 modules do not take advantage of the efficiencies of assembly-line production, say modular experts.

O’Hara also maintains that the B2 modules, which include facade panels, are too complete. Most modules don’t include the panels because they often cause alignment problems during field fit-up.

FCRC and Skanska declined to comment on the criticism of their approach.
FLAT-PACK DELIVERY AVOIDS TRUCK LIMITS

The architects and fabricators that formed the six-year-old Project Frog were tired of mediocre modular buildings. Their idea was to work out a kit-of-parts system that would offer the benefits of off-site construction but eliminate its limitations: weak design, caused mostly by trucking restrictions.

“Traditional modular spaces are constrained by transportation,” says Ann Hand, Project Frog’s president and CEO. “We don’t feel people thrive in a box with eight-foot ceilings.” Through its system of components—flat-packed and trucked to the site—Project Frog found a way for architects to design better spaces, she adds.

The goal is to provide a fast and cost-effective way for architects and builders “to create beautiful and energy-efficient buildings,” says the company. For starters, that means ideally sized classrooms with 13-ft to 14-ft-high ceilings and lots of natural light.

Flat-packed components are assembled on-site from its kits. Only the bathroom pods are volumetric.

Project Frog works with its favorite suppliers to teach them its system. The firm’s most recent offering, called Impact, caters to larger school districts and multistory solutions. Schools cost about $250 per sq ft, compared to about $350 per sq ft for conventional construction, says Hand.

In the past year, the company has supplied 85,000 sq ft of schools. It has more than 250,000 sq ft under construction or in contract for next summer’s construction window.

One recent charter-school client—the El Sol Science and Art Academy in Santa Ana, Calif.—is so satisfied with its first 19,000-sq-ft, 12-classroom building, opened in January, that it just ordered a 28-classroom building. “There was some risk, but they were paired with an experienced builder, Bernardi, and we’re the kind of place willing to try new ideas in a responsible way,” says Monique Daviss, El Sol’s executive director. “It turned out to be everything they said it would be, and we’re going to do it again.”

El Sol’s first building had a $5-million price tag. A big driver, other than cost and design, was speed, says Daviss. And the school wanted a sustainable building, with spaces conducive to learning.

Rick Willison, Bernardi’s project manager, was skeptical about the kit system at first, until he saw almost the entire first floor framed in one week. He is now a believer—so much so that he currently works for Project Frog as a preconstruction manager.

“Subs, general contractors and owners tell us we are doing something right,” Willison says. “The passion that drove me to the company is still alive.”

Modular delivery disrupts the economics, workflow, contracts, coordination points, insurance and building regulations of conventional site-built projects.

There can be issues with the union building trades. Off-site delivery raises questions even about warranties versus bonding. Is a bathroom pod a product or not?

Plan review also must be completed early, but most buildings departments are not geared up for this.

Transportation, picking, setting, tolerances, on-site stitching and detailing is different from site construction. “I have tremendous respect for logistics, which can make or break a project,” says the Stack’s Brown. “Transportation is a big piece of the cost.”

Global Building Modules—with FX Fowle as architect, LERA as structural engineer and Dagger Engineering as mechanical engineer—is trying to market a patented modular system that would solve some of the transportation issues. The concept calls for steel-framed modules that are dimensionally the same as shipping containers; the modules could be produced in port areas of cheap labor and shipped by sea and rail to sites.

So far, there have been no takers. "Everyone is always blown away by how tech-
nically resolved the idea is, but each asks, ‘Who has done a building?’” says David Wallance, a senior associate at FxFowle.

Project Frog has demonstrated a way around flat-bed-truck limitations for 3D modules. The company supplies kits of parts to the site; only bathroom pods are 3D (see story, p. 22). “Flat-pack construction is affordable to ship,” says Ann Hand, Project Frog’s president and CEO.

Modular delivery relies on owner buy-in and early team collaboration. With 3D modular, there is no fast-tracking, but there is resequencing. Design decisions have to be finalized up front, to allow prospective modular builders to price the job and the winner to order supplies.

“Bathroom finish colors and tile patterns are not typically set during the foundation-document phase,” says Maja Rosenquist, project director with Mortenson Construction for the $623-million Exempla Saint Joseph Hospital, which has off-site-built elements (see story p. 20) and is nearing completion in Denver.

The early decisions for the Bronx project “put enormous pressure on us,” says James McCullar. His eponymous firm is the architect for the 64-module project.

It’s best to test the waters of modular in stages. Gilbane started with preassembled multitrad utility racks on a U.S. project. Then, it added vertical risers to the next job: the 270,000-sq-ft Global Technical & Innovation Center in Kerry, Ireland. The various prefabricated components sliced three months off the laboratory’s schedule, says Gilbane. “The modular nature, developed in the [building information model], allowed us to run a number of layout and cost scenarios early,” says Ian Howard, project manager for the client, the Kerry Group. “That gives us a high degree of confidence.”

Discounting glitches with the buildings department that caused a three-month delay, the Stack would have taken two-thirds the time of site construction, says Peter Gluck, of Gluck+, the Stack’s architect design-builder.

Mortenson commissioned the University of Colorado, Boulder, to do a study on its 831,000-sq-ft Denver project to compare it to site construction. The study concluded that the prefab approach for utility racks, bathroom pods, exterior panels and head walls reduced the schedule by 72 work days. The job used 29,500 fewer hours of labor, resulting in $2.6 million in productivity savings, and diverted 150,000 hours of labor off-site. There was 43 million in indirect cost savings, but direct costs were 6% more than site construction, according to the study.

“Certain elements were more expensive until the indirect costs were accounted for,” thanks to the fear factor in the pricing, says Bill Gregor, Mortenson’s construction executive for the hospital.

Mortenson holds a prefab charrette to determine the off-site path for a project. Another important step is a full-scale prototype to avoid repeating a mistake hundreds of times.

Some say design-build is the best delivery system for modular, but any

VERTICAL RISER

A 270,000-sq-ft project in Kerry, Ireland, takes off-site utilities beyond multitrad corridor racks to vertical risers. The various preassembly strategies on the project helped save three months of construction.
DESpite SNAGS, MODULAR IS ‘THE WAY TO GO’

It’s not easy to be first. The team that built the seven-story
Stack in Upper Manhattan, New York City’s first steel-framed
modular mid-rise building, knows that from experience. The
developer of the 28-unit residential building—at 90.5 ft tall, the
tallest completed modular building in the U.S.—bought the
land in 2007, yet the first tenants moved in just this past May.

“There were a lot of pitfalls,” says Peter Gluck, who wears
several hats on the Stack. Gluck+ is the architect and design-
builder, and Gluck is a minority partner in the development.

Some of the long development time is attributed to the
real-estate market crash in 2008. But there were other challenges
associated with the project. For starters, it took three years to
lease the adjacent lot to stage the construction of the building.

It also took “a few years to figure out the best design” for the
150-ft-deep, 60-ft-wide lot, which is not an ideal dimension for an
apartment building, says Jeffrey M. Brown, the building’s
co-developer, with Kim Frank, and general contractor, under the
firm that bears his name.

The solution was a U-in-plan shape that provides a 30-ft-sq
courtyard, which offers more exposures. “The building is really two
buildings connected by a corridor,” says Brown.

The biggest snag was related to the renewal of the building
permit after all the modules were finished by Deluxe Building
Systems Inc., Berwick, Pa., and ready to be shipped to the site.
The New York City Dept. of Buildings would not renew the permit
until Gluck+ made some modifications to the fire-proofing.

The changes were required by the fire department, which was
concerned about fire spread between the modules, according to
Alexander Schnell, a spokesman for the buildings department.

When the plans were filed for the first permit, there was no
mechanism on the online application to indicate the modular
nature of the apartment units. The issue came up only during the
renewal process, says Schnell.

The city has since added a check box on its online application
so filers can indicate modular construction, he adds.

The basement and first floor of the Stack were built convention-
ally. Transportation restrictions, including crossing the George
Washington Bridge only at night, limited deliveries to four modules
a night. “We could have erected more than four a day, but we
couldn’t get more to the site,” says Brown. It was too bad, he
adds, because “we were paying for the crane anyway.” Still, it took
only four weeks to top out the 56 steel-and-concrete modules.

Discounting the three-month delay caused by the permit-
renewal snag, the factory-built modular system shortened the
construction period by a third, compared to a conventional
approach: “We saved 15% to 20% on hard costs, [which] we then
spent in delays,” says Brown. Despite the headaches, he thinks
modular residential is “the way to go.”

A collaborative approach will work. Architect James B. Guthrie, president of
Mileus Group Inc., a modular design-build firm, has doubts about modular be-
coming mainstream any time soon. Until there is a better knowledge base and a bet-
ter supply chain, “modular won’t become widespread,” he says.

The NIBS council was formed to fill the
knowledge gap and gather metrics to
prove the case, especially to reluctant
owners. “We’ve recognized it’s a challenge
to capture some of the potential efficien-
cies,” says Colker.

To help foster off-site, the council re-
cently posted two online surveys. The
deadline for responses is Oct. 15.

surveymonkey.com/s/SC3TWWL, is
intended to identify the opportunities and
challenges associated with the use of
off-site construction processes and
technologies.

The academic survey, available at
www.surveymonkey.com/s/NKZ9LS2,
will determine the scope of off-site con-
struction teaching and research in U.S.
colleges and universities. Results will be
used to support the development of tools
and resources for the schools.

The council also is seeking $150,000
for an off-site construction implemen-
tation guide, to help demystify the process.

Demystification is already underway
in the U.K., home to the world’s tallest
completed modular tower: a 24-story
dorm at the University of Wolverham-
ton. The 10-year-old industry group
Buildoffsite has published hundreds of
case studies that detail the benefits of off-
site solutions. They are available at

Pitfalls aside, mainstream builders’
move toward modular delivery is a logical
step in one of biggest transformations in
the construction industry since the intro-
duction of the combustion engine and
electric power, says Gilbane’s Klawans.

“We’re in the midst of creative
destruction and reinvention of our indus-
try,” says Klawans. “It’s exciting.”