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# 3D printing now rolling out artificial reefs



By Matt Bokor

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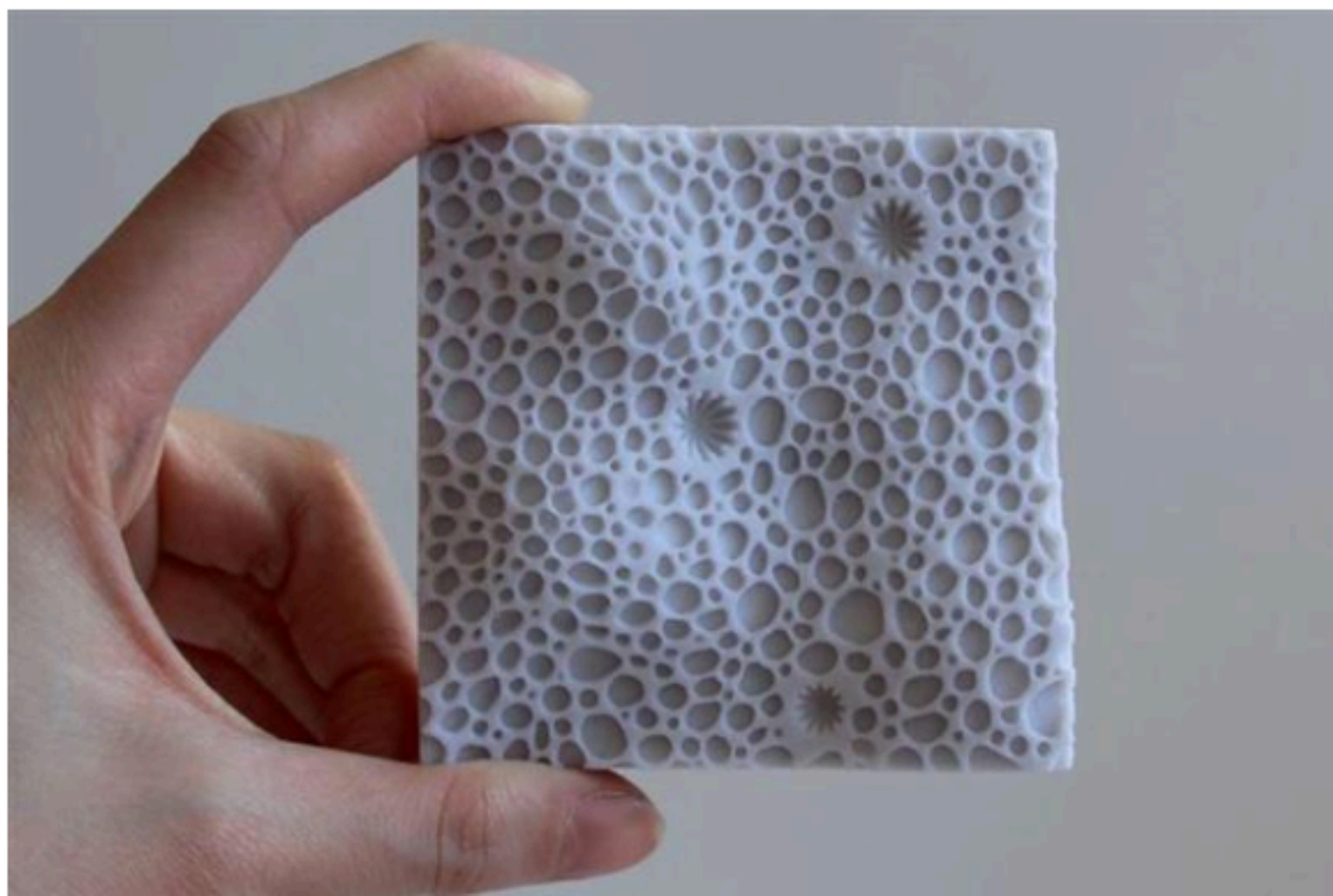


Ocean conservationists are turning to 3D printing to create coral reefs and restore underwater sea life.

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Changing the face of production around the world, 3D printing has carved out a new, undersea niche in the form of artificial coral reefs with the same shapes and colors that attract coral larvae.

The Caribbean island of Bonaire, long at the forefront of coral reef protection, recently formed a partnership with ocean conservationist Fabien Cousteau and an island resort to use 3D printing for reef expansion and restoration.



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Monaco and several Persian Gulf states report initial success with the same technology for reef growth, though mid- and long-term results are not yet available because of the projects' early stages.

"The success of preliminary efforts is what has encouraged me to look into this as a potential arrow in the quiver to restore reef ecosystems," said Cousteau, grandson of the late undersea explorer Jacques Cousteau. "Although all of this is a brand new endeavor, 3D coral printing does hold promise or we wouldn't be experimenting with it."

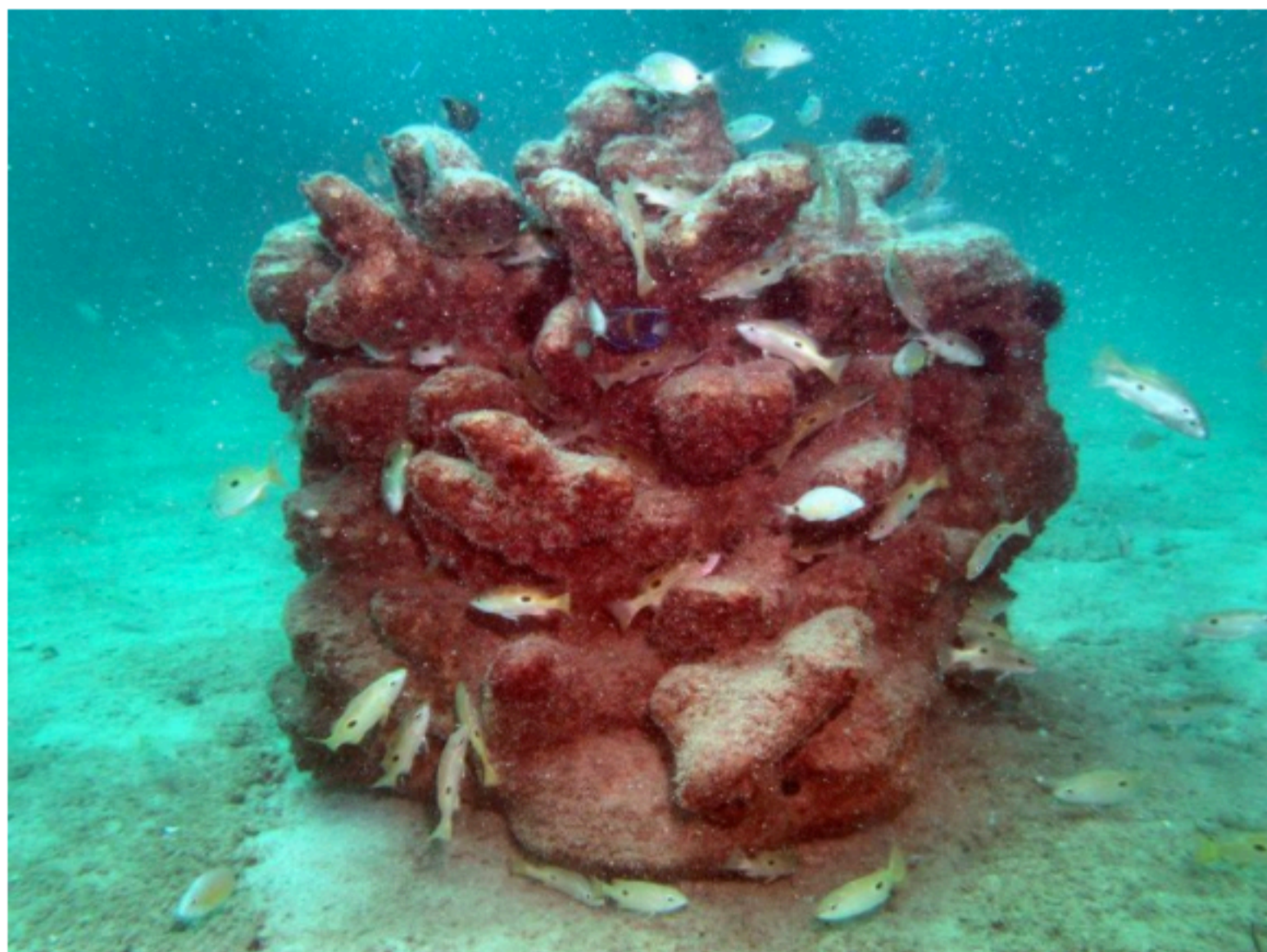
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Developed in the mid-1980s, 3D printing has mushroomed in recent years, and is now used to create things like auto and aircraft parts, prosthetics, artificial organs, smartphone cases, fashion accessories and even castles.

## Like a rainforest for sea life

With coral reefs in global decline, marine scientists have been seizing on today's unprecedented innovation, technology and information sharing to find new ways to promote reef growth and reduce threats.

Covering less than 1 percent of the Earth's surface, coral reefs are like a rainforest of sea life, Cousteau said, estimating that roughly 70 percent of all marine life depends on them. Coral reefs also account for a staggering \$6.7 trillion of global economic development, he added.



"Opportunities have never been better to marry environmental responsibility with economic health for a mutually beneficial outcome," Cousteau said. "Bonaire is in a prime position to enhance reef growth because it has so many natural, healthy reefs already. Our initiative with 3D printing will rapidly assist us in revitalizing more stressed or damaged areas."

### **Cousteau said advantages of 3D technology for reefs include:**

- Reducing plastic and chemical materials used for coral restoration.
- Creating aesthetically pleasing shapes that blend into the environment.
- Mimicking coral and improving recruitment of coral polyps and other organisms.

## Polyps' choice: pink, white and safe

In her [TED talk](#) last fall, marine biologist Kristen Marhaver, Ph.D., said she and fellow researchers used 3D printing to see what sizes, colors and textures would best attract free-floating, baby coral polyps looking for an anchor.

"We found that corals ... still prefer white and pink, the colors of a healthy reef. And they prefer crevices and grooves and holes, where they will be safe from being trampled or eaten by a predator," said Marhaver, based at the [CARMABI Research Station](#) on the island of Curaçao, which is 45 miles from Bonaire.

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Researchers say 3D printing recreates these traits, which are far more compatible with natural surroundings than old ships, construction debris and other materials that have been sunk to create artificial reefs.



According to the [Reef Design Lab](#) in Australia, the world's first 3D printed artificial reefs were deployed off Bahrain in 2012 and quickly began attracting microorganisms, followed by fish that feed on them. The reefs, consisting of hundreds of boulder-sized orbs, were developed by Reef Design Lab co-founder David Lennon, Sydney architect James Gardiner, 3D-manufacturing company [D-Shape](#) in Italy, and [Reef Arabia](#) in Bahrain.

To bring a similar project to the southern Caribbean, Cousteau expanded his nonprofit [Fabien Cousteau Ocean Learning Center](#), based in New York, with a satellite location at the oceanfront [Harbour Village Beach Club](#) in Bonaire. The artificial corals will be made of sandstone and limestone and will be placed just offshore from Harbour Village, which has a long history of conservation efforts.

"We know 3D printing efforts have worked in Monaco and the Gulf States among others," said Eric Ewoldt, executive director of Harbour Village. "With the development of our Fabien Cousteau Ocean Learning Center, now is the perfect time to launch this technology in Bonaire."

## Almost endless possibilities

While experts scour the seafloor to find the best sites, crews are already printing tiles for coral nurseries and several types of structures, Cousteau said.

"Because of the almost endless customization possibilities for 3D printing, structures could be made in quite a variety of sizes," he said. "Installing corals underwater can get unwieldy, so sizes are determined more by this factor. Ten-to-30 centimeters tall (about 4-12 inches) are easier for our volunteer divers to maneuver."

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The shapes will vary but will closely resemble the natural reef, he added. "Nature perfected her chemical soup over hundreds of millions of years. We don't presume to trump her."

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About Matt Bokor 

Matt Bokor is a freelance writer living in Santo Domingo, Dominican Republic.