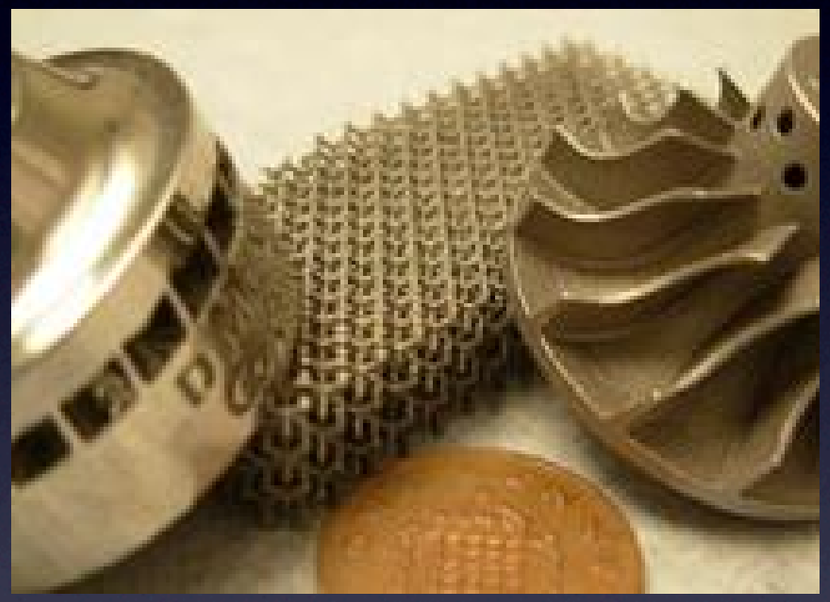
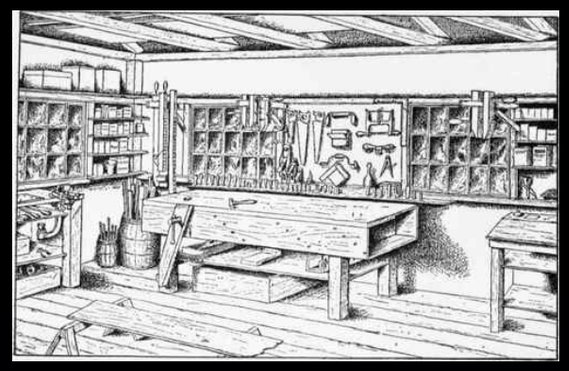


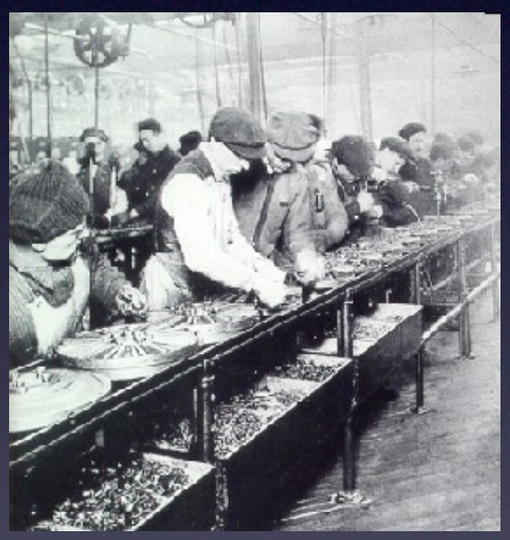
3-D Printing Introduction

December 13, 2013

David Rejeski
Science and Technology Innovation Program
Woodrow Wilson International Center for Scholars
Washington, DC

Evolution of Manufacturing





Craft System, ca 1500

English System, ca 1800

American System, ca 1830

Taylorism, ca 1900

Statistical Process Control, ca 1950

Computer Numeric Control, ca 1965

Flexible Manufacturing with CNC, ca 1985

Changes in tools, process control, and organization

Ramchandran Jaikumar, 2005. From Filing and Fitting to Flexible Manufacturing: A Study in the Evolution of Process Control

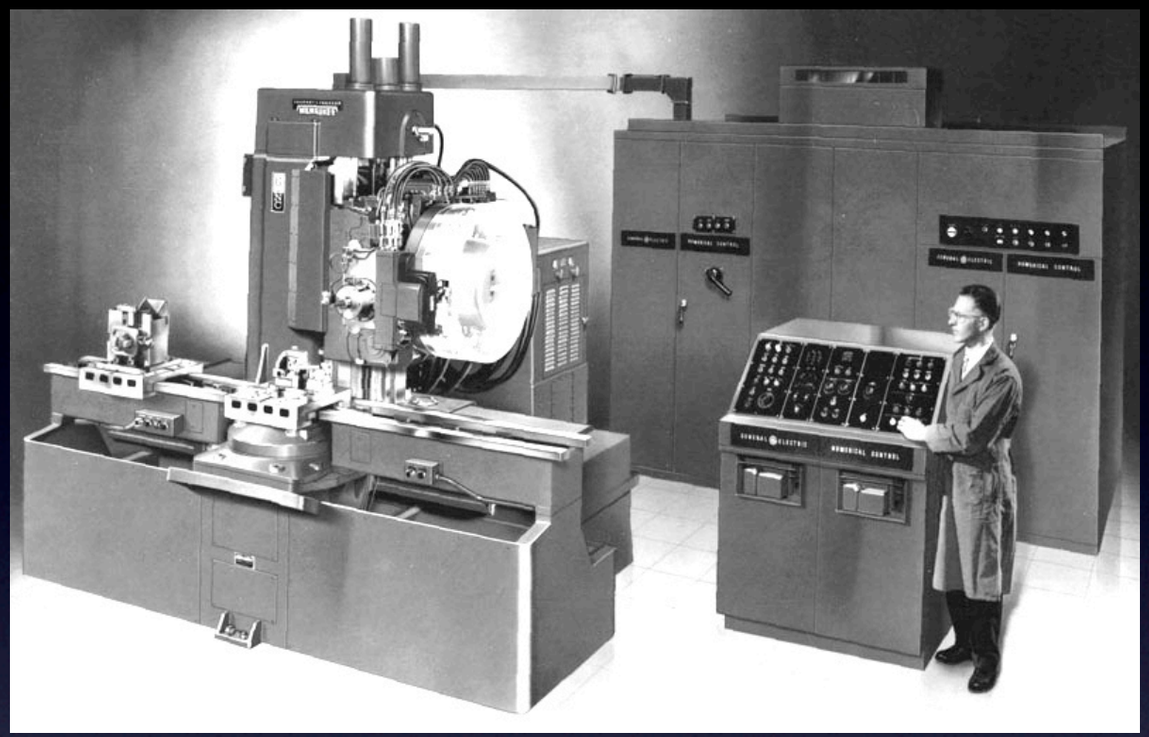
The Industrial Revolution was about Making Things

with Greater precision

at ever Higher speeds

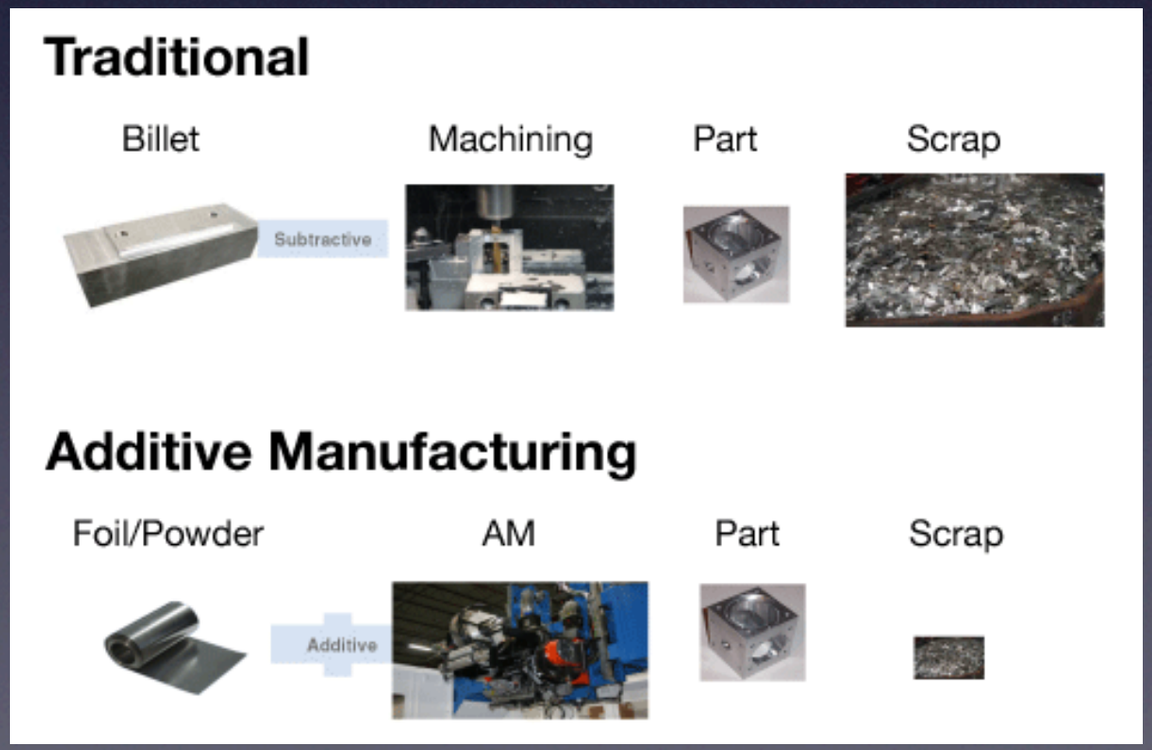
and at Lower costs

Two Important Shifts in Manufacturing



Analog to Digital Control

Computer Numerical Control
(CNC) Machines
Lathes, Millers, Routers



Subtractive to Additive

Early 3-D Printer, 1984

“Prediction is very difficult, especially if it's about the future.”

Niels Bohr

An analysts with Pacific Crest this week said: “After two decades of slow adoption and evolution, we are now reaching a tipping point in 3D printing...expect rapid adoption of 3D printing by consumers in 2017 through 2022.”

According to *Forbes*, the Gartner research firm recently predicted growth of 75 percent in shipments next year for lower-cost printers. Sales for more expensive business printers are also expected to be high, with spending estimated to jump from $325 million in 2013 to $536 million in 2014.

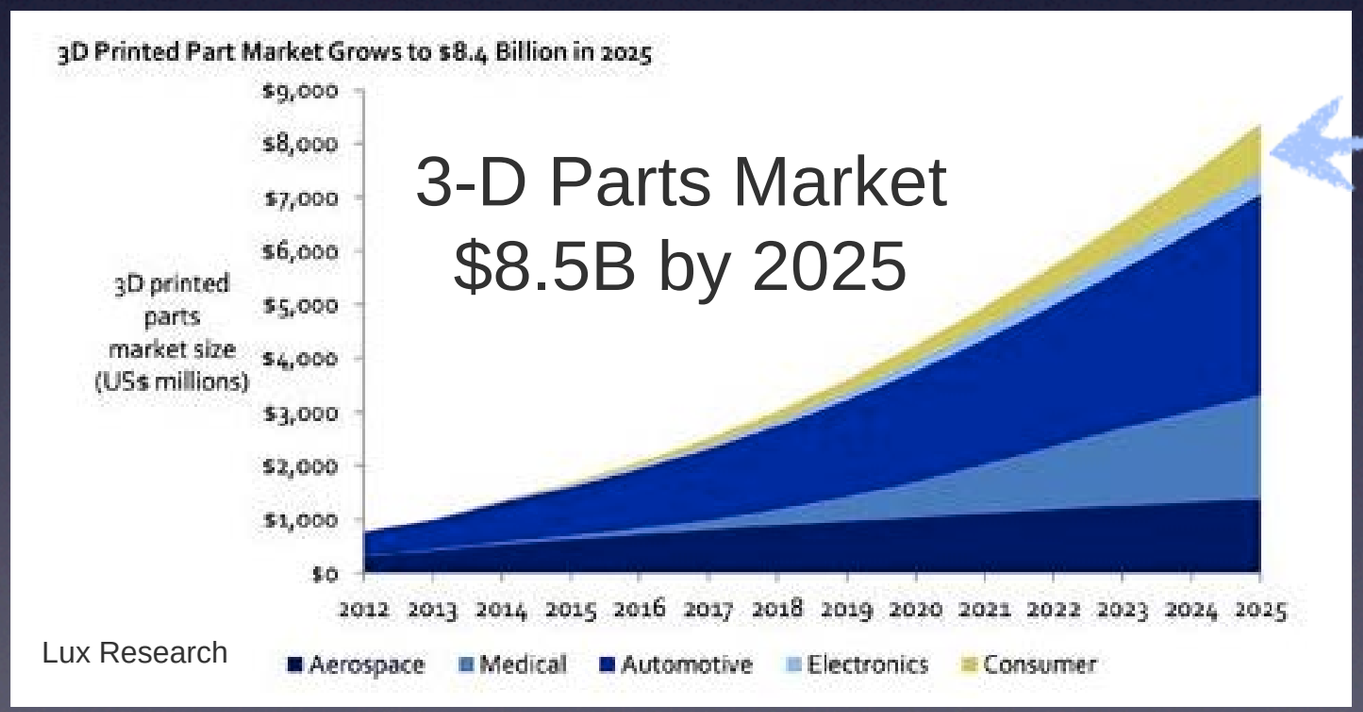
A report released in November by Marketsandmarkets Analysis, estimated that the 3D printing market is expected to grow at a compound annual growth rate of 23 percent from 2013 to 2020, hitting $8.41 billion in 2020.

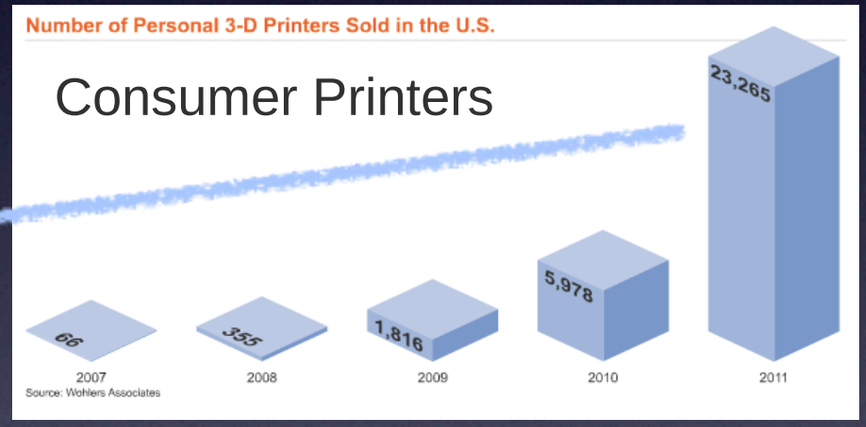
An analyst with Japanese investment bank Nomura wrote in late 2013: “We think recent market optimism about the 'Third Industrial Revolution' potential of 3D printing is overdone, given uncertain growth potential in the consumer market, limited pragmatic applications, and a lack of mass-production ability.”

How Big Are the Markets?

The global market for all 3D printers: $1.7 billion in 2011
$6 billion by 2017

Global Machine Tool Market
$94 B in 2012



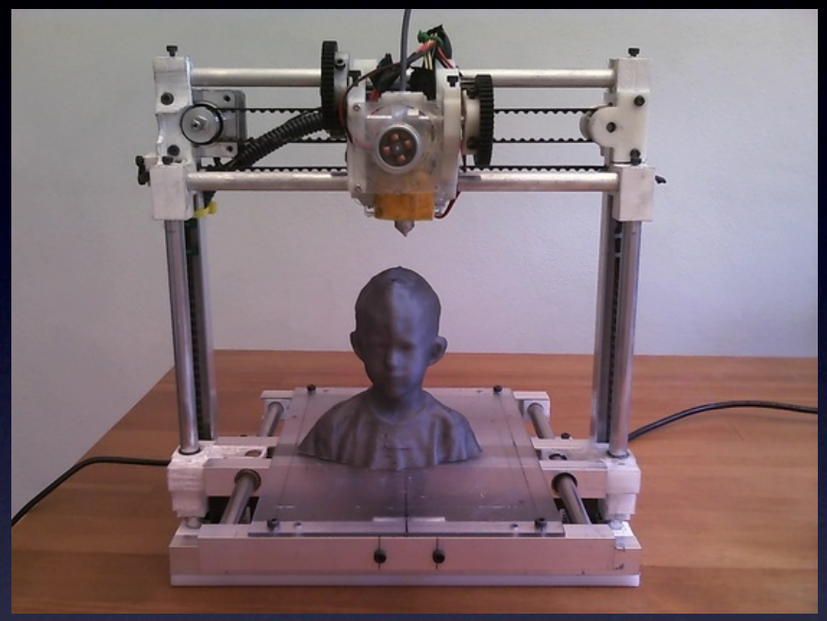


https://www.gardnerweb.com/cdn/cms/uploadedFiles/2013wmtocs_SURVEY.pdf

Wohlers Associates. Wohlers Report 2012: Additive Manufacturing and 3d Printing State of the Indus- try, 2012. ISBN 0-9754429-8-8.

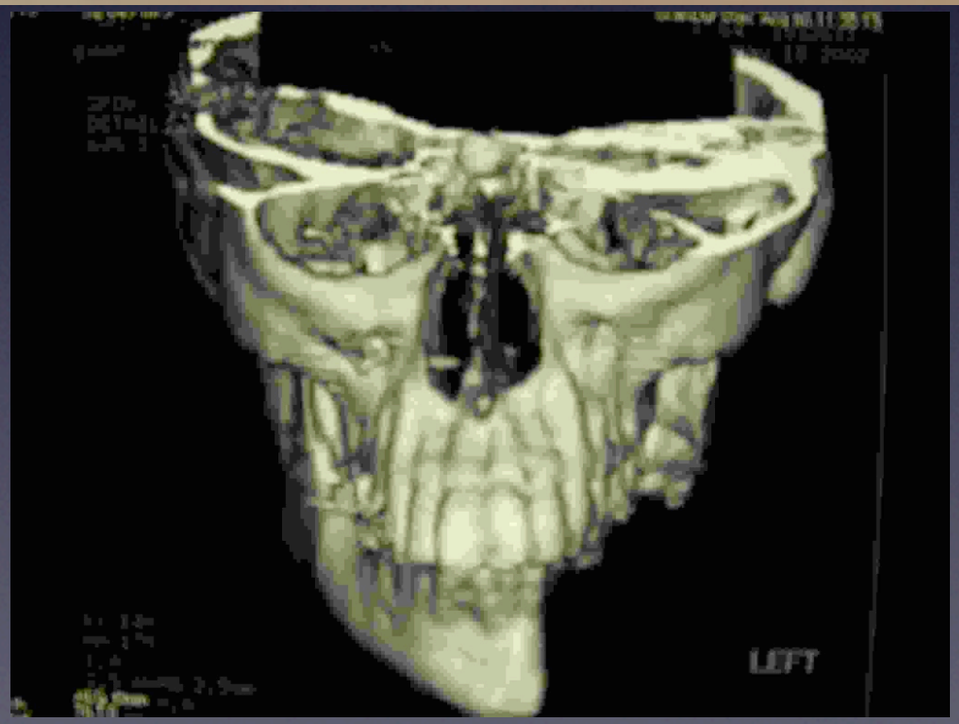
3-D Printing Today: Rapid Prototyping

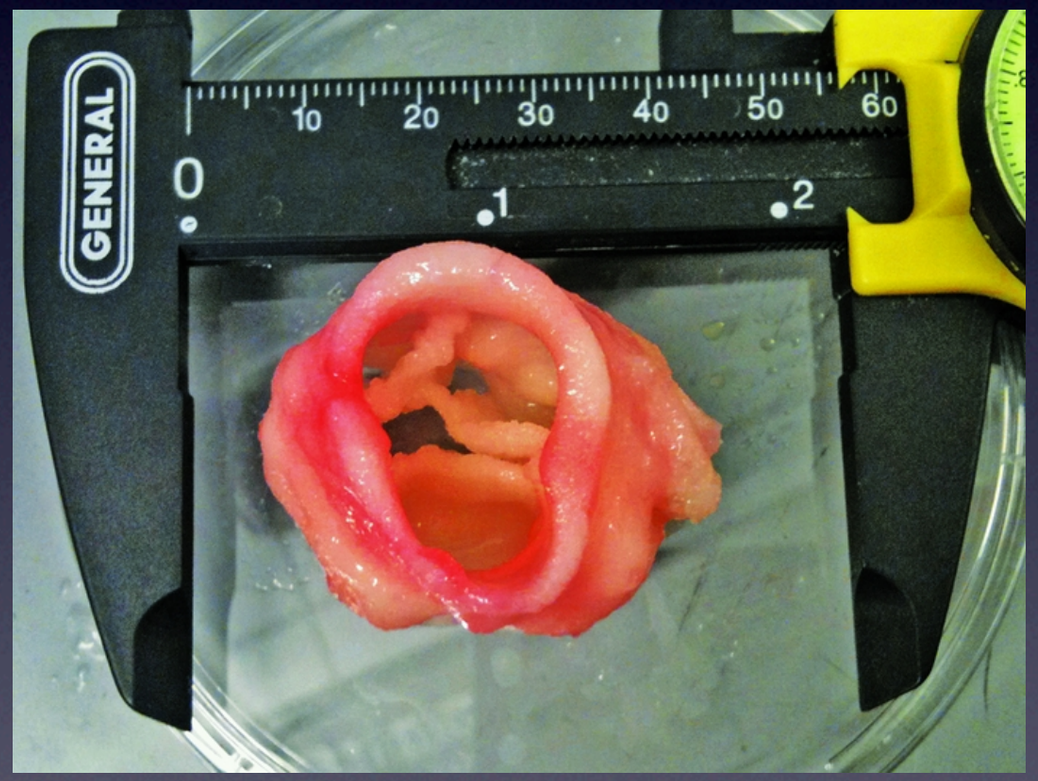
Speed up the Design-Build-Test Cycle



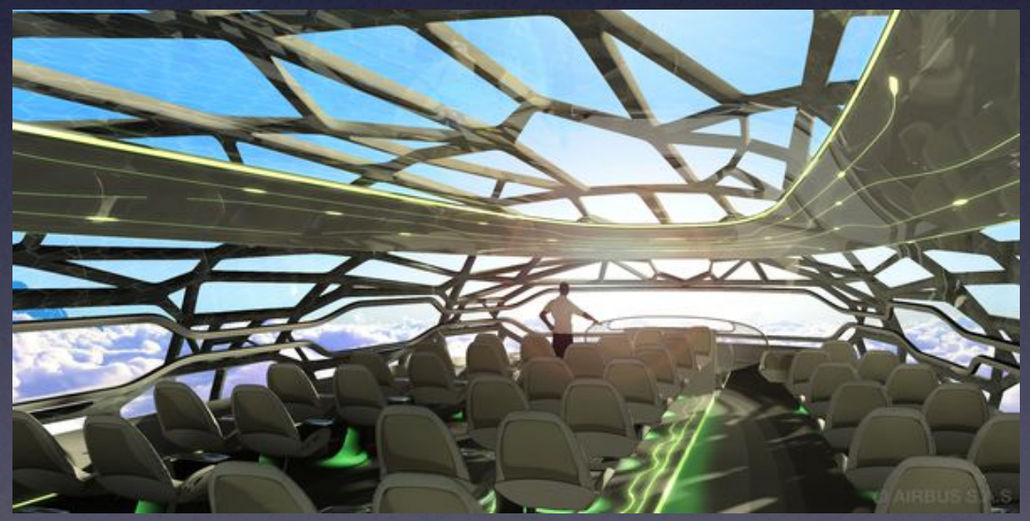
Prototyping:
80-90%
of uses

Custom Products: Medical Applications

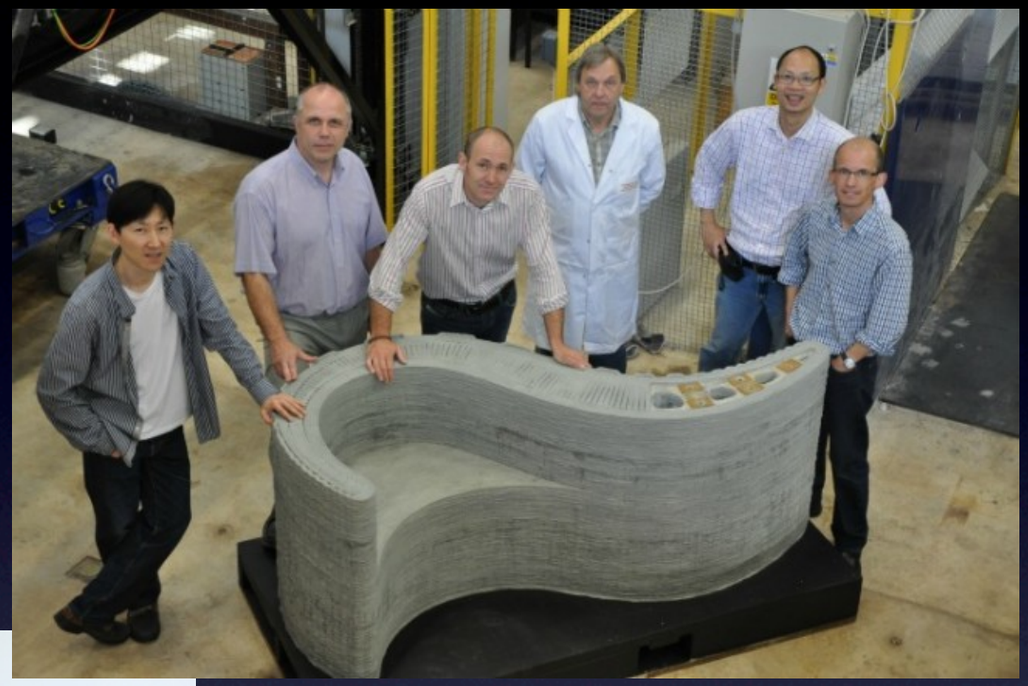




Aviation and Automotive Applications

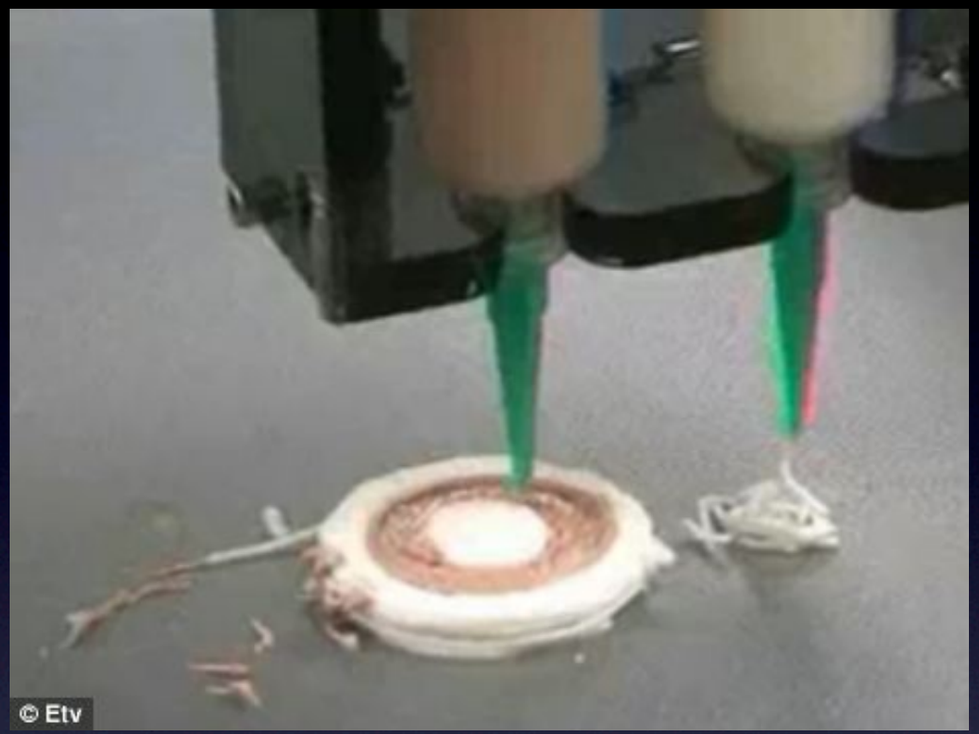


Furniture

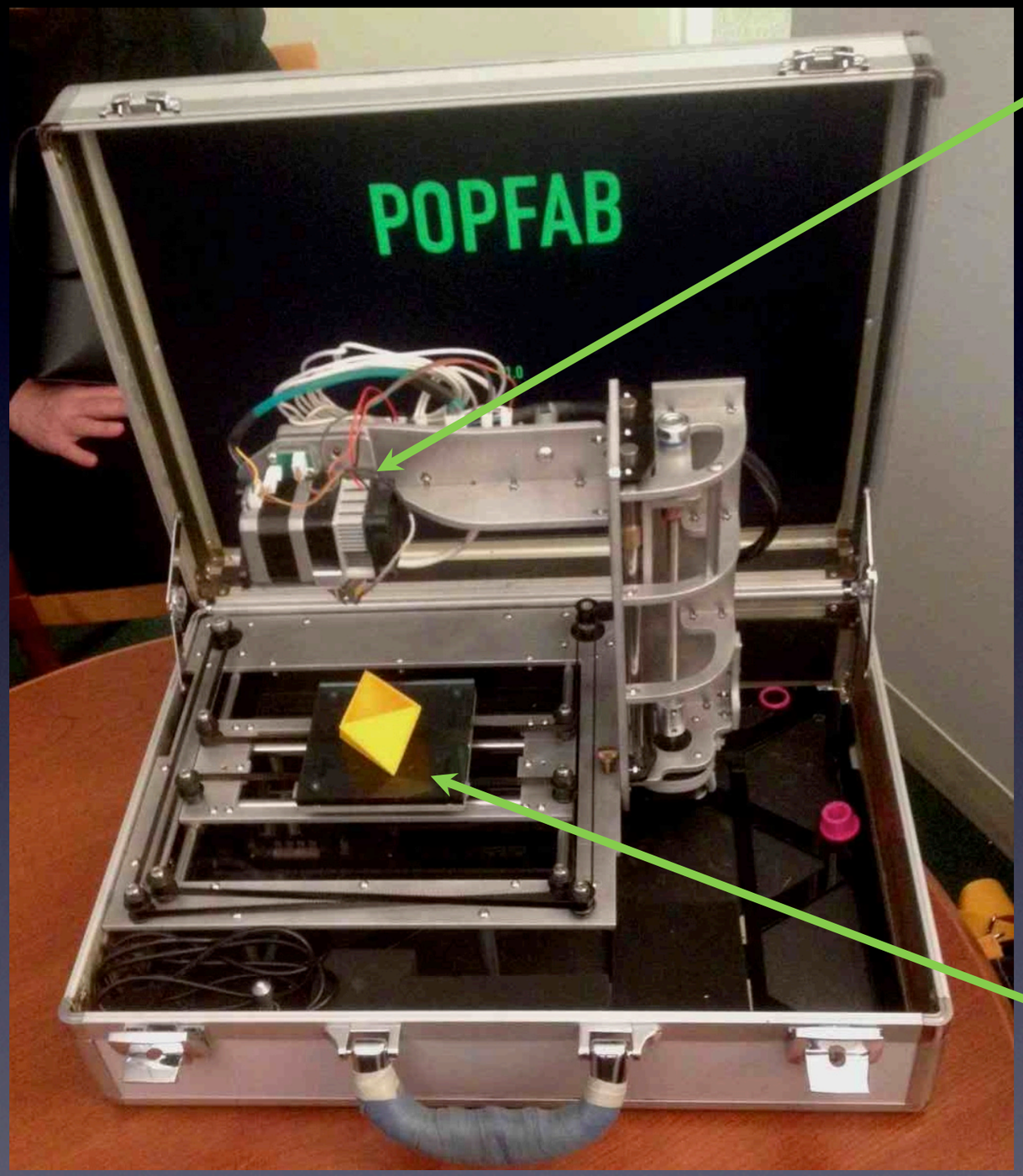


Art and Fashion

Food Processing



Complementary Technologies: Not Either-Or



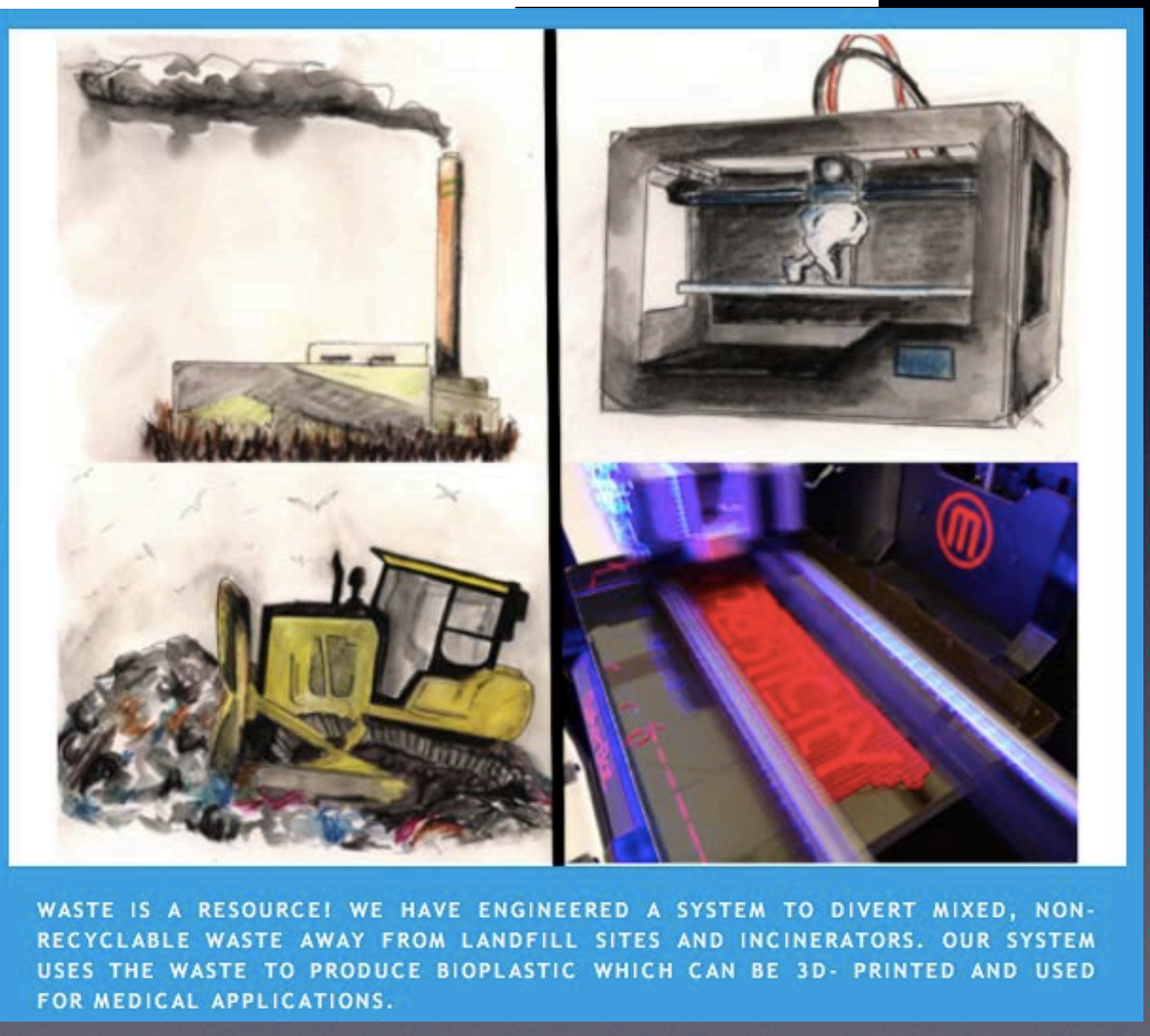
Interchangeable heads

Subtractive
and
Additive

Computer-controlled
XYZ platform

Complementary Technologies: Biotech

PLASTICITY Imperial College London



WASTE IS A RESOURCE! WE HAVE ENGINEERED A SYSTEM TO DIVERT MIXED, NON-RECYCLABLE WASTE AWAY FROM LANDFILL SITES AND INCINERATORS. OUR SYSTEM USES THE WASTE TO PRODUCE BIOPLASTIC WHICH CAN BE 3D- PRINTED AND USED FOR MEDICAL APPLICATIONS.

Waste-to-Print System

Using Synthetic Biology

What are the environmental and energy implications?

What are the claims?

Where is the research?

http://www.wilsoncenter.org/program/science-and-technology-innovation-program