Using Modular to Build for the Future

BY MICHELLE REEVES

One of the most significant advancements in HVAC&R the last century is the adaptation of modular construction, a process that will only grow in use in the future. Modular construction allows complete utility plants to be built in a factory, then separated into modules and shipped to their permanent location for reassembly. This approach allows for shorter project cycles and the production of higher quality, more efficient systems. This can result in significant first- and operating cost savings.

Modular construction has received attention and recognition in recent years, but it is a proven process that's been used for decades in the HVAC&R industry. Gone are the days of selecting a compressor, evaporator and condenser to build a chiller; or selecting a fan, coil and filter to field construct an air handler.

Development of Modular

The earliest reported example of modular seems to be a disassembled house shipped from England to America in the 1600s, but modular building construction really got started in the mid-1800s, when hundreds of Manning Portable Cottages were assembled in Australia from components built in London. Preassembled homes were also being built in New York factories and shipped to California to house the influx of settlers during the Gold Rush.[1]

Most of the early modular market was for homes—Sears Roebuck Company sold more than 75,000 houses between 1908 and 1940.[1] In the 1940s, a larger integration began of modular construction into the commercial market, with it expanding to schools, businesses and medical facilities through the 1950s. In the 1960s, the demand grew for more complex, larger modular buildings and more features like utility solutions.

Historically, utility systems and many of the components within them were built in the field after construction of the building. General contractors, mechanical contractors, electrical contractors, plumbing contractors, etc., were all involved, working on different aspects of the same job. However, with technological advances in system controls and system complexities, by the 1970s there were benefits to having specific system experts with the knowledge and experience to tie the components together with controls. There was a need for modernization in the industry.

In the modular process, systems are designed and built by experts in collaboration with the customer and assembled by professionals who work on the same types of systems all the time. Factory building in a controlled

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environment, with the ability to test results before implementation in the field, greatly reduces the risks associated with incorporating new technologies and products.

The first hydronic systems to be built with the modular process were simple pumping packages, mostly comprised of pumps, electrical and a structural base. As consulting engineers experienced the advantages of these modular pumping systems, they began requesting systems with full mechanical, electrical and control scopes. In 1981, the first module with variable frequency drives (VFD) for variable flow pumping applications was developed.

At the time, VFDs were large, expensive and unproven. It was necessary to show energy savings associated with variable flow systems. The factory build and test setting of modular manufacturing allowed for the development of wire-to-water efficiency to analyze life-cycle cost and show the relationship between system flow and pressure to energy use. The ability to generate a report with hard data helped propel the use of VFDs in the industry so more efficient systems could be developed.

In 1995, variable primary pumping was introduced to the industry. Mainly applied to chilled water systems, it varies the evaporator flow through the chiller. This was a major advancement in chilled water pumping. Prior to variable primary pumping, variable flow through chillers was risky because chiller controls were not as advanced as today's digital controllers, and pump control had not been refined to adequately supply the correct minimum flow to the chiller. Variable primary pumping solved this issue by using high-speed digital control, minimum flow bypass control and measurement of minimum flow through the chiller.

Even with these significant advancements, it was difficult for project owners to fully appreciate all the benefits modular could offer. Pump packages are just a small part of the mechanical system, so it was hard to break out the cost of that small piece in the overall job estimate with multiple contractors still crossing trades on the same project. A bigger piece of the mechanical room needed to be modular to demonstrate the true value and advantages.

That happened in 1996 with the development of the industry's first modular chiller plant. The consulting engineer for a variable primary pumping system asked if the project's chillers could be integrated with the system to create a fully enclosed plant installed outside the facility. The answer was "Yes!" and modular utility options have continued to expand.

Today, modular systems are advancing with developments in cogeneration, indirect evaporative cooling and advanced algorithms for variable flow control. With a focus on research and development that isn't possible in the field, modular manufacturers are able to bring innovations to the market to meet growing demands and provide customers with efficient and advanced utility solutions.

Future is Modular

With increasing energy and environmental regulations, large national and multinational companies are looking for ways to integrate, standardize and optimize operations across multiple locales. The consistency and stability of factory assembly allows for the standardization of procedures and monitoring of quality control.

The interconnectedness of customers, designers, engineers, equipment suppliers and assemblers in the modular process has made it conducive to developing and implementing innovations in our field. It provides an opportunity to incorporate the newest technology and tools like building information modeling (BIM), 3D printing and automation within the manufacturing process.

Modular, off-site construction has also laid the framework to optimize a shrinking labor force and maximize productivity. More customers are seeking out modular, modular manufacturers are growing, and 25% of firms in the 2018 AGC Workforce Survey[2,3] reported adopting or increasing the use of methods like off-site fabrication to deal with labor shortages.

In this way, a centuries-old concept with decades of success in the HVAC&R Industry is a tool of our future.

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