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Optimizing Execution with Modular Construction

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The dynamic nature of the pharmaceutical market has driven industry engineering and construction practitioners to new levels of creativity in pursuit of cost reductions, schedule compression, and mitigation of an unlimited array of risks. For over a decade now, modularization has been explored as a construction technique that aids in the achievement of these goals.

Modular Penthouse Interior

WHAT DOES MODULAR MEAN?

Originally applied to describe process skids, in the world of pharmaceutical facilities, the term "modular" has acquired a connotation of a complete facility, organized in shipping container sized units, built at a remote location, transported to the owner's address, and reassembled on site. The modules consist of structural frames fit-out with architectural elements. Mechanical, electrical and plumbing (MEP) systems and process equipment are already integrated. This approach offers many benefits in the appropriate context. However, it does not fit the bill for most of today's construction projects, such as those that consist of expansions, renovations, and upgrades to existing plants. For these projects, facility owners can take advantage of customized modular product delivery approaches to reduce overall project schedules, increase quality with minimal disruption to site operations and potentially realize cost benefits.

When planning the design, construction, and qualification of a new facility, owners can select from a broad array of techniques to achieve the benefits of modularization without the costs and disadvantages of a full-blown shipping container module solution. Options include prefabricated process and utility equipment, such as skid-mounted clean-in-place or reheat equipment; pre-piped and pre-wired air-handling units (AHUs), modular penthouses complete with air handlers, chillers, and MCCs; large "super-skids" that can be broken down for shipment and reassembled quickly in the field; and modular wall systems and modular pipe racks for HVAC piping and ductwork, plumbing, process piping, electrical and controls.

Modular project delivery (MPD) offers several significant benefits, including the enhanced quality control that is achievable in shop fabrication versus field fabrication, reduced waste, reduced impact on current operations and simplified site logistics.

Transferring labor hours away from the owner's site can reduce cost, as design and fabrication can be performed at a lower labor cost venue, reduce pressure on facility infrastructure, such as parking, and can reduce numerous site-based risks.

A real-life example illustrates this point: one pharmaceutical manufacturer needed a bump-up for an expanded fluid bed drying process. Building the addition on the ground and lifting it into place limited the shut-down duration and minimized the number of personnel needed on the roof. The ability to build multiple modular elements in parallel, with no influence from adverse weather conditions, can reduce schedule risk dramatically, increasing the predictability of construction operations, and can reduce schedule duration by as much as 50 percent. Similarly, the ability to leverage factory acceptance testing often translates into shorter start-up and commissioning duration.

PROJECT DELIVERY CHALLENGES

Modular project delivery also poses some challenges that make choosing a partner with experience in both MPD and technical construction critical to success. Full-plant delivery via shipping containers requires committing to a fixed floor plan early in the design phase of the project. This requirement is inconsistent with the nature of the development and delivery of projects in the Life Sciences industry. Our owners need the opportunity to respond to their dynamic environments by making program changes as late in the project life cycle as possible. The objective of the design and construction practitioner is not to minimize the overall project duration, it is to minimize the duration from decision to delivery. Forcing an early decision does not achieve this objective.

Full-plant delivery via shipping containers can increase engineering costs also. Where the structures of stick-built facilities are optimized for the purpose of the facility, the structures of shipping container modules must be optimized for two purposes: that of the facility, and the requirements of shipping a large module intermodally. Modular projects require additional interface coordination. For example, oversight to ensure that all vendors meet local code requirements, construction materials used are consistent

and compatible, and controls are integrated. It is important to identify any potential maintenance or operational issues and to allow for future changes and renovations. Even logistics can be challenging, as transportation becomes a factor.

A more rational approach to modular construction will reduce waste and cost, enhance quality and create a delivery system that meets owner requirements, such as limiting the length of a shutdown. This approach requires both insight and forethought. Rather than picking an off-the-shelf clean room module, better results can be achieved by engaging designers, contractors and vendors during the design process and leveraging their knowledge to engineer a solution that meets the owner's unique needs and goals. The result is a custom modular approach that is sensitive to the unique requirements and environment of the specific project.

Modular project delivery requires a greater investment in design and construction planning. In traditional project delivery, definition of physical details is deferred until late in the preliminary, or schematic, phase. In the custom modular delivery process, early design must address target systems and layout constraints, structural frame requirements, transportation and constructability constraints and flexibility for future capacity and system expansion. At this point, modularization opportunities can be identified for implementation. Three-dimensional modeling is ideal for defining intent and determining overall assembled dimensions and weight. Moving even small portions of the construction off site can reduce safety risk, minimize impact on operations and improve the shutdown schedule.

Modular Vertical Expansion

systems. Designed to meet the required performance specifications, they can be prefabricated on special structural support systems, shipped just-in-time and assembled. The skidded modules generally require a smaller footprint than conventional distribution systems.

Today's modular wall systems, which evolved from prefabricated PVC-sheathed aluminum frame wall and ceiling panels, offer a high degree of flexibility. Options include "walkable" ceiling systems and prefabricated return-air walls. Modular wall systems can incorporate integrated electrical lighting and receptacles, HVAC ductwork, HEPA filters and controls.

In summary, modular project delivery that is customized to the specific needs of each project offers a number of significant advantages for plant renovations and expansions. From a schedule perspective, performing activities in parallel can reduce overall project duration and make a very favorable impact on the critical "time from decision to delivery." Modular project delivery reduces disruption to the site as well as lay down and waste area. Fabrication in the shop rather than the field results in higher quality work. By reducing labor hours at the site, MPD improves project safety. Modular project delivery may also reduce costs by transferring labor to lower cost centers, taking advantage of higher productivity in the shop versus the field, and generally reducing site requirements. Throughout it all, a team experienced in technical construction can maximize the schedule, quality, safety and cost benefits realized by the owner in the modular project delivery process.

WORKING WITH FABRICATORS

When working with module fabricators, it is important to consider whether they should receive a detailed layout versus performance specifications, and the manner in which interface coordination will take place in the shop and the field. In any case, documentation must be thorough.

Just as a custom modular approach should be developed in parallel with overall project design, modules can be sourced while the site, shell and infrastructure construction takes place. Similarly, modules can be fabricated and factory acceptance testing performed as the infrastructure undergoes commissioning and qualification. These parallel activities can shave significant time from the schedule compared to the end-to-end timelines required for completely stick-built projects. A construction management partner that understands the entire plant lifecycle can help maximize the benefits.

Process and facility modules can be designed and built offsite. When it makes sense, factory acceptance testing and pre-qualification can also be performed prior to shipping them. Once on site, the integrated construction and compliance team verifies receipt, reassembles the modules and performs final testing and qualification. One option that may make sense for many projects is modularization of utility generation and distribution

TOUR HIGHLIGHTS

The Modular Construction Technologies Tour at INTERPHEX 2013 will survey a range of the modularization concepts that have been applied and will continue to be developed for application in the delivery of facilities for the Life Sciences industry. Spanning the range of modular wall panel systems, with and without integrated MEP functions, through process modules, superskids, and Shipping Container modules, the Modular Construction Technologies Tour will introduce attendees to different modularization approaches, their costs and benefits, and the vendor expertise that is available to support their implementation.

Led by noted industry experts, the tour will make stops at selected vendor exhibits and provide an ideal opportunity to obtain information on the latest advances in these technologies and exchange information with commonly-interested attendees. This event has been designed to include the organizations currently making the greatest advances in the enabling technologies that will drive the paradigms for construction of Life Sciences facilities of the future. These organizations include Biologics Modular, AES Clean Technology, GE Healthcare, G-Con, Cotter Brothers, and AWS BioPharma Technologies, and Portafab.