

# Autodesk and the pursuit of bio-inspired 3D printing

Barbara Grady

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Resin from an apricot tree. Autodesk is joining with UC Berkeley to study how nature makes resins that harden into high performance solids.

Autodesk changed design in the manufacturing and building industries decades ago by introducing AutoCAD desktop design software.

Now, as 3D printing emerges as a new way to prototype and even manufacture things, the software maker is angling to play a pivotal role in many ways, as hinted at by its introduction of [Spark](#), an open-source software platform for 3D printing.

One role Autodesk is engaged in, along with several other institutions, is trying to steer the nascent 3D -printing industry towards more environmentally friendly and sustainable ways than the traditional manufacturing it may replace.

Already, [3D printing](#) — or additive manufacturing as it is called at a larger scale — is characterized as a more sustainable way of producing objects. According to the U.S. Department of Energy, 3D printing [uses less energy](#) than factory manufacturing, and creates less waste by printing and depositing exactly the shape of something needed, rather than shaving off or molding a shape from a block of an ingredient, which often leaves unused byproduct. 3D printing also could reduce transport and packaging of goods because objects can be printed near where they are needed.

But there's still the question of the core ingredients of 3D printing — the material upon

which a design is printed and which is then layered to make objects. In most industrial 3D printing applications today, what's used are stereolithography (SLA) resins, or petroleum-based synthetic resins which become solids after light and extreme heat are applied.

The SLA resins themselves, as liquids, are hazardous, fossil-fuel-based materials. They are toxic to marine life so can not be disposed of in drains. Could there be a better, more sustainable material?

That is the question Autodesk is asking along with the [Biomimicry Institute](#) and the [Berkeley Center for Green Chemistry](#) at the University of California at Berkeley. The three organizations have joined together in this quest.

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"One thing people don't realize is that, in the material world, there's a limited set of materials available for this purpose," said Dawn Danby, senior sustainable design program manager at Autodesk, explaining the endeavor.

"There's a lot of discussion about 3D printing — that it could be more energy efficient, cut down on waste, etc. We hope to move the sector in that direction. But there's a limited number of polymers."

Shalom Ormsby, 3D-printing user experience manager at Autodesk, said that in this partnership, the company is trying to expand the understanding of the number of possibilities for stereolithography resins.

"We are looking for more bio-friendly materials. Can it be sourced with components that are derived from more natural substances? Can we look at biomimicry and how nature prints? After all, nature has been printing for billions of years. ... It is more than picking up inspiration from nature; it is looking at polymers that nature uses to make things."

In examining how nature has constructed certain materials, and the performance of those materials in handling stresses and loads, there just may be clues. But the resin that is the core ingredient of today's 3D printing continues to be the stumbling block toward sustainability.

That's where biomimicry comes in. If nature has figured it out, it offers lessons to be

learned. The Biomimicry Institute defines it as "an approach to innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies."

The search for a better resin or building block for 3D printing starts with definitions of what a sustainable alternative would be. "Does it mean safe and not readily absorbed by other living things?" Danby asked. "What safe means is very specific and technical."

The search and innovation process could fill the last piece of the puzzle to make additive manufacturing truly an earth sustaining technology.

"The business case for sustainable 3D printing is really clear," because of the energy savings, material savings, transport and packaging savings implicit in its use, Danby said. But if it still requires petroleum-based inputs and still creates products that, at the end of their usable life, are not recyclable, then it has not lived up to its potential, she said. "The work I do in sustainability is highly tied to making 3D printing better."

## To market?

When asked what solutions are being put forward in its work with the Berkeley Center for Green Chemistry, Danby and Ormsby become silent. Instead they speak about the passion and knowledge the graduate students bring to the task.

Danby said an amazing example they found in nature is the beak of the Humboldt squid. The beak is hard enough for the squid to sever bones in its prey but it must have been formed from gelatinous material because the rest of the squid is.

But when asked if any of the research could eventually lead to commercial products, the Autodesk team said it will not be making any announcements.

**The ultimate goal is to identify promising avenues for the development of high performance materials that are safe for people and the environment.**

"There are definitely people working on this. People are coming up with bio-based materials," Ormsby said.

The Berkeley campus is sprawling, known for its world-class engineering, business, public health schools and science departments. It is often classified as the world's top research university, and any number of startups have emerged from its campus. Berkeley has

numerous entities that facilitate the transition of its research from lab to commercialization, such as the [Skydeck Incubator at the Lester Center for Entrepreneurship](#).

Students in the Berkeley Center for Green Chemistry's "greener solutions" class who worked on 3D printing come from all different areas of study within the university: engineering, physics, chemistry, environmental sciences, business, public health. Most are PhD candidates.

Executive Director and instructor Tom McKeag, who happens to write the [biomimicry column](#) for GreenBiz, said additive manufacturing is an ideal topic for all these disciplines to improve upon and try to perfect.

"There's great opportunity there," he said, explaining that additive manufacturing, if done right, presents the possibility of furthering the circular economy when regenerative materials are used and nature-inspired regenerative design. If they can find the right material or invent something that mimics what is used in nature and is not harmful, "then that puts the industry ahead. Not to be forgotten is the potential for profitable innovation that looking to nature brings."

The PhD science students and masters in business and public health, working in teams are tasked specifically with "using biomimicry as a lens for sustainable material innovation," according to Autodesk. "The ultimate goal is to identify promising avenues for the development of high performance materials that are safe for people and the environment."

## 3D's holy grail

That could indeed be something of a holy grail within 3D printing — identifying or developing high performance materials that are also safe for users and the environment.

"There is quite an alignment between bio-inspired design and the capabilities and exciting possibilities of additive manufacturing," McKeag said.

As Michael Pawlyn, a British architect who gave a TED talk on biomimicry, said, "You could look at nature as being like a catalog of products, and all of those have benefited from a 3.8 billion year research and development period. And given that level of investment, it makes sense to use it."

For sure, there's a movement afoot for bio-inspired additive manufacturing, in recognition that manufacturing uses so much energy and causes significant amounts of greenhouse-gas emissions. We are at a time when nations and economies are trying to figure out how to rein in factory emissions, unlike in the 19th and early 20th centuries when manufacturing took hold in the Western world.

"The additive manufacturing industry can learn a lot from bio-inspired design and has already — such as efficiency in material use and energy," McKeag said. "GE, for example, started making certain airplane parts a few years ago using additive manufacturing rather than casting or machining. These parts had been redesigned using the biomimetic principle of placing more material at stress points and shaving it away where not needed. This not only saved material and energy costs at the plant, but jet fuel costs in planes that were lighter, but just as strong." Often this process results in other savings, such as time not spent inventorying lots of little parts that are no longer necessary.

Still the question remains: "How can we influence the growth of additive manufacturing so we don't make the same mistakes we did the first time" in manufacturing?