A BRIEF HISTORY OF 3D PRINTING

1980s

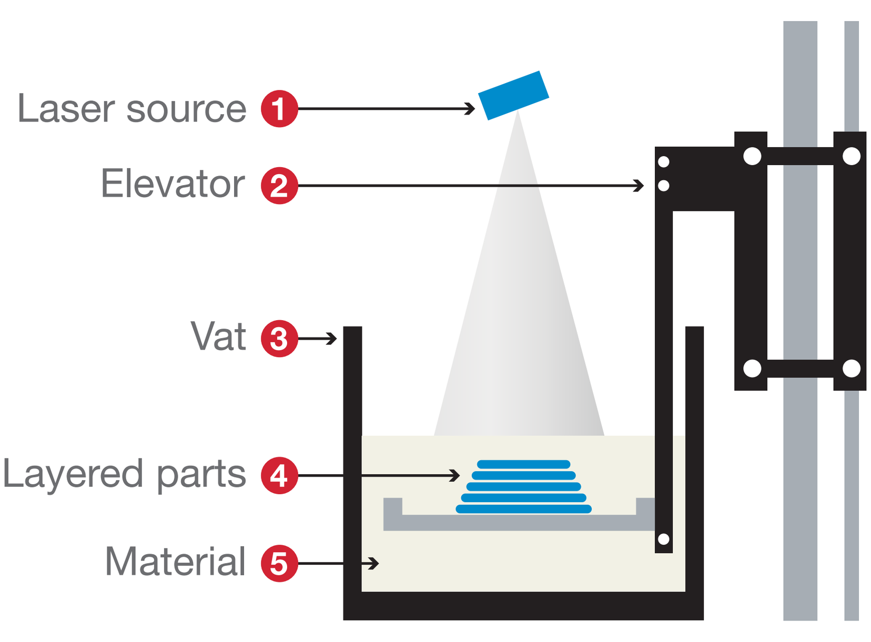
The inception of 3D printing can be traced back to 1976, when the inkjet printer was invented. In 1984, adaptations and advances on the inkjet concept morphed the technology from printing with ink to printing with materials. In the decades since, a variety of applications of 3D printing technology have been developed across several industries. The following is a brief history of the major milestones along the way.

1984
THE BIRTH OF 3D PRINTING

Charles Hull, later the co-founder of 3D Systems, invents stereolithography, a printing process that enables a tangible 3D object to be created from digital data. The technology is used to create a 3D model from a picture and allows users to test a design before investing in a larger manufacturing program.

HOW 3D PRINTING WORKS

3D printers work like inkjet printers. Instead of ink, 3D printers deposit the desired material in successive layers to create a physical object from a digital file.



1. A laser source sends a laser beam to solidify the material.
2. The elevator raises and lowers the platform to help lay the layers.
3. The vat contains the material used to create the 3D object.
4. The 3D object is created as parts are layered on top of each other.
5. Advanced 3D printers use one or more materials, including plastic, resin, titanium, polymers and even gold and silver.

INDUSTRIES

- Automotive
- Aviation
- Do-it-yourself
- Manufacturing
- Medical
- Jewelry

1990s

'92 BUILDING PARTS, LAYER BY LAYER

The first SLA (stereolithographic apparatus) machine is produced by 3D Systems. The machine's process involves a UV laser solidifying photopolymer, a liquid with the viscosity and color of honey that makes three-dimensional parts layer by layer. Although imperfect, the machine proves that highly complex parts can be manufactured overnight.

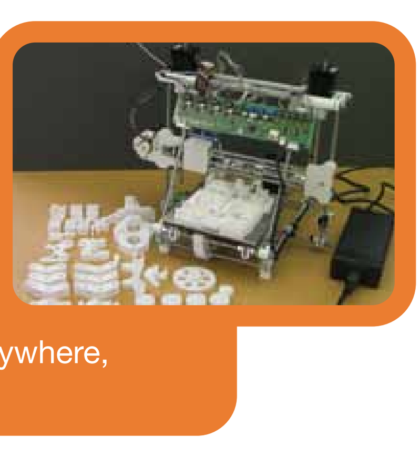
'99 ENGINEERED ORGANS BRING NEW ADVANCES TO MEDICINE

The first lab-grown organ is implanted in humans when young patients undergo urinary bladder augmentation using a 3-D synthetic scaffold coated with their own cells. The technology, developed by scientists at the Wake Forest Institute for Regenerative Medicine*, opened the door to developing other strategies for engineering organs, including printing them. Because they are made with a patient's own cells, there is little to no risk of rejection.

2000s

'02 A WORKING 3D KIDNEY

Scientists engineer a miniature functional kidney that is able to filter blood and produce diluted urine in an animal. The development led to research at the Wake Forest Institute for Regenerative Medicine that aims to "print" organs and tissues using 3D printing technology.



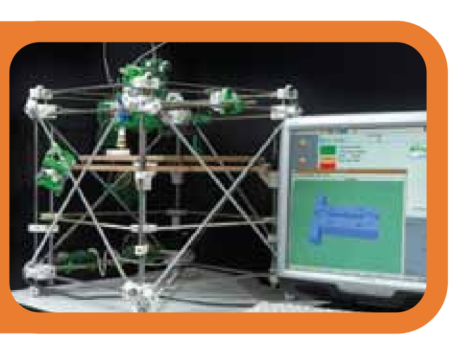
'05 OPEN-SOURCE COLLABORATION WITH 3D PRINTING

Dr. Adrian Bowyer at University of Bath founds RepRap, an open-source initiative to build a 3D printer that can print most of its own components. The vision of this project is to democratize manufacturing by cheaply distributing RepRap units to individuals everywhere, enabling them to create everyday products on their own.

'06 SLS LEADS TO MASS CUSTOMIZATION IN MANUFACTURING

The first SLS (selective laser sintering) machine becomes viable. This type of machine uses a laser to fuse materials into 3D products. This breakthrough opens the door to mass customization and on-demand manufacturing of industrial parts, and later, prostheses.

That same year Objet, a 3D printing systems and materials provider, creates a machine capable of printing in multiple materials, including elastomers and polymers. The machine permits a single part to be made with a variety of densities and material properties.

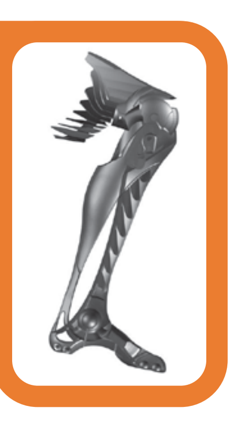


'08 THE FIRST SELF-REPLICATING PRINTER

Following its launch in 2005, RepRap Project releases Darwin, the first self-replicating printer that is able to print the majority of its own components, allowing users who already have one to make more printers for their friends.

'08 DIY CO-CREATION SERVICE LAUNCHES

Shapeways launches a private beta for a new co-creation service and community allowing artists, architects and designers to make their 3D designs as physical objects inexpensively.

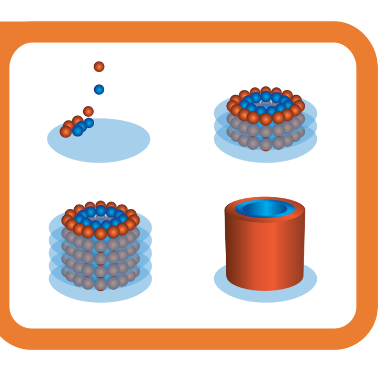


'08 MAJOR BREAKTHROUGH FOR PROSTHETICS

The first person walks on a 3D-printed prosthetic leg, with all parts — knee, foot, socket, etc. — printed in the same complex structure without any assembly. The development guides the creation of Bespoke Innovations, a manufacturer of prosthetic devices which makes customized coverings that surround prosthetic legs.

'09 DIY KITS FOR 3D PRINTERS ENTER THE MARKETPLACE

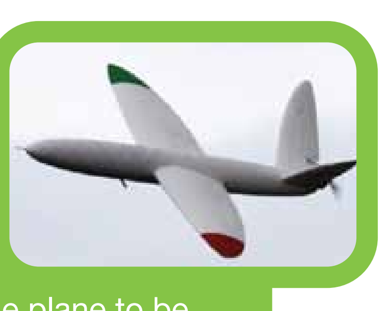
MakerBot Industries, an open-source hardware company for 3D printers, starts selling DIY kits that allow buyers to make their own 3D printers and products.



'09 FROM CELLS TO BLOOD VESSELS

Bioprinting innovator Organovo, relying on Dr. Gabor Forgacs's technology, uses a 3D bioprinter to print the first blood vessel.

2010s



'11 WORLD'S FIRST 3D-PRINTED ROBOTIC AIRCRAFT

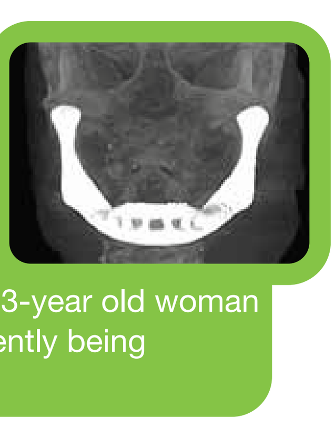
Engineers at the University of Southampton design and fly the world's first 3D-printed aircraft. This unmanned aircraft is built in seven days for a budget of £5,000. 3D printing allows the plane to be built with elliptical wings, a normally expensive feature that helps improve aerodynamic efficiency and minimizes induced drag.

'11 WORLD'S FIRST 3D-PRINTED CAR

Kor Ecologic unveils Urbee, a sleek, environmentally friendly prototype car with a complete 3D-printed body at the TEDxWinnipeg conference in Canada. Designed to be fuel-efficient and inexpensive, Urbee gets 200 mpg highway and 100 mpg city. It is estimated to retail for $10,000 to $50,000 if it becomes commercially viable.

'11 3D PRINTING IN GOLD AND SILVER

i.materialise becomes the first 3D printing service worldwide to offer 14K gold and sterling silver as materials — potentially opening a new and less expensive manufacturing option for jewelry designers.



'12 3D-PRINTED PROSTHETIC JAW IS IMPLANTED

Doctors and engineers in the Netherlands use a 3D printer made by LayerWise to print a customized three-dimensional prosthetic lower jaw, which is subsequently implanted into an 83-year old woman suffering from a chronic bone infection. This technology is currently being explored to promote the growth of new bone tissue.

PHOTO CREDITS

The Birth Of 3D Printing – 3D Systems Corporation
Building Parts, Layer By Layer – Objet Ltd.
Engineered Organs Bring New Advances in Medicine – Wake Forest Baptist Medical Center*
A Working 3D Kidney – Wake Forest Baptist Medical Center*
Open Source Collaboration With3D Printers – RepRap
SLS Leads To Mass Customization In Manufacturing – (top image) NextEngine 3D Scanners, (bottom image) EADS
The First Self-Replicating Printer – RepRap
Major Breakthrough For Prosthetics – Bespoke Innovations
DIY Co-Creation Service Launches – Freedom Of Creation Founder and Creative Director Janne Kyttanen
DIY Kits for 3D Printers Enter Marketplace – MakerBot Industries
From Cells To Blood Vessels – Organovo
World's First 3D-Printed Robotic Aircraft – University of Southampton
World's First 3D-Printed Car – Kor Ecologic, Urbee
3D Printing in Gold and Silver – Bathsheba Grossman and Bert De Niel from i.materialise
3D-Printed Prosthetic Jaw is Implemented – University of Hasselt

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T.ROWE PRICE CONNECTIONS

*The Wake Forest Institute for Regenerative Medicine at The Wake Forest Baptist Medical Center does not have a business/financial relationship with T.Rowe Price. The video of the kidney printing is experimental and not yet ready for patients.

The securities mentioned above represented 0.36% of the T. Rowe Price Small-Cap Stock Fund and 0.86% of the T. Rowe Price Small-Cap Value Fund as of December 31, 2011. The following securities were not held by either fund as of December 31, 2011: Organovo, Shapeways, Objet, MakerBot, Kor Ecologic, i.materialise, LayerWise. The funds' portfolio holdings are historical and subject to change. This material should not be deemed a recommendation to buy or sell any of the securities mentioned.