THE SUSTAINABLE INNOVATION MBA

GROSSMAN SCHOOL OF BUSINESS
UVM's 1 YEAR MBA

3D-Printers and Maker-spaces

Improving Health and Environmental Sustainability through Voluntary Standards

ENVIRONMENTAL LAW • INSTITUTE®

Preface

This report is the culmination of a three-month investigation into the nature of 3d-printing with regards to potential social and environmental implications. Three graduate students from the Sustainable Innovation MBA program at the University of Vermont teamed up with members of the Environmental Law Institute to identify these implications and offer recommendations for sustainability within the specific sector of maker-spaces in the 3d-printing industry.

The Sustainable Innovation MBA is UVM's one-year MBA program that is focused on creating businesses that are inherently focused on social, environmental, and financial sustainability. The Environmental Law Institute is a non-profit, non-partisan organization based in Washington, D.C. whose mission is to create "a healthy environment, prosperous economies, and vibrant communities founded on the rule of law".

ELI recognizes the unprecedented growth in the 3d-printing space, and brought in the SiMBA team to find out what challenges to human and environmental health this growth could present in the future. We conducted significant online research and conducted interviews with experts in the industry to identify a niche audience for whom our sustainability recommendations could have real impact. Community maker-spaces were found to be exploding in popularity around the United States, and also seemed to be the space where the average person would be most likely to interact with 3d-printing.

The recommendations that follow are easy to understand, grounded in real research, and completely attainable by anyone operating or managing a maker-space in a community or educational environment. It is our hope that the information in this report will make its way to many maker-spaces around the country and the world, and many small steps towards sustainable operations will compound into a large and wide-reaching positive impact. For more information, see the accompanying technical paper that was compiled for ELI.

Produced by Adam Figueiredo, Meg Nadeau, and Joseph Humes.

3D-Printing:
An Overview

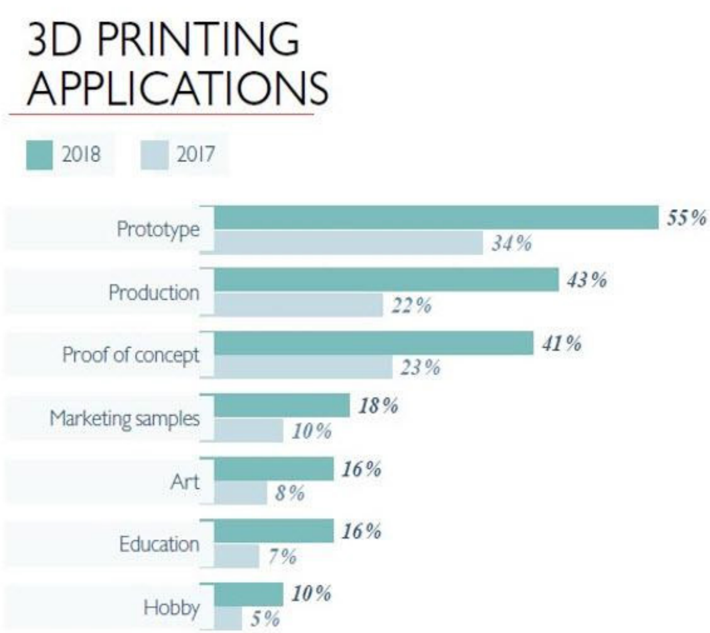
DID YOU KNOW?

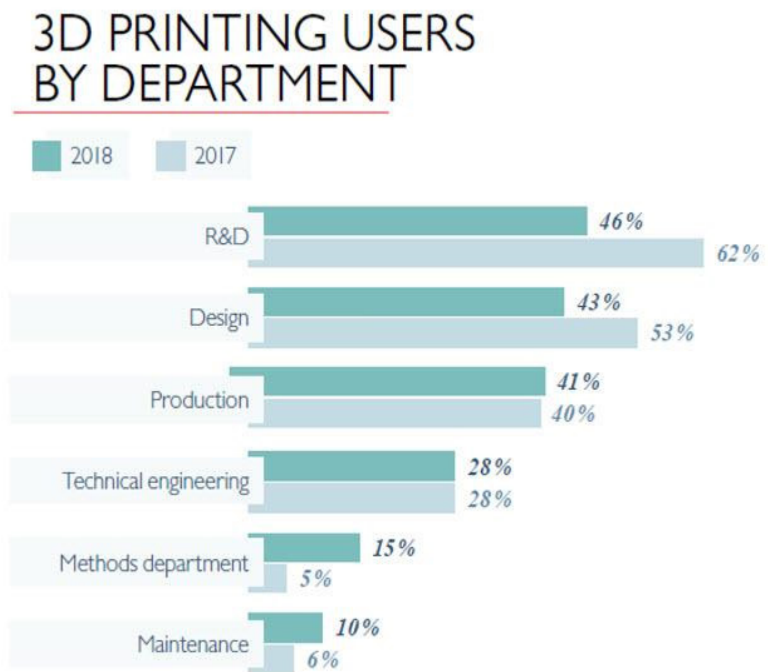
As 3d-printing technology continues to grow, it is becoming more and more affordable for the everyday person. Hobbyist applications are among the fastest-growing sectors in 2019.

3d-printing is a production technology that originated in the 1980s. It is a form of additive manufacturing, a collection of processes that build products layer-by-layer and generate less waste relative to traditional forms of manufacturing. The technology currently accounts for only one-fifth of 1% of global manufacturing and can therefore only be considered potentially disruptive at this point.

Virtually all materials are applicable and the development of bio-based material innovation is revolutionizing product life-cycle impact. The most common material, especially in the context of a maker-space, is a plastic called PLA. This material is extracted from fermented plant starch and can be regenerated many times without losing its tensile strength. Furthermore, it is compostable at temperatures of 90°F.

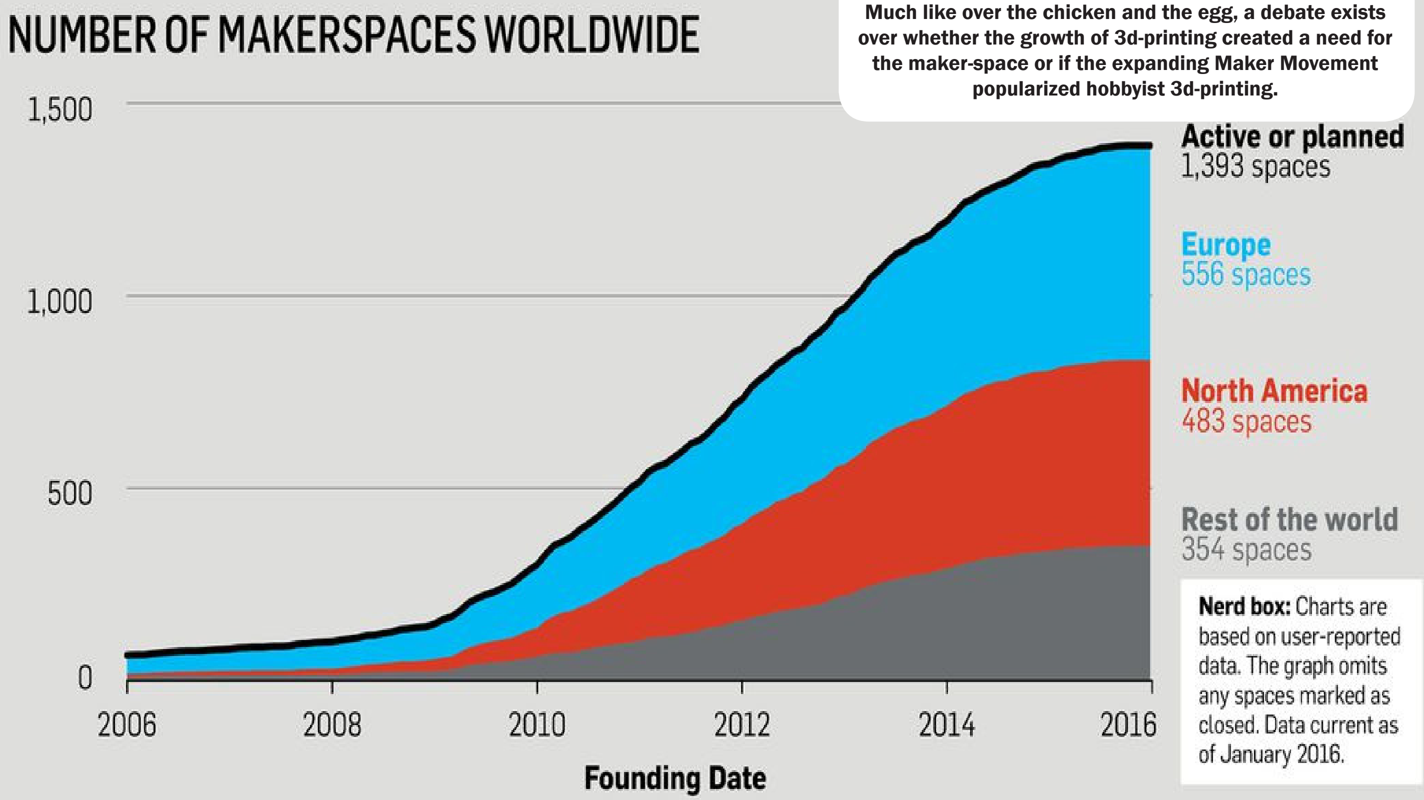
Access to 3d-printing technology empowers design and creation. This is especially so in the context of communities that are separated from global supply chains. The ability to source and produce locally is changing the nature of competition.





Source: Forbes

The Maker-Space



Did You Know?

Much like over the chicken and the egg, a debate exists over whether the growth of 3d-printing created a need for the maker-space or if the expanding Maker Movement popularized hobbyist 3d-printing.

Source: Popular Science (Katie Meek)

A maker-space is a collaborative work space equipped with tools that enable design, creation, and innovation. They can be found in schools, libraries, universities, or public/private facilities. A maker-space promotes learning, exploring, and the sharing of ideas.

In 2005, the first publication of *Make:* magazine sparked the “maker movement”. Since then, maker-spaces have flourished, with more than 14 times more maker-spaces existing across the globe in 2016 than there were in 2006. They are usually equipped with at least one 3d-printer and have thus proliferated in conjunction with 3d-printers.

Maker-spaces add value to communities world-wide. They provide a space for people to access tools they might not have had access to before. They encourage creative thinking and collaboration. They are usually membership-based and the cost is relatively affordable for most.

In the United States, almost half of the population consider themselves makers. Maker-spaces provide an outlet for these people to express their creativity and provide them with a community of like-minded creators.

Sustainability Recommendations

1. Know your needs and know your space

--Perform sufficient research: no two maker-spaces have exactly the same needs and there are many types of printers/applications/materials.

--Document everything: keep a running log of the printers you use, how often they are used, materials being used, prints that occur, etc.

2. Print with a purpose

--3d-printing enables rapid prototyping and encourages creative failure, but that is not an excuse to be reckless. Design and print with intent.

3. Collaboration is key

--If you don't know how to start working towards sustainable operations, reach out in your organization or community. There are people everywhere who are knowledgeable and can help you begin to recycle, source responsibly, or increase energy efficiency.

Health and Safety

1. Air Filtration

-Measure VOC levels in air: sensors can be bought for $100

-Install a high-quality ventilation system if possible, but at the very least do not breathe near a running printer

2. Physical Hazards

-Proper warning signs for hazardous materials and potential for burns

-Fire extinguishers, spill kits, emergency wash kits, MSDS

Materials

1. Responsible Sourcing

-Purchase filament from companies that recycle spools

-Print with PLA when possible

-Purchase recycled filament

2. Waste and Recycling

-Design to eliminate waste such as structural supports

-Recycle all plastic waste and unused projects

-Collaborate with organizations committed to filament reuse

Energy

1. Orientation and Design

-Print time and energy use can be reduced through design choices like orientation on build plate or amount of structural support

2. Keep them running

-Idle printers use about the same amount of energy as run ning printers

-Have as few printers as possible, working as hard as possible

3. Consider clean energy