

Can 3D Printing Help Address the Affordable Housing Crisis in the United States?

The construction is faster, cleaner and more affordable, but experts acknowledge some trial and error is needed



One potential tool to combat the growing affordable housing problem, which the National Low Income Housing Coalition says has grown to a need for more than 7 million homes, is 3D printing.

Lennar/Icon



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On a narrow, empty lot behind a sign that read “Habitat for Humanity: Live Life in 3D,” Sierra Romas watched as a nozzle on a gantry that moves on rails poured concrete layer by layer—166 in all, each less than an inch high—to build the walls of her three-bedroom house.

“It was amazing, very surreal to see a machine doing everything,” she says on a winter evening, sitting in the living room of the finished home she shares with her two sons.



That surreal 3D-printed home built and sold to Romas in Newport News, Virginia, offers one potential tool to combat the growing affordable housing problem, which the National Low Income Housing Coalition says has grown to a need for more than 7 million homes.



The Habitat for Humanity Peninsula and Greater Williamsburg chapter in Virginia has built three 3d-printed houses. jimmor12/Habitat for Humanity

Concrete printing is faster—the walls for Sierra’s 1,300-square-foot home were constructed in about 40 hours. It’s also becoming cheaper than conventional wood-frame building, which has changed little in a century.

Romas’ home is the third that the Habitat for Humanity Peninsula and Greater Williamsburg chapter has built. Janet Green, the chapter’s chief executive officer, says each home has been less expensive than the previous. Sierra’s cost Habitat about \$215,000, which amounted to \$25,000 less than the first one; the land was free from the city’s housing authority. “We suspect the eventual cost to print future 3D homes for Habitat would be around \$180,000 to \$190,000,” she says. These days, the average listing price for a home that size in Sierra’s area is over \$260,000.

Other benefits exist beyond speed and affordability, too. Construction is cleaner, resulting in less waste. (The United States creates 600 million tons of construction and demolition debris annually.) The 3D-printed homes are more energy-efficient because concrete offers better insulation, lowering heating and cooling costs. They’re also far less likely to burn or be blown down, potentially reducing insurance costs. The automation of printing walls and sometimes foundations requires less labor—3D printers can work with only one or two people—at a time when there is a shortage of construction workers.



Alquist 3D is a construction firm that buys or leases printers. So far, the company has only printed straight exterior walls. Alquist 3D

As 3D housing has slowly gained momentum, proponents say it will be a new way to offer people like Sierra, an Army National Guard veteran, homeownership.

Alquist 3D, the company that printed the three Habitat houses, moved its headquarters from Iowa to Greeley, Colorado, last year, enticed by \$4 million in incentives from the city and state. There, the outfit plans to build 100 homes as part of a 300-home Habitat for Humanity project. It’s also working with Aims Community College to create a 3D-printing curriculum, training workers who will be needed to grow the technology’s reach.

The biggest entrant into the 3D-building market is Texas-based Icon, which has more than 400 employees. Icon is working with Lennar, the second-largest home builder in the United States, to print 100 houses in a 500-unit development with architecture co-designed by Bjarke Ingels Group outside Austin, Texas, where housing costs have skyrocketed. The median comparably sized Austin-area home lists for over \$800,000, but these units are currently priced between \$469,990 and \$578,990. Exterior and interior walls for each of those homes were completed in two weeks and the traditional finishing in about six months. Residents recently moved into the first of the homes sold. “We’re introducing drastic time saving, which of course translates into a huge value add in terms of costs and financing,” says Melodie Yashar, Icon’s vice president for building performance and design.

one or two people on site.

“We’ve only been 3D printing in America for about five years. It’s still very new. Nobody’s doing it perfectly,” Mannheimer says. “It’s a constant learning process every time we do this. I suspect that won’t change for probably the next 20 years.”

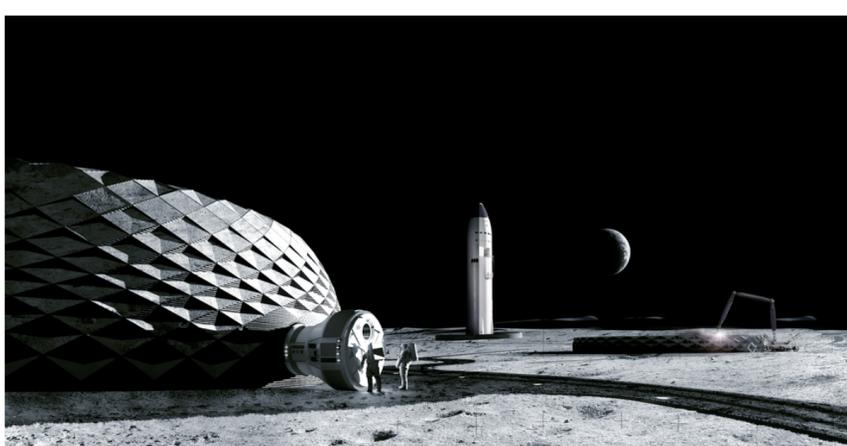
Andrew McCoy, director of the Virginia Center for Housing Research at Virginia Tech, got involved with the three Habitat homes in Virginia after publishing a study showing the state needed 275,000 new homes but was only building 20,000 a year. The university is working with Habitat to monitor the energy efficiency of the homes, and, so far, they are exceeding expectations.

McCoy says market conditions present an opportunity for 3D printing. “We’re in a unique position where borrowing money is expensive right now. We have a hard time finding labor. And when we do, we have to train them and get them up to speed,” he says. “Material costs are really high. The length of time from when we start work to when we get a client into a building has expanded. All these things lend nicely toward a technology like this.”

McCoy notes the building industry needs to be convinced to change the way it’s been raising homes for more than a century. Rather than present construction companies with a concrete printer as an end solution, he wants to engage them in the development of the product to match their needs. “They know the path that got them here,” he explains. “It’s been successful so far—why change that up? So, we want to get in there and say, ‘Look, let’s put this in front of you. How would you use it? How would you like to work with it?’”

Ask proponents when the process will become widespread and the answer is years, anywhere from 2 to 20. McCoy says the Icon project in Texas with Lennar could show builders this is the way. But he’s also not convinced 3D concrete printing is the future. That future might be a combination, including 3D metal and plastic printing of building components that will also save time and money and be easier to access.

The present technology—lumber-framed homes—has evolved over more than a century. Give 3D printing time, McCoy says. “For some reason, we want these things to work out of the box and make money for everybody instantly, and it just doesn’t work that way,” he adds.



Icon landed a \$57 million contract with NASA to work on moon habitats. [Icon](#)

One company that is exploring printing home components is Mighty Buildings, which has a \$5 million grant with the Lawrence Berkeley National Laboratory and Habitat for Humanity to develop sustainable and affordable housing in the San Francisco Bay Area. It is also building net-zero energy homes in a couple of California communities. The company, which has raised \$150 million in funding, supplies a kit of 3D-printed wall panels, doors, windows and roof sections that can be assembled in four days.

“A big benefit for developers is that we shrink the time they need to pay interest on construction loans,” says Alexey Dubov, one of the company’s founders. Its process also addresses the climate crisis. Mighty Buildings’ synthetic stone material uses recycled glass, and the highly insulated homes it builds, with solar panels on their roofs, mean they may produce as much energy as they use.

Will 3D printing for construction gain wide acceptance? Mannheimer is cautiously optimistic.

“There’s two answers to solving this problem of housing. One is: Companies should pay their employees more to afford the rising costs, which, of course, we have no control over,” he says. “Or we have to lower the cost of the materials in the process. Or ideally both. That’s the only solution. So, I think 3D is going to get us there in the next couple of years. But there’s a lot more trial and error that we need to go through.”

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Jim Morrison is a freelance writer whose stories, reported from two dozen countries, have appeared in numerous publications including *Smithsonian.com*, *the New York Times*, and *National Wildlife*.

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