

Research Report: Reducing Waste and Increasing Efficiency on Construction Projects



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INTRODUCTION

There is a tremendous amount of waste generated by construction projects, with as much as 30 percent of building materials being wasted, according to one estimate. This places construction, one of the biggest industries in the world in terms of money spent, behind other industries—namely manufacturing—that have optimized production and assembly to make gains in efficiency and reduce waste, thereby increasing sustainability.

Techniques and processes in one industry can help another. Mass production and assembly lines can be used in construction by making walls, ceilings, floors, staircases—even whole room—in safe, indoor settings, with greater precision and less waste than can be done outdoors. With the specialization and repetition of tasks, brought to us with the industrial age and Henry Ford's mass production of automobiles, comes reduced cost, greater uniformity and happier customers with higher profit margins.

We spoke with industry experts at U.S. CAD—Solution Consultant Nick Krey, Technology Consultant and Autodesk Construction Business Lead Aaron Wagner and National Director, Building Design & Engineering Nathan Lamont—to see why there is so much waste and how to reduce it and make project teams more efficient. All three are passionate about this topic and offered significant input on the challenges in this area of the construction industry, and suggestions on how to improve.

U.S. CAD, based in California, started in 1999 as an architecture, engineering and construction (AEC) technology and consulting leader that specializes in Autodesk and Bluebeam solutions.

The U.S. CAD experts agreed that waste in materials goes beyond the physical properties to include people, time and money. What we gathered from U.S. CAD is that reducing waste starts with making teams and projects more efficient, which also leads to time and cost savings. This involves teamwork, including owners; adopting technology, such as software and taking on new design and manufacturing strategies such as Lean construction, design for manufacturing and assembly (DFMA), and integrated project delivery (IPD); in addition to embracing the use of prefabrication and modular construction.

The key thing is to bring these processes and people into the project earlier.

The U.S. CAD experts have backgrounds in architecture, construction management, building information modeling (BIM) and environmental design.

In this report, we will examine the current state of construction, the growing trend of sustainability, the role of people and collaboration, advantages of software tools, Lean construction, indoor, mass production techniques, and examples of people who are adopting new methods and strategies.

THE CURRENT STATE OF CONSTRUCTION

In 2018, the environmental protection agency (EPA) reported in its waste characterization report that 600 million tons of construction and demolition (C&D) debris were generated in the United States in 2018, which is more than twice the amount of generated municipal solid waste. C&D materials included in the report are steel, wood products, drywall and plaster, brick and clay tile, asphalt shingles, concrete, and asphalt concrete. To put this in perspective, demolition represents more than 90 percent of total C&D debris generation, while construction represents less than 10 percent. Just over 455 million tons of C&D debris was directed to next use and close to 145 million tons were sent to landfills.

Another report from ScienceDirect in 2011 pointed out that while it's hard to provide exact figures of construction waste produced on a construction site, it is estimated that waste is as much as 30 percent of the total weight of building materials delivered to a building site.

We asked U.S. CAD to provide some insight on what they are seeing in the industry when it comes to waste.

Nick Krey, Solution Consultant on U.S. CAD's construction team, and U.S. CAD's Lean construction guru, said that what he sees as the biggest contributor to material waste is due to the fact that construction companies don't want to waste manpower, so they make sure supplies are on-site to avoid that.

"The biggest 'X' factor has always been labor as far as winning a bid. You know you can win work, but as far as bringing in work in for the budget number, whatever that happens to be, it is always based on the biggest variable, which is manpower—not only its availability, but its productivity," explained Krey. "If you can put an extra pallet of framing materials or plywood or concrete or whatever and overdo it a little bit, at least you know your crew won't be standing there doing nothing."

"THAT'S GENERALLY WHERE WASTE COMES FROM—NOT WANTING TO WASTE MANPOWER."

NICK KREY, SOLUTION CONSULTANT FOR U.S. CAD

Krey continued by saying that usually it is a case of not wanting to waste the people's ability to continue a process, such as framing a wall or pouring concrete. That's generally where waste comes from, not wanting to waste manpower. So it's tied back to that."

Nick Krey,
Solution
Consultant
on U.S. CAD's
construction
team.



Krey speaks from his background in construction management and experience working mainly on design build, integrated project delivery (IPD) and Form of Agreement (IFoA) projects, which are very sustainable processes aimed at waste reduction in not only materials, but also labor—reducing waste as a whole in the process.

Based in Newport Beach, California, Krey joined U.S. CAD nine months ago, and mainly focuses on the company's MTWO software with a secondary focus on

Autodesk Construction Cloud. He's also the in-house Lean expert, and serves on the Lean Construction Institute board.

Krey said tying manpower to waste is not that hard to comprehend when you consider that most projects are run through one person and waste ends up being an issue due in part to a lack of communication.

"When one individual has the entire project in their head, usually a superintendent, who always means well but as evident in our general statistics in construction there is always going to be overlap... trade stacking, miscommunication, [issues] of when deliveries were supposed to arrive versus when they did. When a floor is going to become available versus when it does," explained Krey.

He continued to describe a typical scenario, "A lot of that is just seen as waste because one day you are supposed to go in and frame classroom B, but instead you're going to frame classroom D. You have to have those appropriate materials. You end up with a congested jobsite that is being mismanaged."

Krey said something to consider when you load a jobsite full of supplies is if the supplies have the ability to be relocated. For instance, having a load of supplies on wheels would be ideal so it can be moved easily for another activity or project.

Another consideration is when materials are being shipped. Is it shipped when the job is actually ready for that part of the project to be assembled, or is it shipped to the jobsite six months early just to have something built to show the owner and incur revenue?

THE CASE OF A CONGESTED JOBSITE

Picture supplies everywhere, people standing around. That's not exactly what you want to show your clients, right? You want to show them progress. Krey said that is the primary reason for overloading a jobsite with materials: to make things go faster and show progress, which can be problematic.

For instance, construction teams often do what is called 'shell building,' which means putting the frame up in order to show progress to the owner, even when things such as the blockouts for electrical, mechanical and plumbing aren't ready. According to Krey, this can lead to change orders and requests for information (RFIs), which costs more money in the end when information like the mechanical, engineering and plumbing (MEP) is not yet available when the frame goes up.

Change orders lead to more costs. Sound familiar?

NOTHING IN CONSTRUCTION IS CHEAP

"You don't have to be in construction to know that it is often a windmill process that gets touched by ten people before it comes back to you. You know that when you submit a \$1,000 RFI, it's going to cost \$10,000 by the time it's said and done," said Krey. "That's kind of the running rule of thumb; nothing in construction is cheap, especially when you have to ask questions."

There is a time and place for questions. But according to Krey, asking questions up front and having the trades work together from start to finish, along with better planning, is the key. That is where the whole idea of Lean construction comes in, along with other types of project delivery methods such as design-build and IPD.

THERE ARE NO STUPID QUESTIONS

Krey provides an interesting perspective on Lean construction. "Lean to me means respect for people," he said. "You don't attack people, you attack problems. There are no stupid questions as long as you ask them."

The Lean Construction Institute states that, "Lean Construction is a respect- and relationship-oriented production management-based approach to project delivery—a new and transformational way to design. Lean Construction extends from the objectives of a Lean production system—maximize value and minimize waste—to specific techniques, and applies them in a new project delivery process."

“People are at the center of Lean Construction. They collaborate within and across teams using foundational Lean principles with the goal of optimizing overall value.” – Lean Construction Institute (Image source Lean Construction Institute.)



RESPECT FOR PEOPLE IS THE CORNERSTONE OF LEAN THINKING

As Krey mentioned, the foundation of Lean is respect for people and the Lean Construction Institute says “Respect for people is the cornerstone of Lean thinking. People transform ideas and materials into final useful value. Respecting the contribution of each individual is necessary to tap this resource. In addition, people are central to the success of Lean project delivery, and the production management-based approach of Lean project delivery encourages all efforts to make transparent and then optimize all processes and flows within design and construction work. Furthermore, by placing people at the center of Lean Construction, we are reminded to prioritize Respect for People and avoid generating the 8th waste, which can be summarized as ‘Unused/Underutilized Employee Talent/Creativity/Intellect/Skills/Potential’ (Bicheno and Holweg, 2009).”

The Lean Construction Institute also suggests that, “Project teams might also find it useful to customize the way they introduce/initially define changes in the application of Lean Construction based upon the composition of their audience.

For example:

Owner

- Expects predictable/reliable delivery; that is, on time, on budget, and at the level of quality in a safe working environment expressed in the project’s Conditions of Satisfaction.
- Requires actively engaged owner participation to continuously define the value proposition.
- Requires owner representatives to commit to making decisions, sharing the “why” with the partners, and fostering a fair, collaborative environment.
- Expects the owner to be an equally participative, accountable team member.

Design partner

(based upon the Lean principles outlined in Lean Thinking by Womack and Jones, 2003.)

- Defines value from the customer's perspective and in their language.
- Organizes all value-adding work in a value stream.
- Makes the work flow in accordance with the needs of the next customer.
- Pulls work from a provider whenever possible.
- Pursues perfection; that is, "What can we do to make today better than yesterday?"

Partner

- Respects the expertise of the build partners and attempts to maximize their knowledge during design and project planning.
- Focuses on productivity and safety.
- Creates more productive trade partners because all constraints have been removed so they can complete work as planned. This minimizes their comebacks (that is, the need to demobilize and remobilize when work cannot be completed as planned), which negatively impacts productivity.
- Produces better safety results among trade partners because work can be completed as planned. When trade workers perform comeback work, they are potentially double- and triple-exposing themselves to unsafe work conditions.

When it comes to people, we asked, "Can't construction teams plan better for the manpower?"

Yes, said Krey. "This is what IPD and design-build looks to bring, which is to bring the builders earlier into the design phase."

He said what often times happens is this perceived value in what people are worth, such as the general foreman and the people in the field that actually do the job, are often overlooked. The problem is that they don't get allocated early enough in a project because they are overbooked and jump from job to job without being able to utilize the design data from the design teams. When they do get to that jobsite, their submittals should be ready for them, their materials already picked, so that they can get to work on schedule and start building, and then move on to the next project.

What also happens is the general foremen or field leads don't get budgeted into a job because it was not budgeted into the job during the pre-construction bidding process. "Negotiating that value is a lot easier with owners on IPD and design-build jobs, because you can say we can spend an extra \$50-60K on staffing upfront, but the job can get scheduled the way it's actually going to get built versus letting the general contractor or superintendent go into a silo in their office and put together a CPM [Critical Path Method] schedule that no one's going to follow, for the sake of having a CPM schedule because it's a contractual obligation. That can happen," said Krey.

He hated to admit it, but the “old ways” of building are still very prevalent, according to Krey, and not everyone is doing IPD or design-build.

**“THE “OLD WAYS” OF BUILDING ARE STILL
VERY PREVALENT- ‘GO BUILD THIS.’ THERE IS
NO FLEXIBILITY TO BE REMOTELY CREATIVE.”**

—NICK KREY

Speaking of old ways, plan-spec in Krey’s opinion is one of the most limiting types of project methods, which is common in governing body-type projects for school districts, airports, etc. “They generally have a set of plans that have been engineered all the way through construction documents (CDs) and design development (DDs) through the city. This gets handed to the planner and they say ‘go build this.’ There is no flexibility to be remotely creative.”

Beyond that, it’s more problematic because sometimes specs are 15-20 years old, so an RFI has to be submitted to get a simple valve replaced that might not even be in the circuit anymore; which can hold up a job that is supposed to be in the works. “It’s not uncommon when you set up these rigid rules,” he added.

The way to go is being creative, yet mindful; the days of designing for the “cool factor” are over.

Expanding on a couple points already mentioned, while there has to be some room for creativity, there also must be some boundaries and you’ve got to think about others and the end product.

CHANGING THE MINDSET AND WORKING TOGETHER FOR THE END PRODUCT

One thing the U.S. CAD experts all agreed on is that the mindset is changing, and people are starting to work together with other trades and the end product in mind—though there are still some challenges.

Krey said he's seen it in the past where engineers were designing for 'cool factor,' but he thinks this is changing.

"I think the pendulum is swinging back, but for a long time it was about, 'How can I put my stamp on this building.' They weren't designing for it to be constructible. They would just put some stuff in there like architectural features. Really cool wall frames that are not repeatable. One-off products that take time and money," he said.

As U.S. CAD's specialty is consulting on design challenges, they are seeing high-level architects starting to design for construction and not just to design for the sake of design. Sustainability is becoming more of a focus in the industry. U.S. CAD thinks processes like DFMA and design for environment (DFE) can help with that, and they are seeing more of those practices being used.

Nathan Lamont, Senior Director for Building Design & Engineering, leads the Building Design & Engineering team at U.S. CAD, comprised of a sales team as well as technical specialists and consultants, out of Los Angeles, California. He said he's also seen a shift towards a more sustainable focus.



Nathan Lamont,
Senior Director,
Building Design
& Engineering at
U.S. CAD.

**"SUSTAINABILITY
AND
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BEHAVIOR IS
BECOMING MORE
GLAMOROUS."**

—NATHAN LAMONT,
SENIOR DIRECTOR,
U.S. CAD

“I think as it relates to sustainability, for instance, there’s a broader social and community context to the role they play,” he explained. “And sustainability—environmental behavior—is becoming more glamorous. Previously it wasn’t given as much recognition, but I think now it’s something people are willing to market and hang their hat on and everyone from consumers, communities, individuals, other partners and commercial partners are putting some priorities around that. But ultimately, it’s interesting because sustainability measures used to be based on what’s good for the environment, but what’s good for the environment can also be good for the bottom line, the longevity of the asset. It’s not just this outlier by itself, where speed to market in the building world is something that is one of the key drivers. The quicker you can have something built and occupied then that’s going to have an impact on budget and revenue opportunities.”

**“WHAT’S GOOD FOR THE ENVIRONMENT
CAN ALSO BE GOOD FOR THE BOTTOM LINE
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—NATHAN LAMONT

Lamont said that previously, owners would put all the responsibility and decision making on their consultants and GCs without taking the lead role.

“What’s changing is owners of these buildings—the developers of these buildings—are more aware, so they are driving some of this whereas previously it was the design community, it was the construction community that were driving it,” he explained.

“So we’ve seen a bit of a shift there. That’s definitely changed in recent times, which is a positive thing and again it is forcing GCs and contractors and design consultants to step up. They don’t have a choice anymore. So the owners are dictating terms, which is something new,” Lamont said.

When we say owner in this context, we’re primarily referring to large projects such as the owners of medical facilities, universities, high-rise apartments, etc., but consumers and/or residents also have a role in the end product and its sustainability. Lamont thinks the consumer-driven demand is also definitely coming into play here.

Lamont added that U.S. CAD also has a role.

“U.S. CAD has a role to play here that isn’t just something people are going to solve or something technology is going to solve. There are a couple of different pieces to this. I think of the rate of change and the rate of adoption. The rate of change for workflow and process, and the rate of adoption of technology, is certainly accelerating and has accelerated significantly in the last 12 months and the couple years leading up to that. I think COVID has increased people’s and business owners’ awareness around what’s available and maybe it’s a little telling on industries’ priorities as it relates to why are they doing it now versus 12 months earlier. But what it comes down to is the

bottom line is everything to any business, to any industry. And I think that's really been the key driver here," Lamont said.

We think Lamont it was correct above, when he said "the bottom line is everything." Cost and speed to market are the main drivers of any construction project.

However, the real bottom line and point of this report is that collaboration among trades, adopting design technology and new project delivery practices can significantly help that bottom line. You can see how IPD can work in favor of a budget. If changes need to be made, the owner can be brought in for approval and you're not confined to the original estimate.

So, whose responsibility is it to reduce waste?

The short answer is that reducing waste is everyone's responsibility, from the designer to the engineer to the builder to the owner, and even the occupier. That brings up a very important aspect to reducing waste, which involves teamwork and collaboration. Yes, reducing waste including the physical, manpower, time and money, is a team effort. Next, we'll look at how technology can help teams with coordination and collaboration.

THE ROLE OF DESIGN, CONSTRUCTION AND COLLABORATION SOFTWARE: EXTENDING BEYOND DESIGN

An important aspect to all of this that can have a high impact on that bottom line is software, which can help project teams achieve efficiency gains and improve speed to market, cost and reduce waste (beyond material waste) in projects.

We brought in U.S. CAD's Technology Consultant and Autodesk Construction Business Lead, Aaron Wagner, to learn about the role of technology for reducing waste in construction and connecting project teams.

Wagner, who is based in Colorado, has a background in architecture, DFE and BIM. His job at U.S. CAD is to advise customers on what software solutions are the best fit, with a focus on Autodesk Construction Cloud solutions.



Aaron Wagner,
Technology
Consultant
and Autodesk
Construction
Business Lead at
U.S. CAD.

Wagner shared this sentiment on the bigger picture of waste, stating that, "Waste is really something that is physical, that is obvious. We have wasted physical product, but then there is also waste that we have to factor in as time, money and waste of information. So everybody on the project contributes to it, and everybody on the project suffers from it. So it can reduce how much profit we gain, how quick we can get out of it, the type of labor that's required on-site, and especially now, with COVID,

we don't want hundreds of people all clustered together during the day, so we have to be more mindful of using less resources; both labor wise as well as physical product in a better, more efficient way."

We asked what he proposes when it comes to reducing these types of waste. His answer was similar to his colleagues'.

"Lean construction is a good start." But beyond that, Wagner suggests utilizing design and construction solutions such as 3D modeling and collaboration software, along with coordination in the various trades and taking advantage of prefab and modular buildings in construction.

Wagner agreed that collaboration is a very important component to get everyone on the same page and keep them there. Collaboration solutions such as BIM 360 Design (now BIM Collaborate Pro) and Bluebeam are commonly used solutions in the industry.

He said it's a common theme for one trade to get ahead of another, so coordination earlier in a project can alleviate that.

This is where solutions such as BIM Collaborate Pro can help. Wagner explained how even though its name emphasizes design, it extends collaboration data beyond the design team. "A lot of trade contractors love it as well. They really get a lot of good use out of it because of the ability to collaborate in real time."

A contractor said it best, Wagner related, "and it's such a great way to say it. He said 'If there's news on a project, everybody knows about it. Good or bad, let me know.'"

Wagner said that with the BIM 360 platform, the different trades can work together on their prefabrication information as well. "They're doing the shop drawings, prefab stuff... getting it all kind of worked out, but within context of each other's data in real time. So, if you did have to make adjustments, people can see the impacts of that and react to it."

Furthermore, the shop people can see what incoming changes are prior to turning on the spooling machines or starting other processes. Another useful tool he recommended is BIM 360 Model Coordination, which can help with clash detection and conflict resolution. "So you can really see by using just the automation tools to where it kind of identifies where these conflicts are, and you can take it really, really far."

With these solutions, you can also get down to the root of a problem and keep track of who does what. "Is this something that is because it's a design deficiency? Is it because of some kind of code compliance thing? What's the driver behind this conflict that we're noticing? Put that in there. You can assign it to someone. Give it a due date. Give it a priority level."

Then you can start tracking accountability to see if a particular company is responsive. Are they early? Are they late? "You get that insight, and then if that rolls into a change order and then because it's an unforeseen circumstance, you can do that all within the same stream. That goes into BIM 360 Build, which is part of a much larger ecosystem. BIM Collaborate Pro is a really good entry point," said Wagner.

"The interesting thing is that historically, in terms of digital data and stuff, construction hasn't really dug their heels into it much," he said. "It's been mostly on the design side where they've really wanted to take the digital ecosystem as a thing, until somewhat recently. Contractors start to see that, hey, there's a lot of good data within the project that's beyond the drawings and shop drawings and our rolled stock cuts and stuff that we can take out on-site. We can actually benefit from this and benefit from reporting it in a more efficient way, and also planning it in a more efficient way."

Wagner said that PlanGrid, Autodesk's field collaboration solution, is also popular for many trades and subcontractors. It is even used at the superintendent level, because it makes it easy to take digital copies of the drawings to site, bridging the gap between the office and field. With PlanGrid, users can do markups, drop photos in, plus if they see any errors that somebody needs to be notified about, they can do it all right there on their mobile device.

"They don't have to make a bunch of notes on a yellow notepad, hand it to a project engineer, and the project engineer now has the very arduous task of making sure everybody knows, collecting all this data from all these different resources and then distributing it," said Wagner. "That role is pretty much alleviated with these tools."

MAKING THE CASE FOR CHANGE

As we mentioned earlier, the old ways of doing things are still prevalent.

Wagner said the superintendents and foremen who are used to carrying around an 11x17 drawing in their pocket and handing it to their crew still exist. They are the hardest to convince at first.

“They get an 11x17 when they first bid on the project, and that’s what they live by. To them, that’s gospel until somebody tells them otherwise,” he added. “But once they see, wow, my job is so much easier with this digital tool, it’s really hard to get them to let go of it.”

It is easy to see how working solely off paper drawings can lead to issues. “If they go and build off of that [drawing], and there’s other things happening in the project elsewhere that affects that 11x17 they’ve got in their back pocket this whole time, they don’t know until somebody prints them out a new one. Now we’re introducing waste because somebody has to do some rework. So having a digital copy of that in their hands is way more efficient,” Wagner explained.

For instance, if you need to change the size of a duct to fit through a tight corridor, or need to make changes, the engineer can advise on what that new size should look like or if they should implement a new system.

Wagner said coordinating a job with everyone can also be a nightmare.

As he described it, “It’s the worst when you’re building something and start to get through it, and then you try to coordinate things with the general contractor or the construction manager, and you’re trying to coordinate everybody’s time and get people sequenced on-site to install things. Then some people are eager to get things done ahead of time. Other people just kind of want to get to it when they can. Then there are people that are probably the most reliable where they’re just like, tell me the schedule, tell me the things that I need to produce, and I’ll fit it in according to that.”

But he said the “worst thing in the world” is when you do have this well coordinated plan and when people start to go on-site and bolt it all together, none of it fits or they have to do changes right there in the moment. They have to call the architect and say, ‘Hey, this beam is in the way of where we need to hoist the elevator, or we need to put an air handler here.’ There’s not enough ceiling space for somebody to walk under it. Okay. So let’s cut it all out. Let’s re-engineer it, and let’s go back there and install it in two months. Ouch.”

If you had things more coordinated ahead of time, you can save yourself headaches and that financial burden.

Smaller shops can take advantage of software, too, and get involved in these larger projects by being a little bit more sophisticated, said Wagner. “There’s not a ton of upfront cost there. Obviously, whenever you do change the workflow, there can be some cost adjustments. But for the most part if you get involved early enough, usually on the digital side, and you do communicate with the other trades, you can share that information with the suppliers.”

Wagner expressed the importance of how 3D data can also be beneficial for prefab and building, or for manufacturing off-site in factories or warehouses, and how you can extend that data downstream for these both of these approaches.

For instance, companies can take their 3D data and do conflict resolution within models to make sure things aren’t going to run into one another, or use the data to manufacture walls, panels, staircases, etc.

USING DIGITAL DATA FOR MASS PRODUCTION AND BUILDING OFF-SITE TO CUT DOWN ON WASTE

Construction is the most expensive process, other than operations, and contributes to the most waste on the physical side. Taking advantage of prefab or modular construction can help reduce this waste. For starters, off-site fabrication can eliminate manual labor on-site such as cutting materials, which helps reduce waste. “Basically, you want to eliminate as much site-cutting as early as possible within the digital realm,” said Wagner.

He said some of the contractors have gotten really good at preparing materials in a warehouse beforehand. “They show up on-site, bolt it all together with far less crew members, leave, and they’re done with it,” he added. “[There’s] not a lot of site cutting involved, so it’s safer. A lot of the physical waste is really reduced, and then the reduced manpower. That all leads to cost savings across the board.”

You might be thinking this sounds expensive. In the long run it leads to savings and overall safer practices as mentioned above. So why isn’t there more adoption of these technologies and prefab practices?

Wagner thinks that it is in part due to a fear of technology, especially for superintendents that started out as apprentices and worked their way up to journeymen. “They were taught the way they were taught with a saw and hammer, to use the drawings, pull the tape measure out. That’s how you build,” he explained. “So, trusting a computer to help them with that is really scary territory for them.”

And yes, cost is a factor. He said the upfront costs do tend to be higher, so it’s best to have a factory plant or at least a warehouse. “You need to have a warehouse to stockpile this,” added Wagner. You need to have systems that can produce this, but oftentimes it’ll pay for itself within a project or two, depending on the size of the project.”

He’s also seeing production of materials on-site where you produce only what you need. One example he gave was a prefab machinery device that produces light gauge steel, where you can frame up a 3D model in the computer, put it into the device, then place on-site where the installers for drywall can come get a bundle of the light gauge steel that’s produced out of the machine. “The bundle is all coded, it’s dimpled and ready to install. Once that bundle is bolted together they can go grab another bundle that the machine has just produced,” he explained.

So yes, the machine Wagner spoke of is expensive; it's a half-million dollar machine. However you're spending less on material, less on labor, and then you're spending less on resolving inaccuracies and conflicts.

He suggested that for smaller companies who don't have that type of budget to try to have a warehouse to build a stockpile. This can reduce on-site labor and manpower, which is also helpful during the pandemic.

"If they can at least get a warehouse or rent a space to kind of have a stockpile off-site, then they can take this data that's already been vetted," he added.

Wagner said teams like U.S. CAD can definitely help to produce 3D data. "Then shops can pre-assemble the wall panels or floor systems or things like that, and then they just truck it to site and install it. You can do it all on-site, but you're not really going to benefit too much because then you're going to have to sit out there and cut it while on-site, even if you're using the 3D models. There's less chance they will use any kind of 3D content. So they can still benefit, if on a smaller scale."

He mentioned a company that can take your design data and assemble complete modular rooms. DIRTT uses technology and sustainable construction to manufacture modular and custom prefab components, including complete interior spaces. They can build in your systems and utilities into the spaces, including electrical, piping, low-voltage, medical gas, and more.

PREFAB AND MODULAR BUILDINGS ARE ON THE RISE – THE HIGH-RISE

All three of the U.S. CAD experts pointed out that they are seeing more use of prefab and modular construction, and spoke about the benefits of these techniques for reducing waste and increasing project efficiency.

Data from the [Dodge Data & Analytics Prefabrication and Modular Construction 2020 SmartMarket Report](#) supports what the U.S. CAD team is saying—that prefabrication and modular construction techniques are on the rise. About 90 percent of report respondents, who include architects, engineers, GCs/CMs, trade contractors and modular builders/manufacturers have achieved improved productivity, improved quality and increased schedule certainty when using these methods compared to traditional stick-built construction. Plus, reduced waste generated by construction was also a key benefit, along with safety. 81 percent of respondents using prefabrication and 86 percent using modular construction reported savings in reduced waste generated by construction.

One breakdown on modular construction alone showed savings in waste reduction as follows:

- Modular builders/manufacturers at 56 percent;
- Architects/engineers at 23 percent;
- GCs/CMs at 27 percent
- And the various trades at 24 percent.

So, not only are construction sites greener due to less waste being generated using prefabrication and modular construction, but they are also safer according to this report. 79 percent of respondents using prefabrication and 83 percent using modular construction said they saw improved safety performance.

Other benefits cited included improved cost predictability and increased client satisfaction.

Interestingly the SmartMarket Report study also looked at the positive impact of BIM on the budget and schedule performance when using prefabrication or modular construction. Findings showed that less than a quarter (22 percent) of respondents who report using no BIM claim that they experience schedule performance improvement from the use of prefabrication, whereas the companies that use BIM on half or more of their projects are a significant majority (61 percent) and cited improved schedule performance.

On the modular construction side, 21 percent of non-BIM users reported cost performance improvements compared with 46 percent of those using BIM frequently.

Benefits From the Use of Prefabrication and Modular Construction (Percentage of Users Citing Medium, High or Very High Levels)

Dodge Data & Analytics, 2020

■ Prefabrication
■ Modular Construction



Benefits of Using Prefabrication and Modular Construction.
(Image source: Prefabrication and Modular Construction 2020 SmartMarket Report, www.construction.com.)

The general forecast indicates that using these approaches is on the rise, however not everyone is on board. The SmartMarket Report stated that contractors report that architects and engineers are not enabling prefabrication and/or modular construction in their design. Design professionals state there is a shortage of prefabrication facilities within the vicinity of their project sites, in addition to owners' lack of understanding of the value of modular construction, as main reasons they do not use these approaches in projects.

U.S. CAD shared similar sentiments, Lamont said. "If you would have mentioned prefab or modular five years ago, a designer would laugh at you. They would never have something that is modular, especially an architect. It's just outside of the scope of an architect, it's below them."

Lamont said with today's manufacturing techniques, however, most people wouldn't know the difference whether it's a one-off product or prefab. He said with the quality of prefab and modular products, it's hard to tell if it's a bespoke design and construction technique or one that's been made 120 times in a factory.

Does that matter? If it's good for the overall quality of a project and the environment, it really shouldn't.

Summing up some of what we learned above, there are seven key benefits of prefab and modular construction approaches that won us over and should be considered for your next project:

1. Improved Cost Predictability
2. Improved Productivity
3. Improved Quality
4. Improved Safety Performance
5. Increased Client Satisfaction
6. Increased Schedule Certainty
7. Reduced Waste Generated by Construction

PREFAB VS. MODULAR

Popular building types utilizing prefab and modular approaches include healthcare facilities, hotels and motels, multifamily, college buildings and dorms, offices low-rise and high-rise, schools, retail stores and shopping centers.

Before we get into some examples of these buildings, let's look at the differences of each.

Prefab products are primarily made off-site in a factory, before being assembled on the construction site, and include light gauge steel, flat pack and steel frame. Prefab units may include doors, stairs, window walls, wall panels, floor panels, roof trusses, room-sized components and even entire buildings.

Modular buildings are structures that are at least 70 percent prefabricated. Modular construction looks a bit like stacking LEGO blocks where containers are made almost entirely in a factory, and sometimes include wiring and fixtures that are pre-fitted.

Structures built with shipping containers may come to mind when thinking of modular construction; however, there is a big difference between building with shipping containers and modular system containers. Though both are forms of modular construction, and shipping container buildings are sometimes mistaken for those made from modular system containers, modular system containers are manufactured in factories.

Shipping containers are considered a form of modular construction, and usually consist of stacking existing repurposed/recycled shipping containers.



**Shipping
Container
Development
Green Jeans
Farmery and
Food Hall,
Albuquerque,
New Mexico.**

(Image
source [www.
greenjeansabq.
com](http://www.greenjeansabq.com).)

AEC INDUSTRY LEADERS EMBRACING TECHNOLOGY

All three U.S. CAD experts provided examples of leading AEC industry professionals using the industry trend prefab and modular construction and taking advantage of software solutions.

One healthcare facility provider they praised who is utilizing prefab and modular techniques is Kaiser Permanente out of Oakland, California. One project where they took such an approach is on the Kaiser Permanente Hesperia Medical Office Building, located east of Los Angeles, which opened in January of 2021.

The 54,000 sq.ft., three-story medical office building consisted of a large amount of prefabrication utilized by McCarthy Building Companies to drive cost, quality and schedule performance. BIM was also used for coordination and the project was under an IPD contract.

Lamont mentioned Steinberg Hart, based in California, is also doing some great things around modular construction.

Kaiser Permanente's Hesperia Medical Office Building Hesperia, California. (Image source Kaiser Permanente.)



Linwood Modular Housing by Steinberg Hart, Los Angeles, Cali. (Image source Steinberg Hart.)



Wagner mentioned he worked with a customer Hensel Phelps, who has a sustainable design focus, taking advantage of collaboration software and making sure that all the data is in one place for everybody.

[Hensel Phelps](#) is also experimenting with robotics technology from Boston Dynamics, maker of mobile robots, so they're definitely a company on the forefront of technology.

Wagner also mentioned a subcontractor that U.S. CAD works with work with which has every part of their business on BIM 360, even their human resources (HR) forms. "We helped them get their W-4s and all that type of stuff into the system, so when they hire a new sub, they invite them to a BIM 360 project. Okay, here's your data, fill it out, give it back to me. So then their entire business is in one ecosystem."

YOU TOO CAN LEAD BY EXAMPLE AND BECOME A GAME CHANGER IN THE CONSTRUCTION INDUSTRY

For starters, begin embracing these new approaches outlined throughout the report.

Also, start thinking about the future. Krey said the aging workforce is an issue that everyone in construction is fighting against. “The average age of senior field management is bumping up three years a year, every year, so they aren’t getting any new blood or they are not getting people to stay, which will be a long term issues.”

“The way some people like U.S. CAD have to answer that, or the way we can bring benefit and value, is by powering through technology and software platforms; you know, standard processes—a better way of utilizing existing staffing. You’re not going to be able to just go get another foreman, but if you can bring a project engineer up to speed a lot quicker on where documents are, knowing the right documents are in there right place at the right time in the right hands, and the managerial high-level stuff to just keep flowing information back and forth between the field and to the powers that be, that’s where we can bring the most value to address. Where we’re going to get a shortage of labor and it’s going to be hard to address.”

The mindset has to change as well.

Krey talked about how the status quo is U.S. CAD’s biggest competitor in the construction industry. “There’s something about construction where everybody is somewhat proud of the fact that this is the way we have always done it. There are the people on the cutting edge, the ones in the world who are trying to change how things are done, but then there are the 80 percent who are still doing things the way they’ve always done and don’t see the need for change because they’ve seen success that way.”

“As a whole, people need to be less comfortable with the status quo and realize that as an aging workforce we need to attract young talent, of which most grow up with computers. So, if we’re going to keep doing things the old way, with plan and spec, with a set of drawings, you’re not only going to lose your back-end workforce, you’re not going to bring in the next generation.”

“Hopefully the stigma of trade schools gets lifted and college is not the only answer,” he added. “We need a workforce and an influx of physical labor.”

Educating people on what’s available or possible with regards utilizing technology for different delivery methods, and taking a more holistic approach, is where U.S. CAD can help.



