

Right the First Time—Every Time

“It’s already done. You just have to execute it.”



Click the image to see Sango Court set highlights, and 3D architectural tour of the kitchen and bath using these QR codes.



KITCHEN 1



BATH 1

“It’s already done, you just have to execute it.” These words from Autovol’s CEO and Co-Founder Rick Murdock sum up the ideal plan-to-execution formula in modular construction. In the case of Sango Court, this ideal was in many ways realized. Perhaps the biggest reason why is that the stakeholders collaboratively “built” this modular project four times in preplanning before driving the first nail in execution.

“We did the project first in our heads, then on paper, then with the digital twin model, then with logistical dry runs, and finally at the actual site,” says Tom Giarrusso, Nibbi Project Executive.

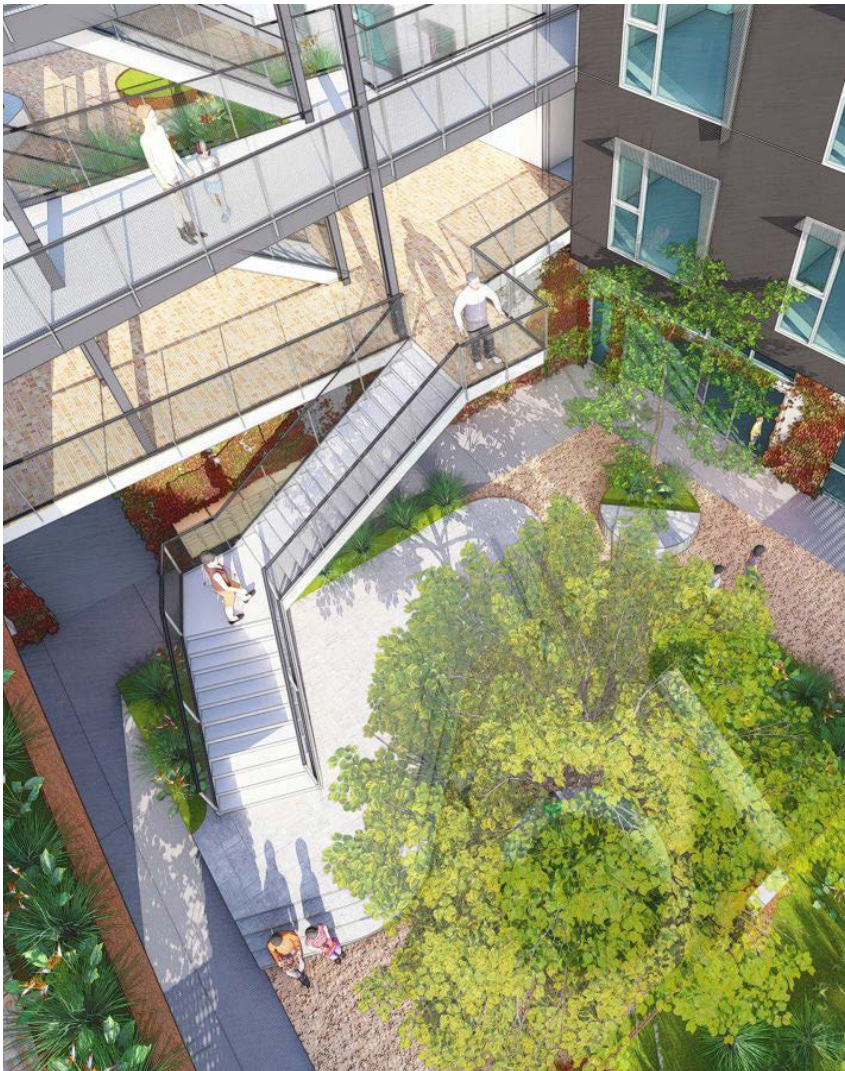
“Do it right the first time” was an especially fitting theme for Sango Court in Milpitas, CA. It was a first-time modular project for Nibbi Brothers General Contractors, Resources for Community Development (RCD) the owner, and the City of Milpitas. It was also Autovol’s first step beyond its initial series of 6 projects with The Pacific Companies, whose CEO, Caleb Roope, had helped found Autovol. According to Carolyn Bookhart, Director of Real Estate Development at RCD, it was the right project at the right time.

“RCD wanted to explore the use of modular as an approach that would increase efficiencies and reduce costs in our development work,” she says. “We have found that to be true.”

The Project

Sango Court is an affordable apartment rental development in Milpitas, CA. The 102-unit, transit friendly location is about a half mile from the nearest BART station, and close to parks, shopping, schools, dining, and numerous employers. This made it a potential gem in a high-rent area where affordable housing is desperately needed.

Developers and builders in the Bay Area have been among the most hard pressed by rising costs, labor shortages, and supply chain issues that have increasingly plagued housing in many urban centers. These factors have demanded smarter approaches, including modular innovation on projects where it can pencil. So while Sango Court was originally slated to be a conventional site-built project, the team of RCD, Nibbi, and David Baker Architects chose to pursue modular. And with a culture steeped in diligence and rigorous planning, Nibbi's foray into a new approach was not taken without in-depth feasibility research and logistical scrutiny.

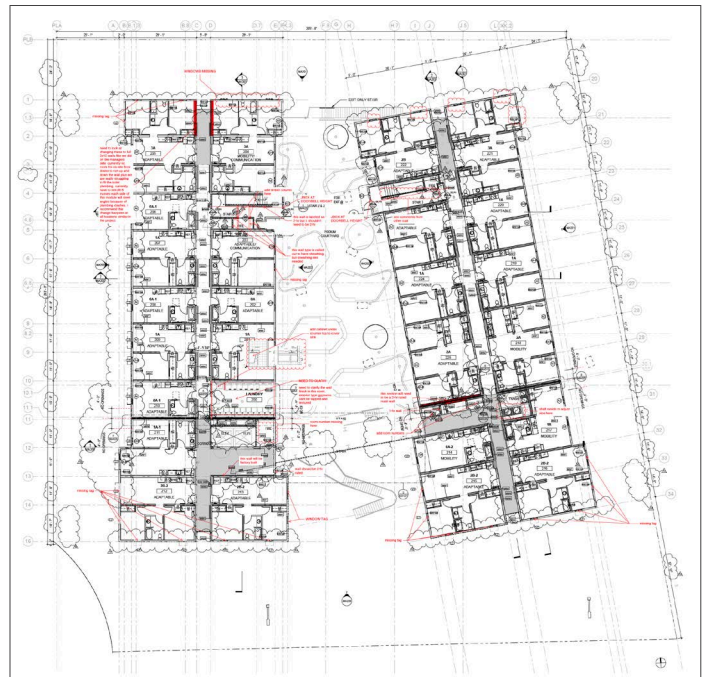


Sango Court, designed by David Baker Architects, brings a very open and livable design to its Bay Area residents.

The Challenge

After a lot of careful planning, financing was secured—but not without time requirements. So with the clock ticking, the team selected a modular manufacturer and booked a date to go online for production. Then came the hurdles.

With a site-built project, delays can sometimes be accommodated. But with a modular manufacturer, a factory is reserved for a start and end date. If the date is missed, the project may have to wait for other projects to complete. In the case of Sango Court, financing timelines and manufacturing windows became too far out of alignment for the originally chosen manufacturer. The project needed a new manufacturer, and not just any manufacturer.



The final design removed 'sawtooth windows' in the original design, not ideal for modular.

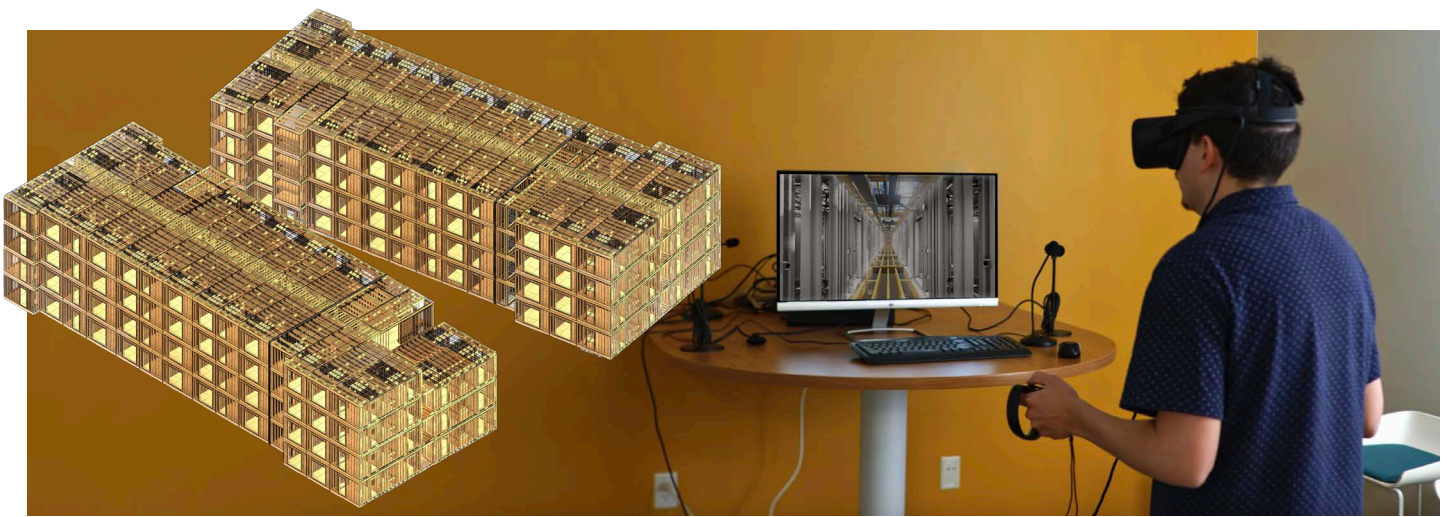
Nibbi had researched modular extensively and knew some key criteria were essential: The manufacturer's factory had to be within a certain shipping distance from the site. The factory would need an opening in its existing backlog to fit the project. The factory needed to show a track record of high-quality, timely completion. To this end, the manufacturer needed to be bondable. With a short list of qualified suitors, Nibbi did quick and thorough diligence and ultimately selected Autovol.

"We looked at lots of things. The quality, precision, and speed their automation was able to achieve," Giarrusso said, "was an impressive differentiator we knew could really help us succeed."

Autovol, considered by many to be America's most technologically advanced multifamily modular operation, was still fairly new on the scene. Up to this point, the unique human-robot team of the three-years-young company had built projects for just one customer. Autovol's heavily automated approach had been quickly proven by successfully completing 6 multifamily projects for TPC in just two years. Now the factory would be put to the test with its second-ever customer, one who was new to modular construction, with an already designed project, on a tight timeframe.

Mission Critical Preconstruction

Autovol had pioneered the use of automation and robotics to enhance modular construction by doing the heavy lifting and adding machine-level precision to repetitive framing tasks. The logic-intensive preconstruction method demanded of automated modular brought extra benefits to the Sango Court project. Autovol had worked side by side with preconstruction innovator Prefab Logic to create a digital twin modeling approach and a sprint process as advanced as the Autovol factory.



A digital twin of Sango Court provided data for VR reviews, clash detection, automation code, and AR models to guide factory and onsite tradespeople.

The Prefab Logic approach is to build a project down to the finest detail as a digital twin, involving all stakeholders upfront. The data built into the digital twin drives everything in execution: robotic instruction code, clash detection programs, VR and AR 3D models for approvals and to guide tradespeople, as well as material procurement and takeoff lists. The sprint model was designed to force collaborative decision making upfront, when changes can be made digitally. This prevents changes later that can cause orders of magnitude more cost impacts and schedule delays once the physical building is being executed.

Tim Mathson, Prefab Logic Operations Manager during preconstruction, said the team really leaned into this approach to solve a variety of unique aspects of the building design.

“To make sure the things being built in the factory and onsite aligned, everything had to be spot on, down to about a quarter inch,” Mathson says. **“A lot of things had to be coordinated very quickly on a design that had been years in the making, with a factory that had very specific requirements for robotic framing, but also very standardized design and materials approaches that optimize cost and efficiency.”**

Reflecting on the preconstruction phase. Mathson also shares a fundamental lesson learned about MEP space.

“Thinking about space allocation ahead of time for the plumbing and mechanical design is key,” Mathson says. **“I would also say that having a chase in the corridor is a big benefit. Even though it takes much needed space within the units, it creates more efficiencies in the factory and onsite to help reduce overall cost and time to build a modular project.”**

Design Challenges

Some of the inventive features designed to make Sango Court unique and livable for residents posed challenges: A large laundry room requiring special venting. Large fresh air ducts in rooms. Open sloping corridors. Lack of a chase compartment for mechanical, electrical, and plumbing through corridors. An exterior facade featuring “sawtooth windows” (a feature that was removed through design revisions). These and other design elements required modeling not only for the factory build, but to guide subcontractors onsite.

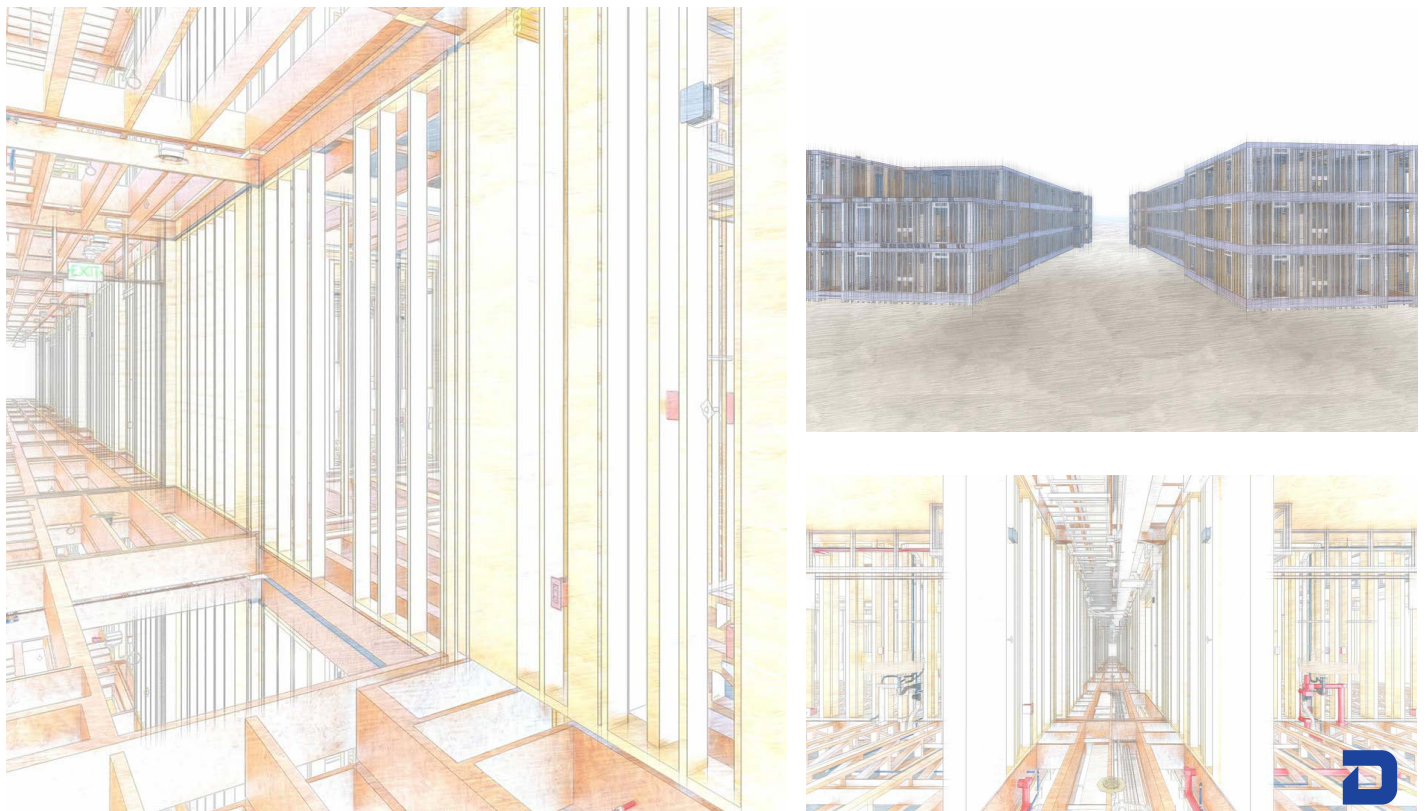
“With a good model, and an easy-to-use VR and AR platform, the subs could see what was coming from the factory.” Mathson says.

In spite of the project needing to be adapted very quickly, Mathson says all parties rose to the occasion.

“The team that came in was really open and receptive to understanding, making some changes, and rethinking things that could make the project a success,” Mathson says. “It was a great team of open-minded stakeholders, all willing to collaborate.”

Another lesson learned, according to Mathson, was that things will work a lot better when the design team and the factory team know and align each others’ requirements upfront. He says with an automated factory, this becomes even more critical.

“There were a lot of floors that were recessed because each end of the corridors required sloping to drain. Things like this required onsite work and adjustments because automated factory best practices weren’t optimal for them,” Mathson says.



Modeling helped teams realize the rich complexity of design features in Sango Court. Images courtesy Dynamic 4 US.

Feeding the Beast

Modular construction offers many benefits: being able to prepare a site while units are being built offsite, having a set of materials pre-purchased upfront kept safe and dry, having a dedicated crew of highly skilled tradespeople performing the work indoors and out of the elements, and many others. This dedicated resource is also why it's so important to hit a scheduled factory slot. A factory is a beast that must be fed with a new project every 6 to 12 weeks to run continuously, bring in revenue, and keep its skilled people thriving.

According to Randall Thompson, Nibbi Senior Preconstruction Manager, the Sango Court team collaborated extensively to get the project redesigned, submitted, and ready for the dedicated window of time reserved with Autovol.

"Prefab Logic had a very structured proven sprint method to work through the design coordination," Thompson said. "If we hadn't had that structure, and everyone collaborating extensively, it would have been likely that we would have had a schedule issue."

In spite of significant redesign of the project for a new factory, the entire team leaned into it and took advantage of the sprint method and design reviews using a digital twin. From this data, code was written to drive the robotics. From start of redesign to state submittal of design addendum took about 5 months. From submittal to completion of integration and factory shop drawings took 2 months. Despite a team of stakeholders who hadn't previously worked together, the project had gone from start of redesign to factory ready in less than 8 months.

Bookhart noted the technology and approach led to some pleasant surprises as the project became factory ready.

"The design, construction, and modular team were very experienced, prepared, and well organized, and we saw ease of permitting at the state level," she shared. "The digital twin technology was fantastic for catching design and coordination details before start of production."



Mobile-friendly digital twin models let stakeholders, factory tradespeople, and onsite contractors see every detail in virtual and augmented reality.

Go Time

While 70 to 80 percent of the construction by floor area would be completed inside the factory, that work would be processed through much more quickly than an onsite build.

Total time online in the factory, aside from prototyping, was about 9 weeks. During that time, all 102 units were framed, wired, plumbed, floored, insulated, and inspected. All appliances and interior finishes were completed. The project included studios, as well as 1-, 2-, and 3-bedroom units. Each module was carefully planned to be pieced together in a precise sequence onsite.

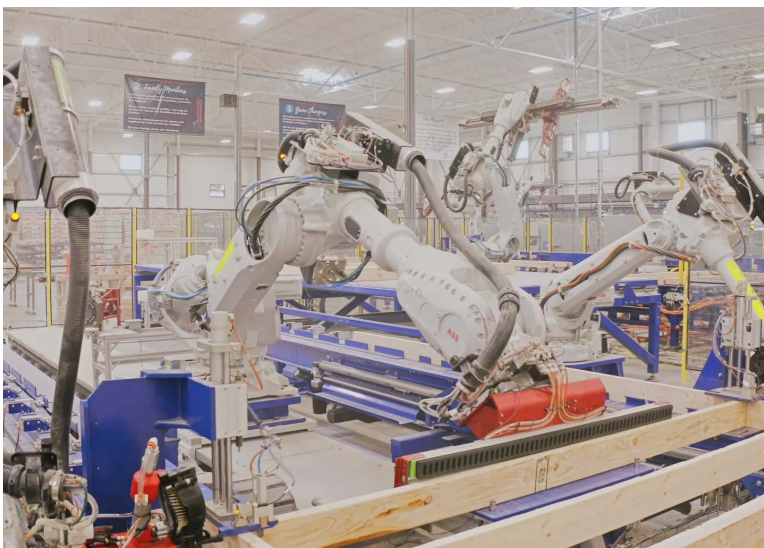
Sango Court's range of units was one key design consideration that was extra important, according to Curtis Fletcher, Autovol CTO and Co-founder, who shared a few other tips on design for modular.

"You want to ensure that your unit types stack so that you have alignment," Fletcher says. "So you want units—one bedroom for example—on top of each other to be of the same type," Fletcher says. "You also want to make sure you're thinking of the other demands of the project beyond just dwelling units: common areas, electrical rooms, etc. Do you need an IDF room, a generator, a fire pump on the job site? Making sure early on that you have space allocated for these is important with modular. Once it's in the factory, you don't have a lot of flexibility to make changes if you didn't get that space planned in."

Fletcher says that involving a modular preconstruction consultant early in design can prevent headaches and redesign later on.

"When you're getting the initial design done, it pays to get someone like Prefab Logic involved early in the design process. With good preconstruction services, you can create the best outcome not just in the factory, but onsite."

During factory build in Idaho, state inspectors from California inspected for code compliance. Autovol has its own extensive QA process as well. Units are inspected, tested and audited against the approved building system, as well as Autovol's fit, finish and workmanship standard using go/no-go points where compliance must be guaranteed before a unit can progress. To further ensure coordination and communication, Nibbi assigned one of its own people to be at Autovol to check in daily on the factory progress. Autovol had also hosted the project team at the factory at the prototype stage—including subcontractors who would complete the project onsite—to help ensure success at the project site.



Floors, ceilings, and walls are assembled by robots—reducing physical stress and increasing precision.



Teaching Each Other

According to Autovol CEO and Co-founder, Rick Murdock, the project was a prime example of success through communication and collaboration. And he credits early involvement and education as keys to success.

“Everyone got to see what we were going to build in detail using the digital twin,” Murdock says. “Subcontractors got to see and touch what they would be working with in the field because they came to the factory. Nibbi was an excellent collaborator. Our factory people also learned from them.”

Fletcher elaborated on one example of how the Autovol factory learned from Nibbi and adapted its approach.

“The job required a peel-and-stick weather barrier with a self-healing membrane that is much more labor intensive in the factory,” Fletcher says. “But the result on the jobsite is much better. It produces a tighter building. Water intrusion is the most costly risk in a modular project. We embraced the material and Autovol is making it standard moving forward.”

Steve Clough, Autovol Project Manager for Sango Court agreed that collaboration was key. “The hands-on collaboration was constant. I would talk with someone from the project 2 to 3 times a week,” Clough says. “We were learning from them, and they were learning from us. And all the egos got thrown out the window. That made it an especially enjoyable project.”

Clough cited another key process from Nibbi that will benefit future Autovol projects.

“Nibbi had a great way of creating a centralized submittal documentation library that we have adopted,” Clough says. “We now have more diligent processes in place for all the products that go into the building. By completing this job, we now have a centralized library we can pull from.”



The developer, architect, pre-con, general contractor, and subcontractors visited the factory early on.

Factory to Site

At Autovol, completed modules are prepped for shipping inside the factory with protective paper on flooring, straps securing appliances, and shrink wrap to keep water out. The plant was built to include a large yard to store modules until the final site is ready or storage near the site is secured. Modules are placed on “cribs,” designed to enable flatbed trucks to quickly back under each module and get it on route to the project site.

Finished Sango Court modules varied in size, with the largest at 14' 7" x 68' x 12'. Each module is carefully marked with an alphanumeric code that ensures it is set in the correct sequence. As modules were shipping to Sango Court, an unexpected hiccup came about. Due to highway regulations and road construction the largest of the modules exceeded a temporary restriction on size. Three shipping companies—Westervelt, Western, and Landstar—coordinated with Nibbi and Autovol to keep the project on schedule.

A lesson learned here is that shipping costs can vary based on the unexpected—from road construction to fuel cost fluctuations. It's also important to know that size matters when it comes to shipping modules. Autovol CFO, Kyle Gantz explains.

“Shipping companies won't normally guarantee a cost—and overruns have to be passed on. Reroutes can be several hundred miles, and with recent fuel costs, that adds up,” Gantz says.

In the Bay Area, shipping and trucking are even more of a concern, according to Patrick Sullivan, Nibbi Project Manager for Sango Court.

“In California, and especially in the Bay Area, it's very likely that any major thoroughfare will have permit restrictions that impact when a 70-foot module can be on the road. It's critically important to understand the truck routing to staging areas and the project site to minimize trucking costs and keep the operation efficient and on schedule,” he says.

Basics of Modular Financing

Modular projects are financed upfront, so a major percentage of the job is paid before the building is erected onsite. Typical payment process:

- Upfront deposit to secure a schedule slot
- Deposit for materials purchase
- Payment to start manufacturing modules
- Payment when modules are complete
- Payment for transport of modules to site



Completed modules are shipped from factory to a 'laydown yard' near the final site.

The Set

With modules shipped to a laydown yard near the Sango Court site, it was time to erect the building. As this was Nibbi's first set, they had planned and practiced extensively, leaving nothing to chance, according to Giarrusso.

"We preplanned, and preplanned, and preplanned," Giarrusso says. "We had multiple preconstruction meetings and got everyone together including the crane supplier and walked the whole process, first on paper, then we drove the routes the trucks would take, we timed it at various times of day to dial in the set efficiency and productivity. So we pretty well knew how much time it was going to take. And all of that was pretty predictable for us. We actually bettered our predicted production rate."

As Westervelt shuttled modules to the site from a nearby storage yard, Nibbi had a union team running the cranes that set the modules. They also hired Accuset, an experienced modular installation company as a consultant. And the subcontractor preplanning critical to staying on schedule had begun many months prior, Giarrusso says.

"The subcontractor base in the Bay Area doesn't have much modular experience. We hedged that by bringing everyone to the plant to help them understand everything when they got to the field," Giarrusso said. "Because we 'built' the project on all these different iterations leading up to the physical build, the physical build was in many ways the easy part."

Another key player onsite at Sango Court was Joe Sievers, Autovol's Director of Onsite Services. Sievers acts as the manufacturer's representative onsite, bringing decades of experience with the modular set process. Sievers was impressed with Nibbi's performance on its first modular effort.

"Nibbi's preplanning and staffing was exceptional. Having inspectors there to inspect the subtrades was well thought out," Sievers said. "Often you have a cluttered site with all the mechanical, electrical, and plumbing subtrades climbing over each other to get their prospective tasks completed. Not here. There was great attention to coordination, cleanliness, and safety on the site. Nibbi staffed well and even had a carpentry team onsite that could take care of unknowns."



The Sango Court building was assembled over a 12-day period thanks to careful planning and expert consulting.

Dry In Essential

Sievers says having the products and staff available for closing up, making structural connections, and completing the dry-in process is a best practice that can make or break a modular project. He emphasized the importance of “dry in and close up”—a process to protect the building against water intrusion.

With an onsite build, the outer structure and roof are built first. With a modular build, the building is built from the inside out. Modules are set over a period of just a few weeks, and the building is near complete before the roof is added. This makes water the Achilles heel of a modular project that must be anticipated in advance and addressed throughout the process.

“Nibbi’s forethought of keeping the building dry in case of weather phenomena was well thought out and executed,” Sievers says.

Sullivan recognized the critical lesson related to preventing water intrusion that motivated Nibbi on this project and will guide their process even more on their next modular project.

“The construction team was highly diligent about keeping water out of the building. You have to take a personal ownership to make sure every element of the building is protected, not just go home, and cross your fingers,” Sullivan said. “For those doing their first modular project, I would first try to build a schedule that sets during the least rainy time of year, but, as we experienced at Sango that isn’t always feasible. The team here was successful in creating specific protocols for work to be completed every day to ensure the building was dried-in. During pre-construction, I would make every effort to implement best practices and simplify the roof design to minimize the duration between the completion of setting modules and completion of permanent roof install. That can greatly reduce the risk of water intrusion.”



Assembled onsite and up to 80% complete in weeks, the building needs quick protection from rain.

Completing the Building

Once modules are assembled onsite to form the apartment building, final onsite completion—in a nutshell—includes:

- Plumbing, fire sprinkler, electrical and low voltage completion, including connection of already plumbed and wired units to domestic water, fire water, central power and communications services.
- Installation of mechanical systems beyond those in the dwelling units
- Completion of the roof and exterior facade and other features that give the building its character and aesthetic quality
- Completion of corridors and common areas such as laundry room, storage rooms, and leasing offices
- Podium level open space amenities such as hardscape and landscaping

The beauty of modular construction at this point is that a huge amount of mechanical, electrical, and plumbing work are already done. But all of the above tasks as well as the structural integrity of the building are dependent on being able to have precise alignment of modules—which starts in the factory.

Michael Dorsa, Nibbi Superintendent on Sango Court says alignment was one of the big considerations for choosing Autovol's data-driven automated plant.

"From our research, alignment was a big thing we knew could make or break a modular job," Dorsa says. "On this project, it turned out very precise. We were plus or minus a sixteenth inch on all the corridors, and plus or minus a half inch on the entire exterior facade."

Already mentioned, a paramount concern for completing Sango Court onsite was protecting all the finished modules from water intrusion. Dorsa says the building's unique features made this especially challenging.

"Some features of the building design weren't really ideal for a modular build. We had lots of openings in the exterior facade: two wings, one building, five levels above the podium, with open corridors exposed to the elements on both sides." Dorsa says. "On the podium there's a connector bridge rather than units, so everywhere that bridge intersects is wide open as well. We also had to make sure we kept water out of those areas."

While these features will be enjoyable for residents, a lesson learned is that with a modular project, features like these require rigorous preplanning to protect all the finished construction from water.

The building also has a complex range of features that made the roof a major focus in terms of preventing water intrusion.

"We had a fairly complicated roof," Dorsa says, "We had almost 1,000 roof penetrations. Preplanning to make sure all the blocking is installed in the modules needs to be coordinated in the factory. Pulling all that design and coordination into the design phase is an important best practice."

For the roof work done onsite, Dorsa emphasized preplanning for unpredictable weather was once again essential.

"Having a clear gameplan on how things are going to be phased is important. Once you're done setting, you're building your parapets, all your overruns, and everything that's going to attach to your roof before your finished roof system can go down," Dorsa says. "We phased each roof into sections, so we would never have more area opened up than we could temporarily protect very quickly in the event we had a sudden forecast for rain."

355 Sango Court—Quick Facts

- Classification: 100% Affordable Multifamily Housing, including supportive housing for 40 special needs units (including homeless, seniors, and disabled)
- Buildings: 1
- Units: 102
- Unit types: studio (23), 1 br (40), 2 br (27), 3 br (12)
- Efficiency: GreenPoint Rated
- Parking: 60 vehicles (including 36 parking stackers), 102 bicycles
- Amenities: interior courtyard, community room w/kitchen, resident services

Planning Pays Off

As these activities were conducted in late fall and early winter at Sango Court, the preplanning paid off.

“We built this project through the worst winter we’ve had in northern California in some time,” Dorsa said. “And we had no major water intrusion.”

Throughout the post-set, Dorsa says that extra staffing and planning paid off.

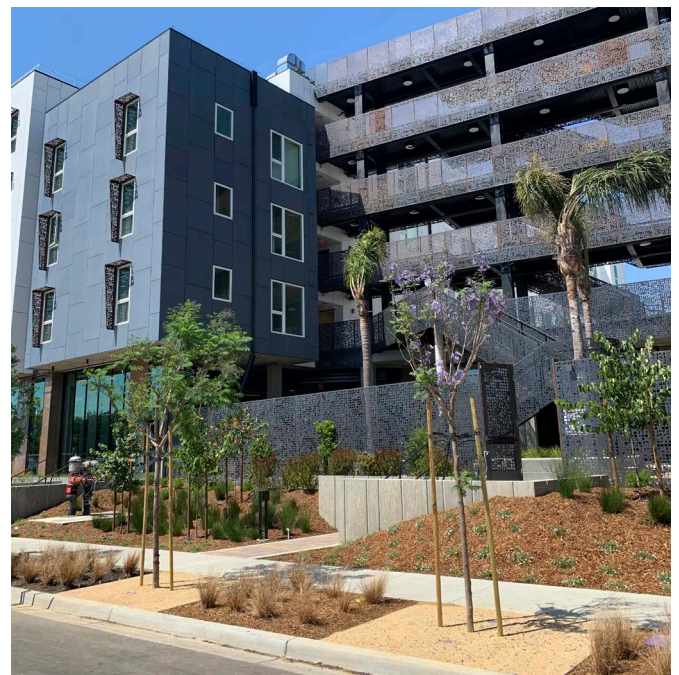
“We had planned a full-time staff of four on the job, two on the office side and two on the field side” Dorsa says. “The city of Milpitas had never done a modular job, so they kept a very close eye on every structural connection. We staffed the job as originally planned and the job turned out profitable for us.”

The time between set and building completion at Sango Court turned out to be 10 months. With Nibbi’s first modular project having now received its certificate of occupancy, Giarrusso reiterates one of the keys to the success of Sango Court.

“There’s not a point that’s soon enough to bring all the parties together—the architect, the modular manufacturer, the general contractor—and guide the client on removing their conventional build framework, and replacing it with a modular framework,” Giarrusso says. “You don’t have the luxury of a conventional build to make decisions and changes as you go. You have to think of many things upfront, and explain why you need to make them. The modular mindset forces that process upfront. But it’s great. Because it’s much better when all those decisions are made early on any project.

Phases and Times to Completion in Calendar Days

- Preconstruction redesign: 5 months
- Design integration/shop drawings: 2 months
- Factory online to offline: 64 days
- Shipping finished modules: 50 days
- Onsite modules crane set: 12 days (12 shifts)
- Total: 119 days factory online to final module set
- Onsite completion: 10 months
- Time saved: 2.5 months



Sango Court stands as a great example of a city, developer, and GC bringing their first modular project from vision to resident-ready, saving time in the process.

First-Time Modular Tips

In spite of some challenges, all the parties consider Sango Court a success and a great example of teamwork between multiple companies. The project exemplifies how modular construction can bring high-quality housing to areas of greatest need quickly and profitably—even for a first-time team. Sango Court has also yielded lessons like the ones shared and insights for those considering a modular approach.

Giarrusso shares an insight that any first-time modular team can keep in mind to make modular an option from the start of project design.

“Go in with a modular mindset. You can always pivot later. It’s a lot easier to go from a modular design to conventional. Going from a conventional to modular design, it just doesn’t work well,” Giarrusso says.

To think modular first, Sullivan elaborates that a lesson learned was the importance of educating developers and designers on modular, and making sure design details aren’t deferred.

“We had over 40 deferred submittals on this job. In the modular world, all that design needs to happen in the design phase of this project prior to locking the design for manufacturing,” Sullivan says. *“If the designs are incomplete and elements are missing or uncoordinated, you’re potentially redoing completed work, which defeats the purpose of building modular.”*

Dorsa emphasized team composition as something important for success.

“The reason the job was successful was picking the right partners,” Dorsa says. *“Autovol’s manufacturing process is way further along, which led to a much better quality product. Prefab Logic. Accuset. Westervelt. All helped make the project successful.”*

On partnership, Clough shared how one small thing can make such a big difference for successful collaboration between all the stakeholders with different needs.

“Communication is the whole thing, but especially communicating the ‘why.’ It’s one thing to say ‘this is how we do it,’ but to communicate the why makes a big difference. And if you don’t know why, it’s okay to say, ‘let me find out.’”

Both Nibbi and Autovol gave kudos to RCD as a good owner-partner as well, empowering and allowing Nibbi to put all their research, planning, and decision making to work so the first modular project for both parties would succeed.

“The owners have been with us every step of the way,” Giarrusso says. *“They put a lot of faith and trust in Nibbi to find a path to a successful project.”*

From the owner side, Bookhart emphasized the importance of early planning and shared a list of tips for first-time modular development.

“Explore options for modular very early,” she shared. *“Talk with your public lenders about their comfort with modular and ability to fund early deposits. Work with your contractor to plan for any potential rain occurrences. Pick a design and construction team with modular experience. Discuss the financing timeline with the modular manufacturer, particularly around multiple TCAC rounds prior to start of construction.”*

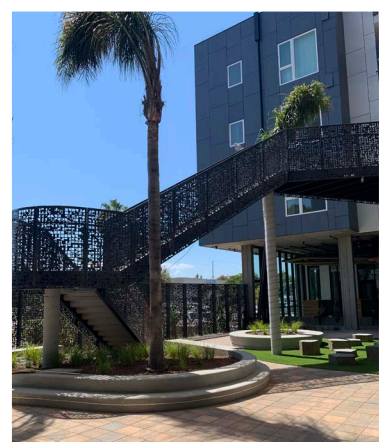
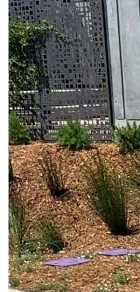
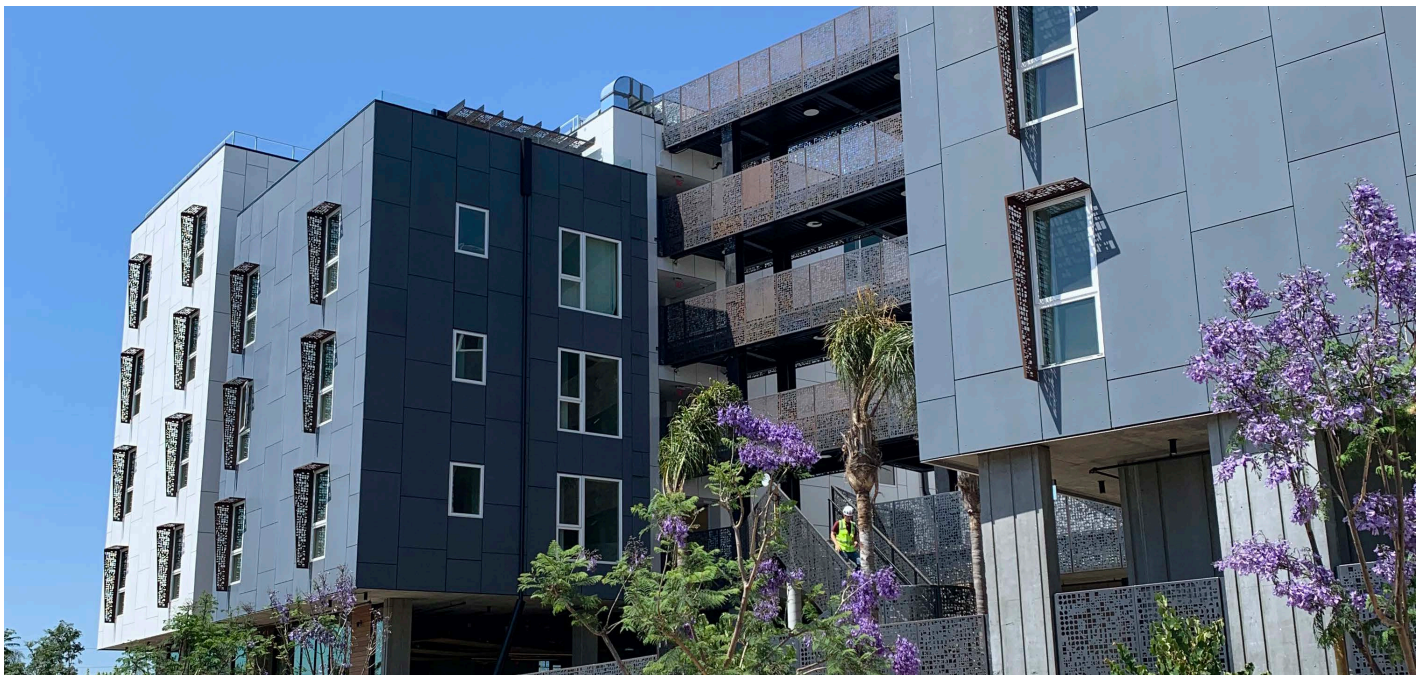


Through careful planning and teamwork, the onsite set process was completed in just 12 days.

Looking Ahead

With their first modular project now deemed successful and ready for residents to enjoy, Giarrusso says Nibbi is further applying their modular mindset. And as usual, they have a gameplan for doing it right by doing the diligence upfront.

“Modular is not a panacea, it’s not the answer to everything. Some projects don’t lend themselves to it,” Giarrusso says. *“If a client is open to a modular job, we look at both approaches. We’ll actually go to the site, we’ll drive it, check the routing, logistics, laydown space, and such. Then we’ll look at it on conventional basis, and run the numbers and feasibility for both techniques. It may or may not work. But if you think modular first and run the logistics you’ll benefit regardless. If you have to pivot to conventional, you’ll still have a super efficient project where you’ll save money.”*



Sango Court provides over 100 affordable homes, with outstanding functional and visual appeal for residents and community alike.

Valued Collaborators

Click a logo to visit the website of any of the team here who helped make Sango Court successful.



Lessons Learned

- Design “modular first” then pivot to conventional if preferred
- Build an offsite/onsite dream team
- Plan, plan, plan—and rehearse
- Use data-driven 3D modeling
- Build digitally with all stakeholders
- Design for roof simplification
- Plan for water protection
- Bring subcontractors to the factory
- Replace egos with teachability
- Know factory-specific best practices
- Know onsite contractor best practices
- Educate & communicate the “why”



David Baker Architects

