# New York Modular

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New York City has recently had a number of projects designed and built utilizing volumetric modules, an alternative method of delivery.[1] This interview, moderated by Guest Editor Ryan E. Smith, is with four leading architects in New York City who have recent experience with modular design and construction. Peter Gluck with GLUCK+, Mimi Hoang with nArchitects, Chris Sharples with SHoP Architects, and James Garrison with Garrison Architects respond to a series of questions regarding factory-based production of architecture.

**Smith: I think we'll start off with the first question here; each of you—why did you become interested in alternatives to traditional modes of architectural production?**

**Gluck:** Well first of all we're an architect-led design-build firm, so we build all our buildings. We are interested in building and we are interested in all the ways building might best be done. The more we know the more opportunity we have to build better buildings. We look at off-site construction as just another way to build and it gives us another set of arrows in our quiver if you will.

**Hoang:** I feel like the charlatan because we've only done one modular project and it's really very much tied to the competition that we did for the micro unit apartment building at Carmel Place (Figure 1). Modular went hand in hand with the problem of micro living and also pulling off a project like that next to NYCHA[2] housing. It's about building. It's also about controlling quality, controlling output, and trying to take the heat off everything that needs to happen in situ and having parallel work sequence happening elsewhere so it can ostensibly move faster.

**Sharples:** I think in our case it was really a perfect storm. We had just finished Barclays and Forest City was getting into doing residential development for the whole arena site. The challenge was that the first building going up, 50 percent had to be affordable. And the challenge with Forest City Ratner was seeing the hard cost numbers coming back high. It's hard to get the financing, especially if you're doing 50 percent affordable. Bruce Ratner, the head of Forest City, looked at the idea of modular. We actually started off designing a conventional building and halfway through he said, can we take that conventional building and turn it into a modular building?

He gave us eight weeks to develop the concept, and after eight weeks everyone felt pretty confident. It had a lot to do with the market conditions. This idea that maybe you could actually save close to 20 percent on the cost in terms of time savings and possibly by also fabricating in a factory. Obviously there's a bigger story here and it's not necessarily the outcome of B2, but that was what was guiding us in the beginning.

**Garrison:** Well I think those of us who walk out on construction sites over the years are amazed by the lack of order and poor level of organization that our construction trades have devolved toward for [a] variety of reasons. And I was aghast as a young architect walking out into a project in the middle of the water, mud and debris on job sites with bolts dropping from upper stories whizzing by my ears. We don't necessarily organize ourselves very well to build. The statistics that are out there that analyze the efficiency of contemporary construction, show that fact. The statistics show that the US has a 10 percent decline [in] construction efficiency since WWII.[3] There's a problem to be solved and off-site production is one way to look at solving it. Our interests have been

**Figure 1.** Carmel Place is a micro unit apartment building, designed by nArchitects and built in modules, that was commissioned based on winning a competition. (Image courtesy of MIR | nAtrchitects. Reproduced with permission.)

how we might use that, at the same time exploiting what architectural potential it has. It's about how to better build a better mouse trap in the end.

**Smith: Let's dive into a workflow question. In your experience, how does embracing this alternative method of subassemblies or entire volumes installed on-site with concurrent factory and site work occurring change the workflow and responsibility of the architect?**

**Sharples:** To back off of modular for a moment to talk about the way that our practice has evolved over the past few decades: when we got out of school, technology was evolving and changing, everyone was really using software to generate renderings and still drawing in 2D.

And what we were finding and a lot of architects were finding, that we could really begin to model every component of the building and if we wanted to take it all the way down to the screw head we could. What it did, is it gave us a chance to really prototype virtually every aspect and begin to also think about how we would even begin to construct it. So you start entering into conversations of means and methods in these work flows. And so we took that in an area where we thought we could have a greater degree of control. That was in the envelope of the building. I think Porter House was really the first example of that back in 2000–2001 and then it culminated with the Barclays Arena finishing in 2012, where we actually generated the whole building information modeling (BIM) model; where we created the shop ticket for the fabricator. That type of integration gave us the confidence to think that when modular became a point of conversation with Forest City, we go beyond

the skin and how we understand all the different components from the MEP, structure, to finishes, to the fit outs. I think one of the changes that we saw is that there are different kinds of digital models that evolve here. There's the design model and then there's the construction model. Peter and Jim can speak to this much more than I can because in our case at B2 Atlantic Yards, we didn't get a contract to go into a factory and work directly (with) the manufacturer on modular because our bid was too high. But the fact is that the design model is very different from the model that actually is used to build the mod which is in a way the instruction model. I think that's something that we lost out on in our experience, but it's something we had a sense of missing because of what we had done with Barclays (Figure 2).

**Hoang:** I think that's a good way to frame it Chris, that there's a difference between the design model and the construction model.

**Figure 2.** Barclays 2 Atlantic Yards developed by Forest City Ratner is a thirty-two-story modular build in Brooklyn, New York. (Photo by SHoP Architects. Reproduced with permission.)

I think in terms of the design model, the thinking about sequencing and trying to work into the design concept from the very beginning how you're going to build it of course influences all the decisions that you make in the beginning and catapults all the decisions into a much earlier point in the project so that you're more aware of all that. And then I would say for the construction model, for modular in particular, I think instead of waiting for all the rough stuff to happen for the shell and the systems and then finally at the very end you are seeing the finishes, what modular does is that you can see all of that in the prototype. I think that there's various scales of prototyping and modular. It can be unit or it can be the system of façade panel or whatever it is. So I think that kind of logic of prototyping is the most impactful one in terms of our work as designers.

**Gluck:** One of the things we are trying to do is to essentially change the profession. Actually the comment about two sets of drawings really proves what I'm talking about. There are two sets of drawings, the architects make a set of drawings based on their design interest and their knowledge of construction. Then those drawings are taken in the field by various subcontractors and a complete second set of drawings are fabricated, which doesn't make any sense to us at all. It makes sense to us to have the understanding and knowledge. A lot of the technical parts we work to understand in the beginning so that we try to make a set of drawings from which the building is built. We feel that architects have limited themselves to looking at only a part of the issue. So understanding the sequence of building and understanding the way things get done, understanding the various subcontractors, how they work together is part and parcel of designing a building. It allows you to design a much better building, much more efficiently.

**Garrison:** We've been at this in a variety of different ways for several years now, and I have come to the conclusion, that requiring or expecting human beings to use excessive foresight and planning is one of the most challenging aspects of modular construction. Because the prototype that Mimi is talking about has to be completely resolved before it goes into production and it's not affordable to have an integrated process in modular

design. You cannot modify or have the plumber come in [and] make tweaks here or the carpenter come in and make little tweaks there once the building is rolling out of production line in the factory. So the relationship between the builder and the architect is more like a manufacturing sector effort—like an automobile or anything else where the actual construction sequence of all the materials have to be understood by both parties from the beginning as you walk forward with it. I think there are many transitional efforts in modular design, but the ideal, as Peter says, there are no two sets of drawing in a true design build-effort from the beginning. And that's the only way that it can work.

**Smith: To Chris's point, he had mentioned that their firm approached how to leverage digital technology to integrate with fabrication. And we have seen that in certain sectors of construction. Certainly in HVAC ductwork delivery there has been significant integration with the mechanical design all the way through fabrication and install. What is it about modular in particular that as you scale up to a volume the architecture, engineering, and construction (AEC) industry seems to be struggling with integration of design for fabrication and manufacture.**

**Sharples:** I think one of the challenges here is that you have signed on a particular manufacturer. I don't know if you call it a prequalified relationship, but the fact is, in most cases everything is design-bid-build. It's a competitive process and the challenge is getting the client to pay upfront. In that case you do have two models. You do have the design model and the builder has to take that information and actually build their own model because they have to build the product. Whereas with the manufacturer you are actually in the same room working the problem together and eventually ending at a prototype. So for us it really isn't

about product innovation as it is process innovation. But the culture of the two is very different. One working with the manufacturer you can start day one and say these are the project goals, these are the constraints, and these are the costs we have to hit. Where with a lot of projects in New York it's basically lowest bidder and some of the subs aren't even up to dealing with the model in the first place. It's a completely different can of worms and that's one of the challenges. Looking at how you can break this into certain components where you can start to develop a very integrated process is key. But getting everybody to play together, that is a cultural issue right now.

**Gluck:** I would say if you look at the profession, if we are talking about architecture as a profession, you are looking at a siloed process. Where architects seem to think that they are more artists, that somehow the actual construction endeavors belong to someone else. And it seems to me that what we are trying to do is break that silo, not have the tremendous difference between the designers and the builders. It sounds silly to think of going back to the old master builder, but that was a completely different idea. Now architects have to be up-to-date and familiar with all the processes that go on and the way things are built. If you're talking about premanufactured, most building parts are premanu-factured. Take for instance just the window. It's a very sophisticated set of materials that are put together in a factory and now we just think of them as stuck into a building. But that's not the way windows were originally made, they were made on the job piece by piece. So if you think of the building as a whole series of the premanufactured components, which in fact it is, it's very hard to design a good building unless you really understand all the aspects. It's a daunting task but it's just a necessary task that in this particular time we are in, it's a task that architects have to understand if they are to produce

really good buildings. And the more you understand, the more tools you have, the better buildings you can make. It's not only about making buildings that can fit the budget, although that's important, it's about making better buildings, buildings that perform better and that perform architecturally better. It's impossible to assume that you're going to do that in a vacuum, and architects seem to like to sit in their own office in that back room outside of the realm of construction.

**Hoang:** I think that builders, general contractors, are more used to thinking about a building in terms of putting together a whole bunch of components, but they are not so adept to thinking about the components working all together in terms of a system like modular. So one of the trickier things we had to deal with on the Carmel Place project was the regulatory agencies. They have to really catch up, so I am talking about the UL rating and the fireproofing, etc. You would think that on paper modular is much better. There are double walls, there's double floor and ceiling. This just hasn't been tested. There are a certain number of regulatory agencies who are just catching up to how modular is combined to create a wall or floor assemblies.

**Gluck:** They caught up on our back, because when our modules rolled into town, all of [a] sudden the building department realized, oh my god, this is a modular building. And the plan checker, who had plan-checked it, who approved the building, had not even realized that it was being built somewhere else.

**Sharples:** Yes, we got impacted by that!

**Gluck:** I think that what you are experiencing is hard. In regard to the UL business, it is not just the regulatory climate, it's the state of manufacturing in regard to these kinds of building. They have special

systems and the way fire systems work, the manufacturer pays for them to be tested and very few of these companies have evolved to the point where they have a system that they understand well enough to have it tested. I mean we are going through that with several modular manufactures right now. It's really important to understand that the modular industry is a very undeveloped industry. It doesn't exist yet in the same way that our window industries, that all the various manufactured components, that the rest of certain components of buildings exist. We don't have modular builders who have well-developed systems or well-developed technical resources. And one of the reasons that a lot of modular projects are fraught for one reason or another is because there is no real robust modular infrastructure in the United States at this moment and this is something that will have to evolve if we really want to use this (Figure 3).

**Garrison:** There is a real problem for these companies. There are a series of extraordinarily unsophisticated companies and the factory is in fact simply a leftover building in the rust belt from the steel manufacturing process that went out of business fifteen years ago. The factories, they aren't really factories, they are just sheds that are found objects. The sophistication that makes the building is really low. There is a tremendous difference between these so-called factories, that are in rural Pennsylvania by the way, that when you put together the buildings in New York City, you have to zip up or hook up the building afterwards. This is done by New York City trades. Now you have a tremendous[ly] complicated cultural difference between the architect and the under-sophisticated modular companies, and then the building trades in New York who have to put the things together. In our mind, that is the biggest problem, putting all the various cultural pieces together.

**Figure 3.** The Stack design, developed and built by Gluck+, located in New York. (Photo courtesy of Gluck+. Reproduced with permission.)

**Figure 4.** NYC Parks Beach Recreation Project designed by Garrison Architects. (Photo courtesy of Garrison Architects. Reproduced with permission.)

**Smith: It's not necessarily a new idea, right, we've been talking about volumetric modular construction for decades as an architectural profession and as a construction industry. We've talked about some of the barriers, are there any other barriers that you've identified beyond jurisdictional barriers? How about standards and financing?**

**Gluck:** Financing barriers. Fear of the bank and you are financing the project and the project is 3/4 built and sitting in the parking lot outside of the factory and the project has difficulty—what do you do? Do you sort of go down and get all the workers from the bank to get trailer hitches on their cars and pull the modules into place? It's just a totally different way of looking at the financing of the building. A positive thing we did find, we had expected to find some negative reaction from the people who would live in the buildings, but we found that without exception the community was excited and this was something modern and

new and exciting, and there was no negative whatsoever of the idea of manufactured housing. It was a real positive.

**Garrison:** I think you have the two big constraints and I'll restate them. I think it's the state of affairs, of the state of the manufacturing for modular. And for the second it's the fact that our architects at this moment are removed from the building process to take responsibilities for the assembly of the built object. So you have these two things that are a little bit of a perfect storm and one might supplement the other. If the architect is more detail oriented, what they are doing they may be able to see get manufactured. If the manufacturer is more developed at what they are doing they could see the architecture, but right now what we have—that's quite incomplete on both fronts.

**Hoang:** I think one of the barriers is that everybody equates modular as being extremely cheap or somehow free because it's built elsewhere or there's the element of repetition. That is just a pet peeve on our part.

**Garrison:** You know that's an interesting thing. I don't know if we've heard the last of that argument yet because we had an interesting experience recently. We purchased a modular building where the modules were constructed in Poland. That manufacturer managed to reduce the price of that product that we specified by 25 percent under any of the Pennsylvania-based rural manufacturer. And, you know, they did it because the Polish labor force is a relatively poorly paid labor force. They really did it by having repeated that particular building type at hand, which is these micro hotel rooms, over and over again. The one they did for us might have been their fifth or six and they basically ran and they had enough of it solved that they could move rapidly through many of the issues in construction. So I do think there is a promise there that we might see in the future if we get to the point where we can do something similar.

**Sharples:** It really does come back to a different mentality between a builder and a manufacturer. The alternative to conventional modular is other forms of prefab.

We're working on this mass timber opportunity, obviously we have to work with the fire department on that, but the idea is how you can begin to kit these systems, whether they are completely modularized or partially assembled off-site. But understanding how you begin to look at these issues of efficiency, as Jim was alluding to at the beginning of the conversation. I really believe that visualization like what Dassault is doing with the 3D Experience,[4] the fact that you can do quality takeoffs in Revit, you can begin to visualize and understand how you are going to set up your job site. And to Peter's point, the architects have a big responsibility and obviously we have this issue of means and methods, but I think that by creating these visualization tools and virtually prototyping early on in the design process, and you can get the builder prequalified, you can begin to build this culture that is incredibly iterative and it feeds back its knowledge that as you include in the next project, and you take that knowledge and move it forward. I keep harkening back to when Kaiser was building those Liberty Ships.[5] The first Liberty Ship took, I don't know a year, but at the end of the day they figured out how to build one in ten days or even less. Obviously they weren't designed to last very long, but the thing is it's a process that gives back information so that you can always work on developing efficiency and obviously at the end of the day also improve your craft.

**Garrison:** Chris how do you reconcile that with a kind of variation that we are more less expected to deal with in our architectural setting?

**Sharples:** That's a really good point and I think what it comes back to is understanding what kind of projects demand that level of variation. What are the constraints that set that up? For example, if it was modular and you are doing a modular building, what kind of constraints are we looking at? We probably have maybe three or four different unit types that

can break down to even more discrete differences. At B2 we had twenty-six different ones, but that had a lot to do with design guidelines of the massing of the building that we had to follow. You set the rules and there's a certain grain of detail that you can get to where it begins to work against you—but that is modular.

For a prefab project there might be a little more leeway with that, especially when you are looking at mass timber where wood is incredibly forgiving. Even if you show up with your predrilled holes for your plumbing, if you need to drill another hole you can drill another hole right there on site, it's not a big deal. I think when it comes to façades, we actually can be highly customized and I think that proves out on projects all of us have been involved in that the façade, the unitized façade system, can be highly customized in the factory and be different for different projects. It really depends on the problem you're trying to solve. I think modular, because it's the whole thing that has to be manufactured, there's a limit of how much customization you can have.

**Gluck:** Along that line, the fact of the matter is that the modular system is really not like an automobile, there are not a thousand of these things being produced. What we've all done, we have designed the building based on the requirements of that building, and then figured out how to cut it out into pieces and bring it into town. That's what off-site construction is. It's not an analog to an automobile or a product of any kind, it's not like that.

**Garrison:** Peter I'm going to take issue with you on that. I think that if you do it that way that you can't take advantage of the production type. It requires us to consider it a modular componentized system from the beginning rather than cutting it up and bringing it in. Somehow there has to be some level of standardization, otherwise I have to say from my point of view, the pure brain drain required

to solve the manufacturing problems under the set of variables that exist is daunting, I mean nobody will pay for it, it's extreme (Figure 4).

**Gluck:** I think the reality is there is no aggregated market, every project is different, so you have to determine what can be replicated and what can't be, and an awful lot of it can be. And that's not a disadvantage from my point of view, that's an advantage that off-site construction allows us to realize.

**Hoang:** I think that we are also talking about whether or not it's important if the building reads as a modular building. Is it important for any of us that it is legibly a stacked modular building and that goes into the façade and the different techniques of putting the façade on in situ versus in the factory? What to do with the mate line? How much do you want to repress it versus not? I think all of that is just design.

**Garrison:** When I made my comment I was not thinking of façades, I was thinking of the way in which modules are assembled. I do think there are a set of techniques that need to be standardized and that may be a matter of how the plumbing shafts and bolted connections work. But there is something that has to be common and carry from project to project and right now there really isn't. Right now it is all over the map. Some level of consistency would allow these things to evolve I think.

**Smith:** So what you are suggesting perhaps is standardized details of how systems go together or even down to the level of a standardized specification that aggregates different levels of specification sections, for instance.

**Garrison:** Yes, standardized assemblies. Unitized window wall is one that is a fairly standardized component at this point and we certainly have a similar set of componentry for forming arrays and other pieces we have to integrate.

**Gluck:** One thing that was mentioned was means and methods. Means and methods is something that architects are not allowed to touch. We are talking about the means and methods. That's what this discussion is about. What does that tell you about our profession?

**Sharples:** We are allowed to choose paint colors.

**Smith: So with regards to that, as a follow-up question, what will it take to reach a tipping point when advanced production methods in design and construction proliferate? When will it reach a tipping point?**

**Gluck:** An aggregated market. That's the problem with housing in this country, housing is not built by the government. There are incentives to build and every project is different, every site is different. If you think of this off-site construction as simply a better way of putting the pieces together, as another way of assembling the pieces in a better environment for quality and control, that's what is going to happen. I don't agree that the replication of the same components and the same pieces will ever happen in this country as I understand it.

**Garrison:** There's a lot of repetition in particular among New York City apartment houses. There are virtually four unit types that could be found throughout the city and there may be at some point some utility in becoming more standardized. I do think that there is something happening in regard to the scale of projects. If we had a well-developed modular industry and Chris is dealing with something like the Atlantic Yards project, there is enough scale there that the repetition would become a variation on a system and would become an inherent part of the problem and could be ruled out and in an advantageous way because the scale would exist. I think we are seeing a time where modular projects are becoming larger. We have a project in Queens where we've been working on this couple of thousand-unit development and at that point these things start to become repetitive systems. So I think there is something perhaps there.

**Hoang:** I think scale of projects, yes, but also the problem is scale of the manufacturing base itself. So it's a bit of a paradox because where we need it most, in densities, where we could have the scale necessary for housing projects, that's where we don't have the scale, the spaces, for large manufacturing companies to roll this stuff out. And therefore we have to go to Pennsylvania or Canada and then there's the cultural disconnect that someone was talking about earlier. It's a paradox, we need space to build all this.

**Sharples:** To that point Mimi, the fact is this whole city was built on manufacturing, thanks to the Erie Canal. We got all of Brooklyn Waterfront with all those buildings over there that a lot of modular projects that recently were completed were manufactured in those places. So we don't have to go to Pennsylvania. The idea that we can do this locally and train a workforce locally and we have these waterways, you think of these ideas to develop all these residential projects that are in Hunter's Point along the waterfront— it's just it's a no-brainer when it comes to access.
The other thing that I think people forget is that living next to a conventional construction site in the city is probably the worst thing you could ever wish on somebody. It's eighteen months to two years of hell of listening to noise, debris, idling trucks. The whole argument is looking at how we can really clean that up and make it a much quieter, more organized approach to how we do residential development in the city. There's a great story there, but at the end of the day I do believe we have to rely on manufacturers—it is a manufacture mindset that we have to have here. I do believe that some of the best people for this are builders, if we could just evolve the process of how

we prototype and not just in terms of the physical building itself but in terms of how we work the model and how we are working together. And this comes back to what Peter was remarking on. On day one when we got out of architecture school it was a means and methods problem. I cannot believe we were so naïve. We could not advise people on the site and then we started thinking about how would we build this so then you start modeling that stuff, and so for us it started with building envelopes. Architects have to agree and be more aggressive in taking on this responsibility. We all understated the issue of risk, but when you visualize everything to every detail you take out all the ambiguity. 2D drawings leave too much ambiguity, there's too much interpretation, but when you're working on a model that's coordinated it's very, very easy to navigate and see where the problems are.

**Gluck:** Hear, hear!

**Hoang:** Yes!

**Garrison:** I think we all agree with that. I'd like to add to that. Just by way of example we just set a modular building in Williamsburg. It is a 117-room hotel set in eleven days. So that's a reduction in the disruption of urban life that is dramatic and that's a great thing. But there is something really interesting about what Chris was talking about with regard to the local, the requirements or maybe the advantages of building. Locally, for all the economic workforce-training reasons, all the things we could formally see that are there, I think there's also the evolution of local building norms and I think those things make distinct cultures and make places that we can identify with for their own nature. I have to say that the hardest thing, not just the Pennsylvania crew as an example, but the hardest thing with dealing with the business of building in Poland was absolutely the cultural disconnect between what we do and what we expect, who we are and another culture trying to build for us.

**Smith: I appreciate that everyone. We are out of time here. Are there any closing comments people would like to make?**

**Hoang:** I think I'll pass.

**Sharples:** I think I said enough.

**Gluck:** I think my grumpy position is pretty clear.

**Garrison:** Well all I would say is that you got some very brave architects on the phone here; because these acts of building, these kind of buildings are extremely challenging and they've really stepped out to try and do this. You all deserve a big round of applause.

## Author Biographies

Ryan E. Smith is an Associate Professor of Architecture at the University of Utah. He has led a research team investigating offsite design and construction for nearly a decade while directing the Integrated Technology in Architecture Center (ITAC). He is author of *Prefab Architecture* (Wiley, 2010), and co-author/editor of *Building Systems* (Routledge, 2012), *Offsite Architecture* (Routlege, 2017) and *Leading Collaborative Architectural Practice* (Wiley, 2017). He is past-Chair of the Board of Directors of the National Institute of Building Sciences, Offsite Construction Council. Smith is a Senior Research Fellow in the Centre for Offsite Construction, Edinburgh Napier University in the UK.

Peter L. Gluck is Founder and Principal of GLUCK+ in New York. For over forty years, the practice has committed to crafting bold, innovative, and conceptually unique architecture with real-world expertise. The firm's work is diverse and consistently recognized through national and international design awards and publications. Most work is constructed by the firm through their unique approach to Architect-Led Design-Build (ALDB). In 2014, Fast Company's "World's Top 10 Most Innovative Companies in Architecture"

list included GLUCK+ "for taking control of the entire building process." The Stack was the first prefabricated steel and concrete modular residential building development in New York, winning an AIANY/BSA Housing Award in 2015.

Mimi Hoang, AIA, is a Principal of nARCHITECTS and an Adjunct Assistant Professor at Columbia's Graduate School of Architecture. Along with partner ERic Bunge, she co-founded nARCHITECTS with the goal of addressing contemporary issues in architecture through conceptually driven, socially engaging, and technologically innovative work. Their work instigates interactions between architecture, public space, and their dynamically changing contexts. nARCHITECTS was honored with an American Academy of Arts and Letters award in Architecture and the AIANY's Andrew J. Thomson Award for Pioneering in Housing. Mimi received an M.Arch. from Harvard's Graduate School of Design and a B.Science from Massachusetts Institute of Technology.

Chris Sharples is a Principal at SHoP Architects in New York City. SHoP is an internationally acclaimed design firm specializing in the integration of technology. SHoP has completed many offsite construction projects and is currently working on the design and construction of Atlantic Yards, which is slated to be the tallest offsite fabricated modular building in the world when completed that is receiving international attention.

James Garrison is an architect and educator whose work expands the boundaries of sustainability, demonstrating how modern architecture can address the ecological challenges of our era. A graduate of the Syracuse University School of Architecture, in 1978 Garrison joined Polshek and Partners in New York, where his perspective shaped the firm's signature projects, resulting in four Progressive Architecture Design Awards and two American Institute of Architects Honor Awards. In 1991,

he founded Garrison Architects. He personally oversees the firm's wide range of projects, including the recent, award-winning modular Lehman College Child Care Center, NYC's Beach Restoration Modules, and NYC's Office of Emergency Management's Emergency Housing Prototype projects.

## Notes

1   "Modular construction," once a term to describe HUD code housing, construction site trailers, and school pods has more recently become more prevalent in architecture. Modular, sometimes referred to as permanent modular construction or volumetric to distinguish it from relocatable or temporary modular, is one of the methods among a myriad of production technologies that leverage factory-based processes. This is an emerging design and delivery process called off-site construction. In the past five years the architects being interviewed have designed and developed a number of modular commercial structures, including The Stack (GLUCK+), B2 Atlantic Yards (SHoP Architects), nArchitects microhousing (Carmel Place), NYC Emergency Housing Prototype, NYC Parks Beach Recreation Project, Lehman Child Care Center, and others (Garrison Architects).

2   NYCHA stands for New York City Housing Authority, which develops affordable housing in New York City.

3   Garrison is referring to a study by Paul Teicholz, emeritus faculty at Stanford, who calculated the productivity in the construction sector compared to all other nonfarm industries from 1964 to 2004. During this forty-year period, all other nonfarm production industries increased in productivity by 3 percent or more per year while construction declined at 0.32 percent per year. These data were updated by Teicholz in 2012, and an article on AECBytes in 2013 showed similar results. Matt Stevens at the University of Melbourne substantiated these findings in a report to Stevens Construction Institute in 2013. Other authors have challenged Teicholz's results, including Daniel Davis in *Architect Magazine* and a Bureau of Labor and Statistics whitepaper authored by Sveikauskas et al., both published 2014.

4   Dassault has launched a platform that seeks to provide a central integrating software that amalgamates and creates networks for construction company management, marketing, project design, visualization, performance analysis, and social media. See http://www.3ds.com/about-3ds/3dexperience-platform/.

5   The Kaiser Liberty Shipyards were seven major shipbuilding operations on the West Coast of the United States during World War II. Kaiser was known for developing new methods of shipbuilding.