

Additive Manufacturing Technology and Trends

MCA Session Topic: CAM for CAD

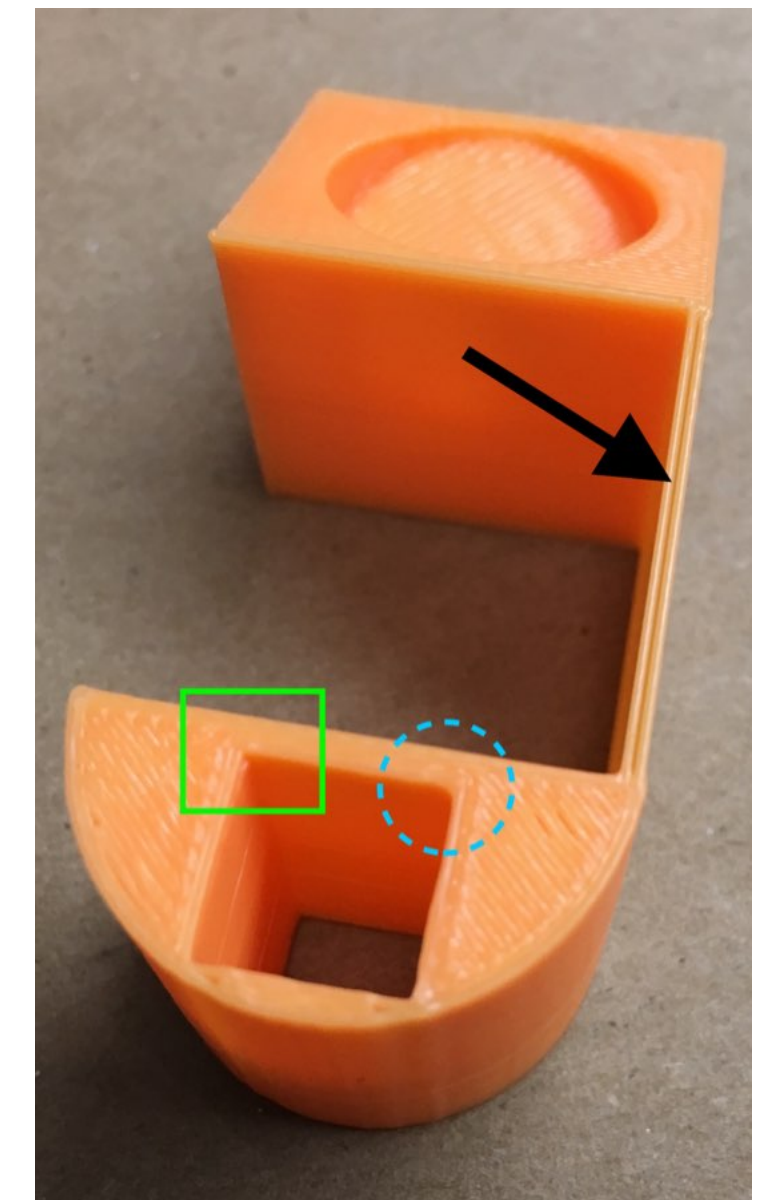
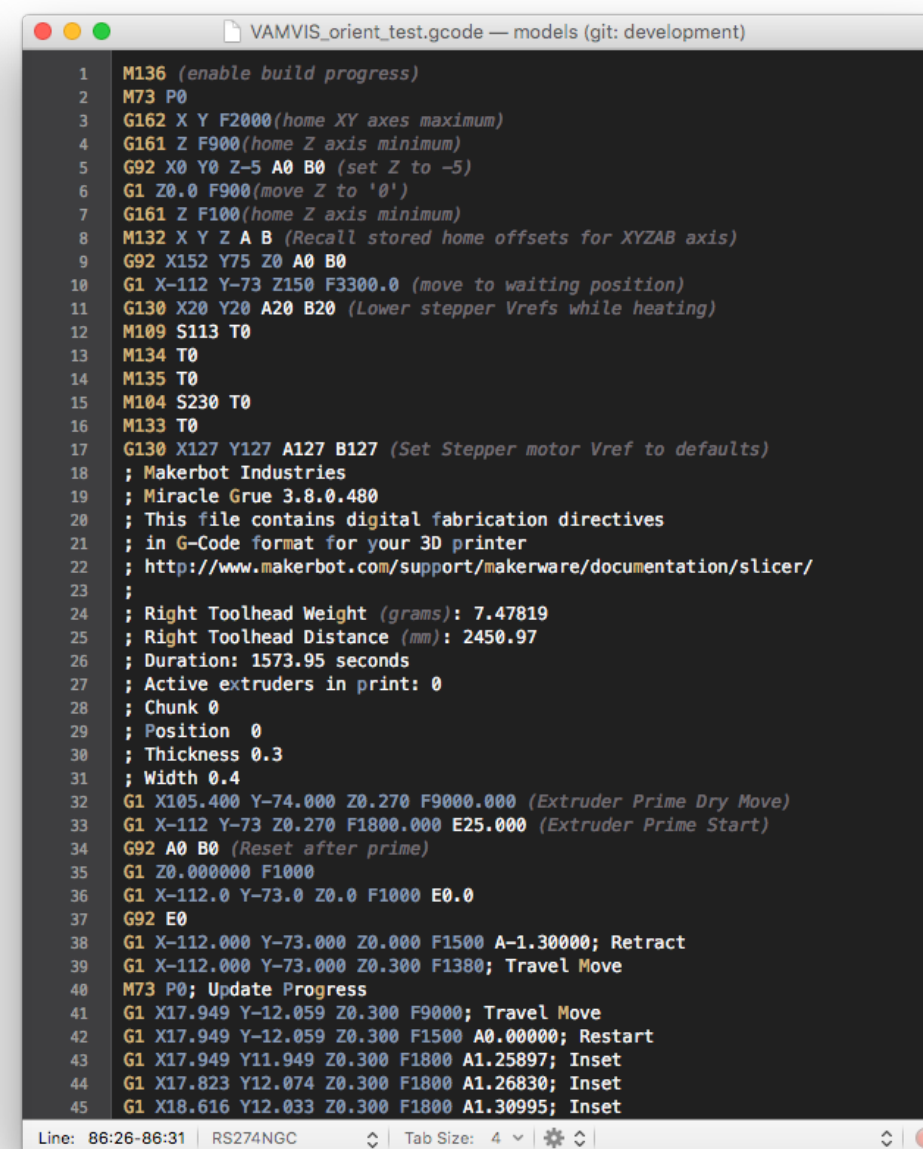
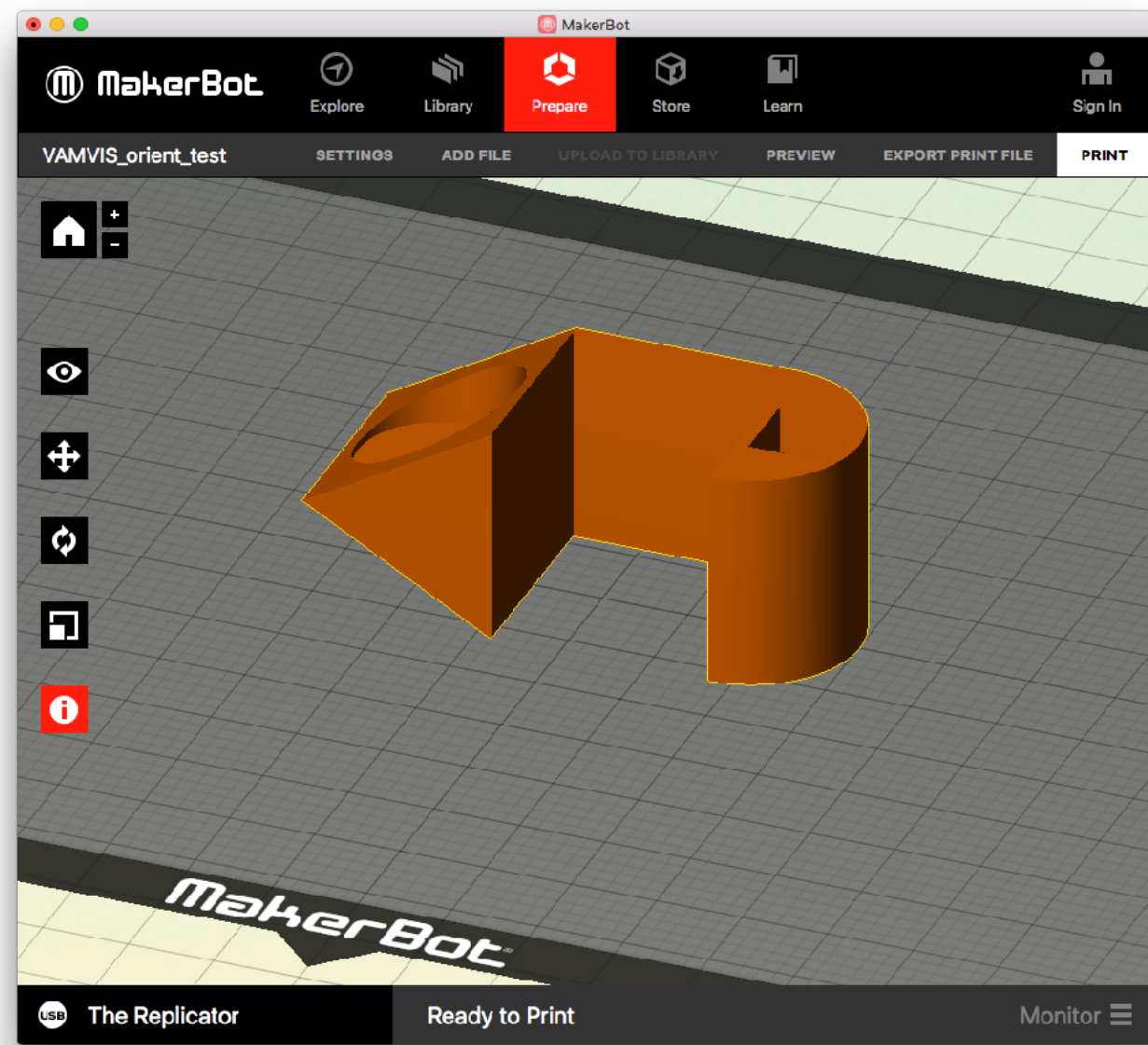
6/26/22

Instructors:

1. Alex Raymond Renner: arenner@iastate.edu
2. Michael Holm: mdholm@iastate.edu

Deep Dive Take-Away

- “Better methods are needed that enable users to explore trade-offs (compromises) among build goals and to find machine settings that enable them to best meet their goals.” [Gibson, 2010]



What Caused Printed Part Errors?

Eight Steps¹ in Additive Manufacturing

1. Conceptualization and CAD

2. Conversion to STL/AMF

3. Transfer to AM Machine and STL File Manipulation

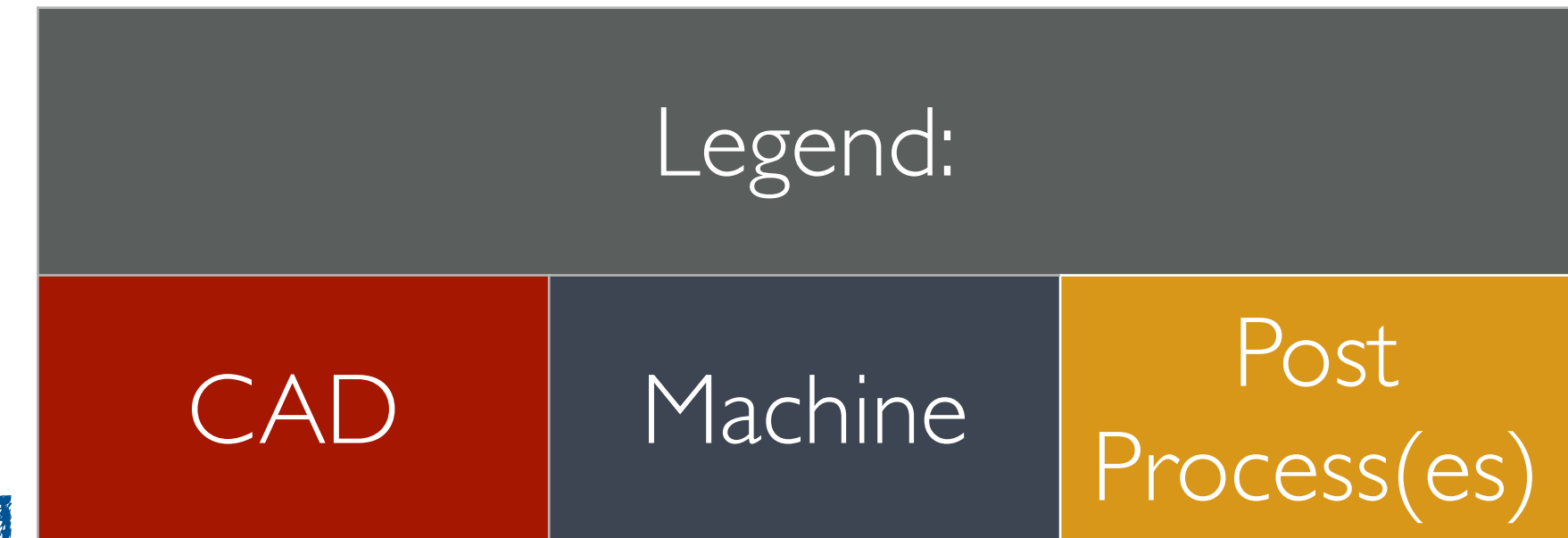
4. Machine Setup

5. Build

6. Removal and Cleanup

7. Post-Processing

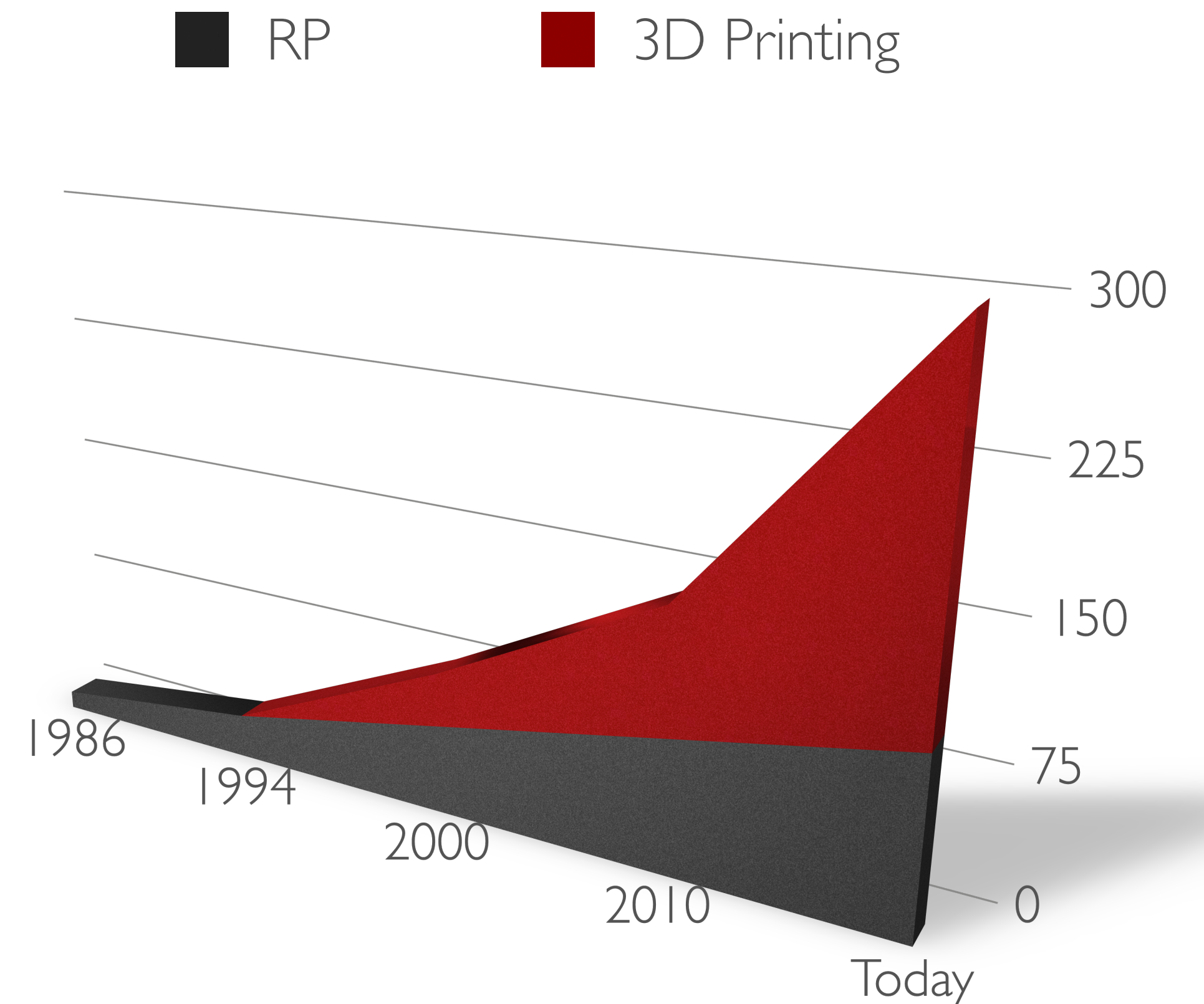
8. Application



- Process iterations are rarely performed.
- Software tools require previous user experience to prevent print failures before printing.
- Potential cost savings are very high.

“Desktop 3D Printing”: RP and DDM

“Desktop” used as term for systems < \$5,000
Used for same reasons Rapid Prototyping (RP)
machines were used and for Direct Digital
Manufacturing (DDM) making the final part
Fundamental manufacturing processes have not
changed



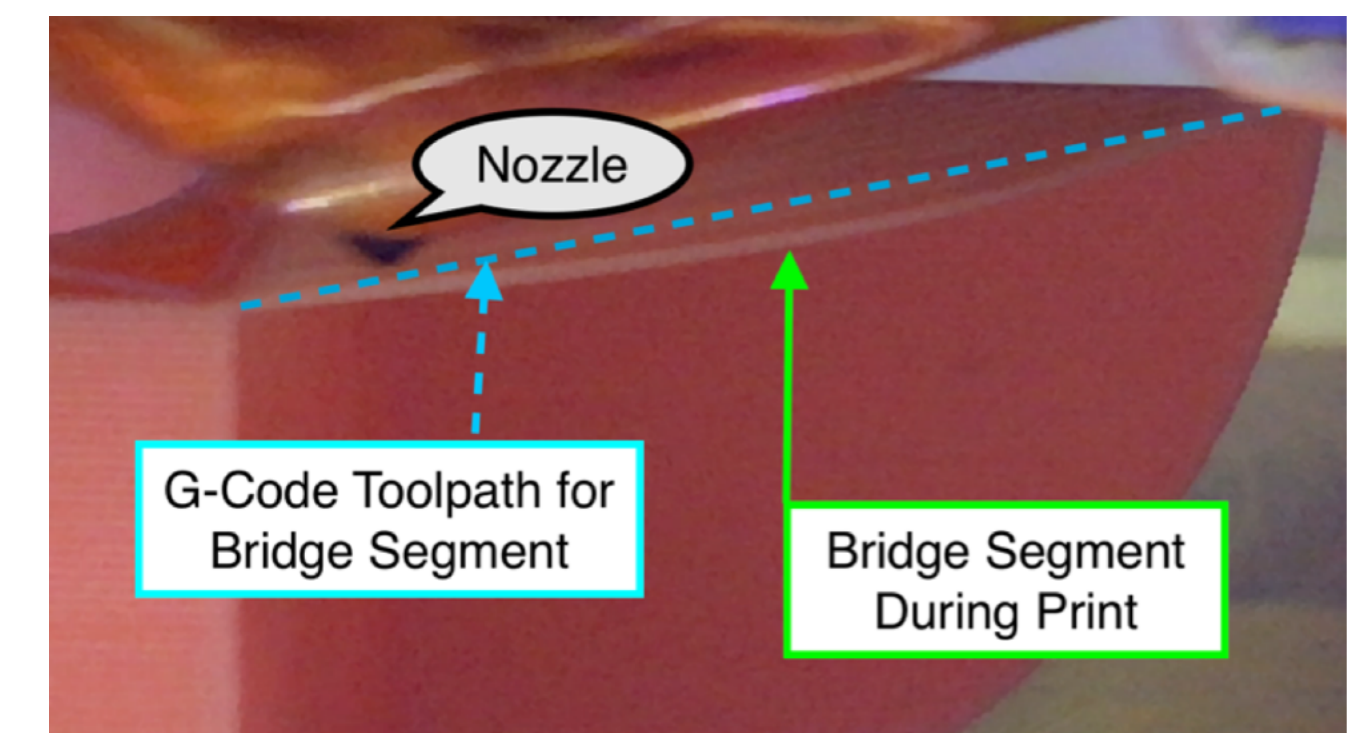
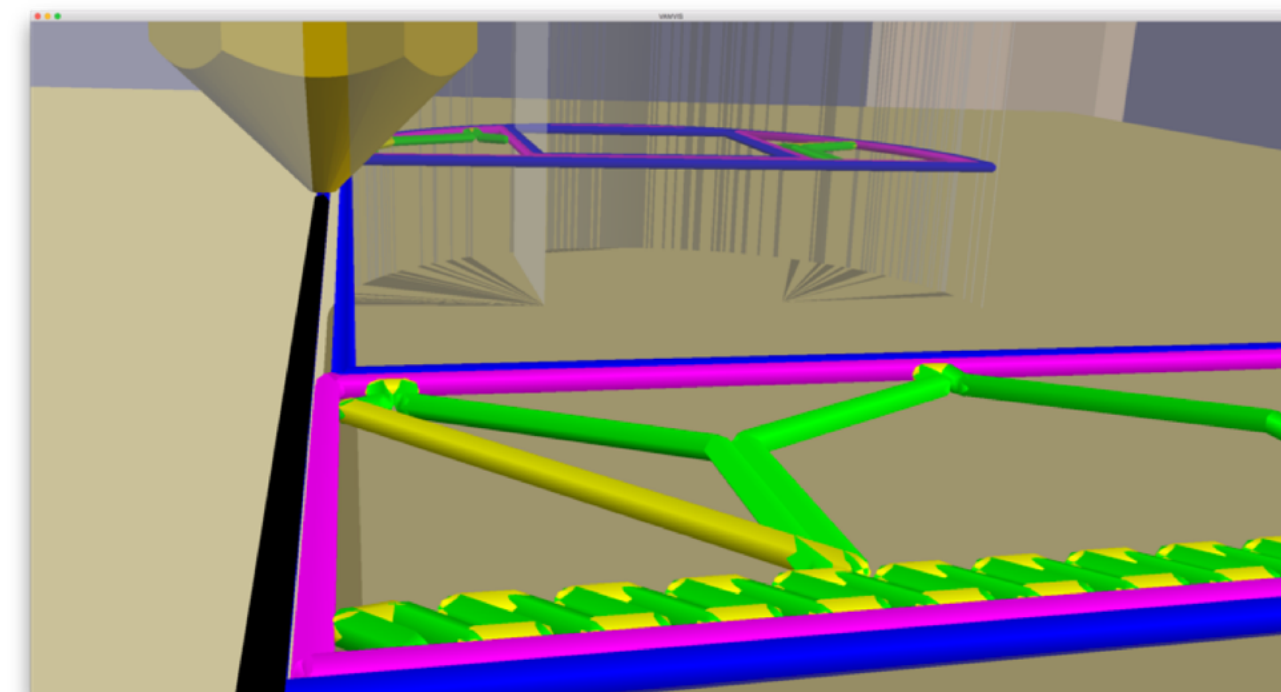
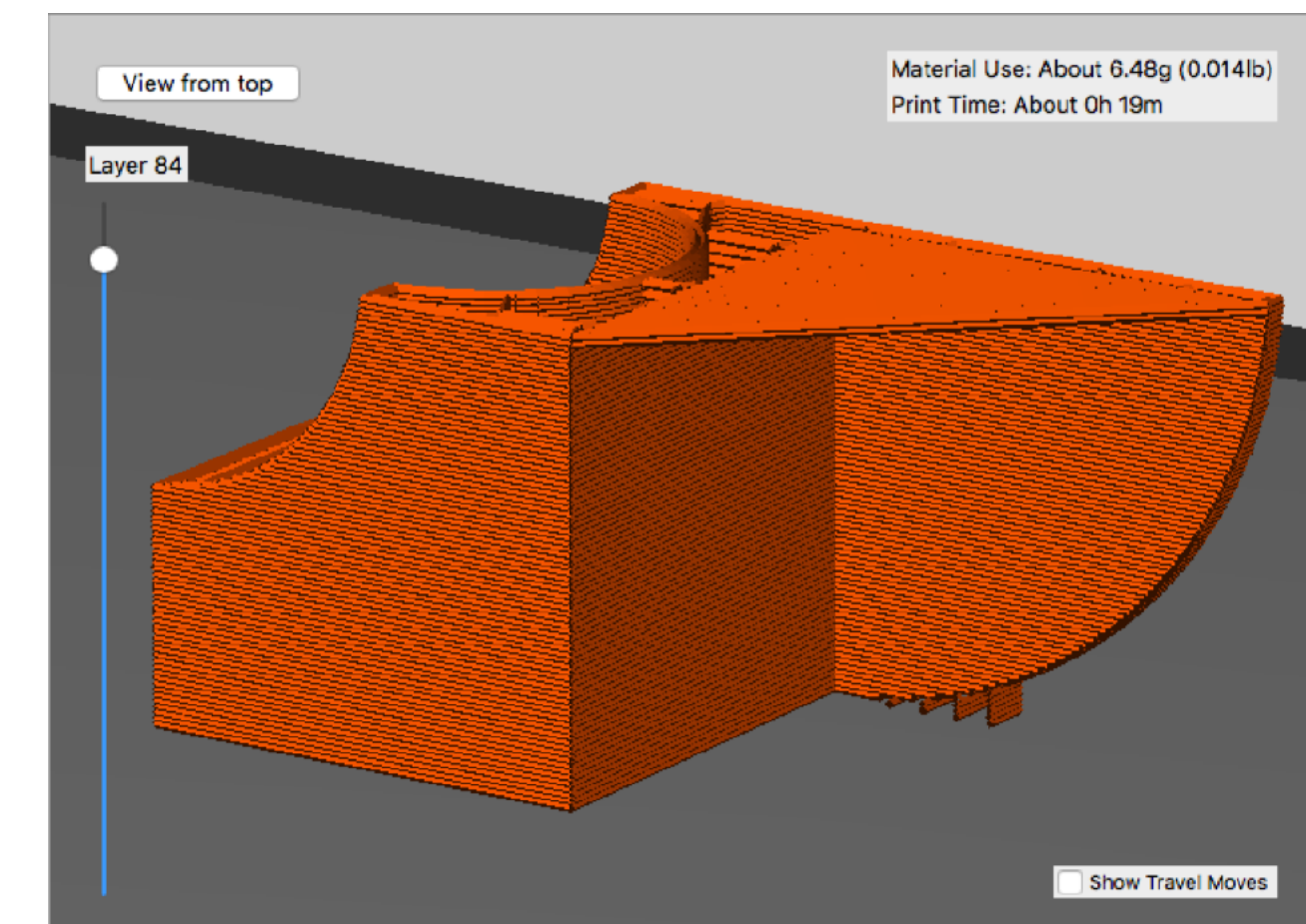
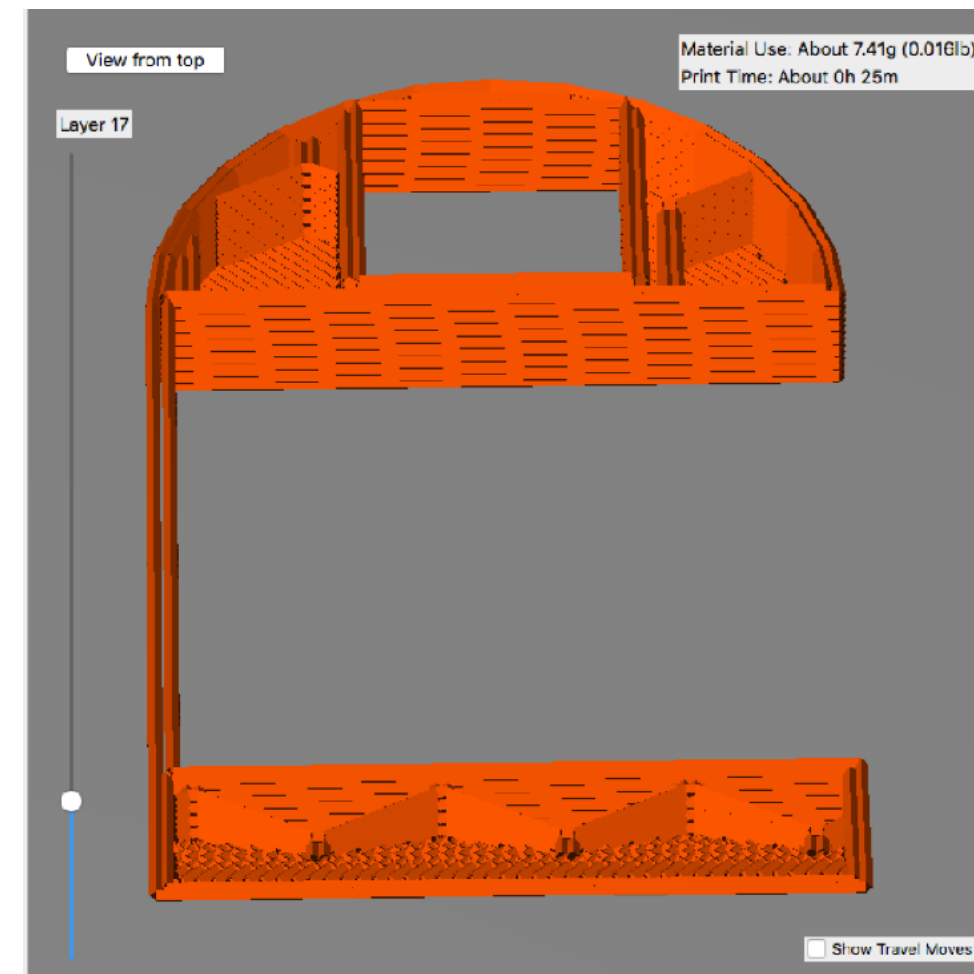
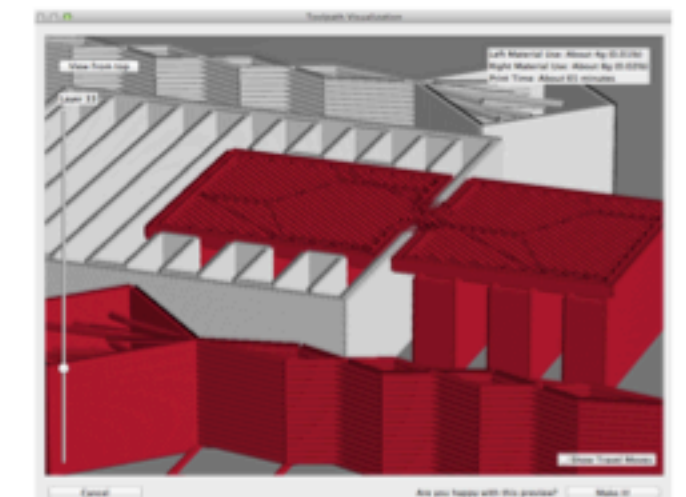
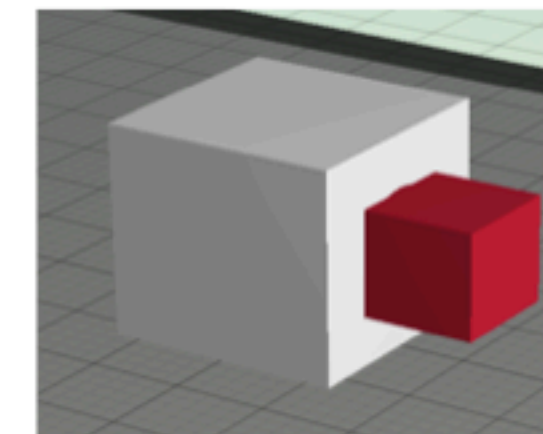
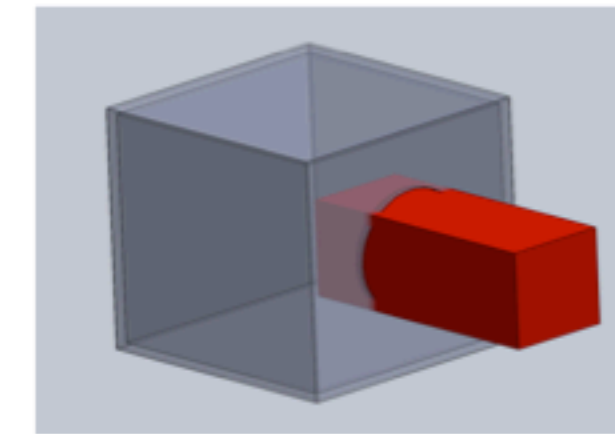
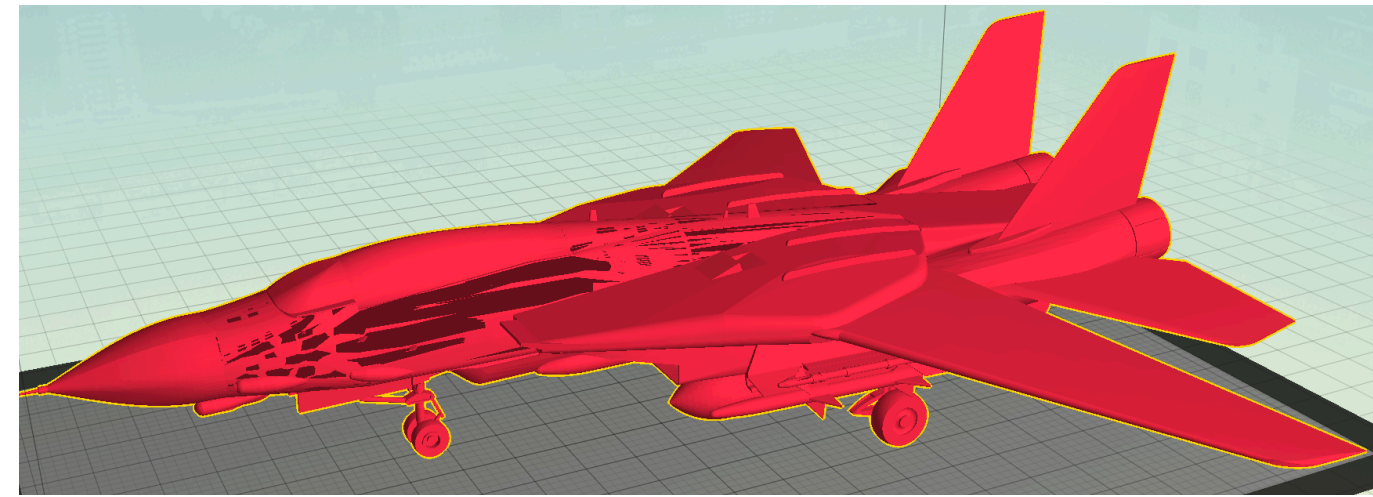
3D Printing Myths - Expert List

1. AM is a low-labor content, “pushbutton” technology.
2. Additive manufacturing is fast.
3. AM is greener than conventional manufacturing.
4. AM systems can produce anything.
5. With AM, it’s just as efficient to build one part at a time as it is to build many.
6. AM systems and materials are inexpensive.
7. AM will replace conventional manufacturing.
8. AM can print guns.
9. Every household will own a 3D printer.

Wohlers, Terry, and Tim Caffrey. "Additive manufacturing: going mainstream." Manufacturing Eng 151.6 (2013): 67-73.

Who's to blame: CAD, CAM, Printer?

- Iterative Process
- Consult 3D printer operator as early as possible
- Not just designing to meet customer requirements
 - Non-manifold geometry
 - 3D Print job settings (resolution, Raft, Support)
 - Machine maintenance and calibration
 - Machine Constraints



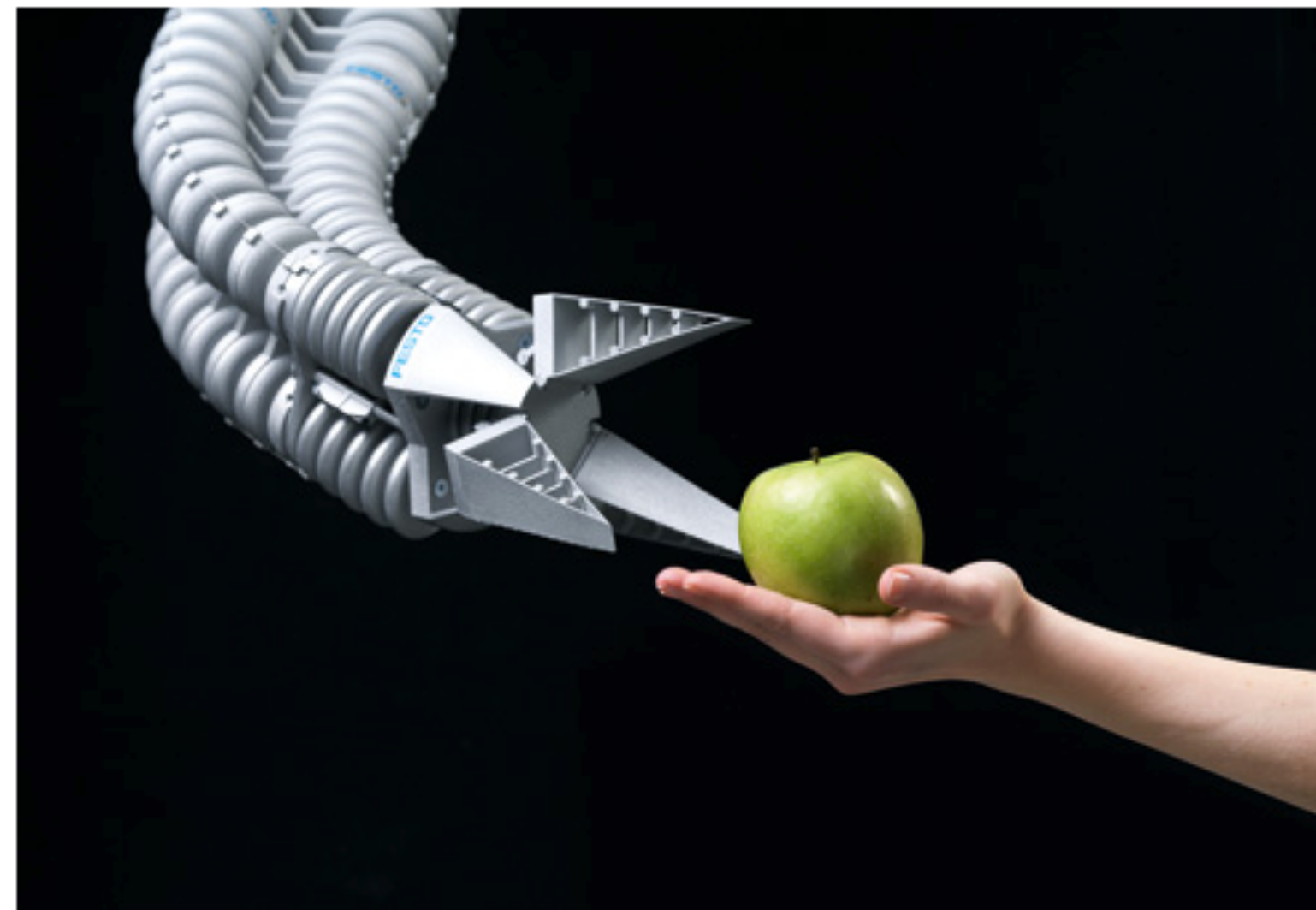
RP and 3D Printed Part Examples

- Mass Customization
- Truly “Rapid” Prototyping
- One of One
- “Mass Production”

G T I
ARR



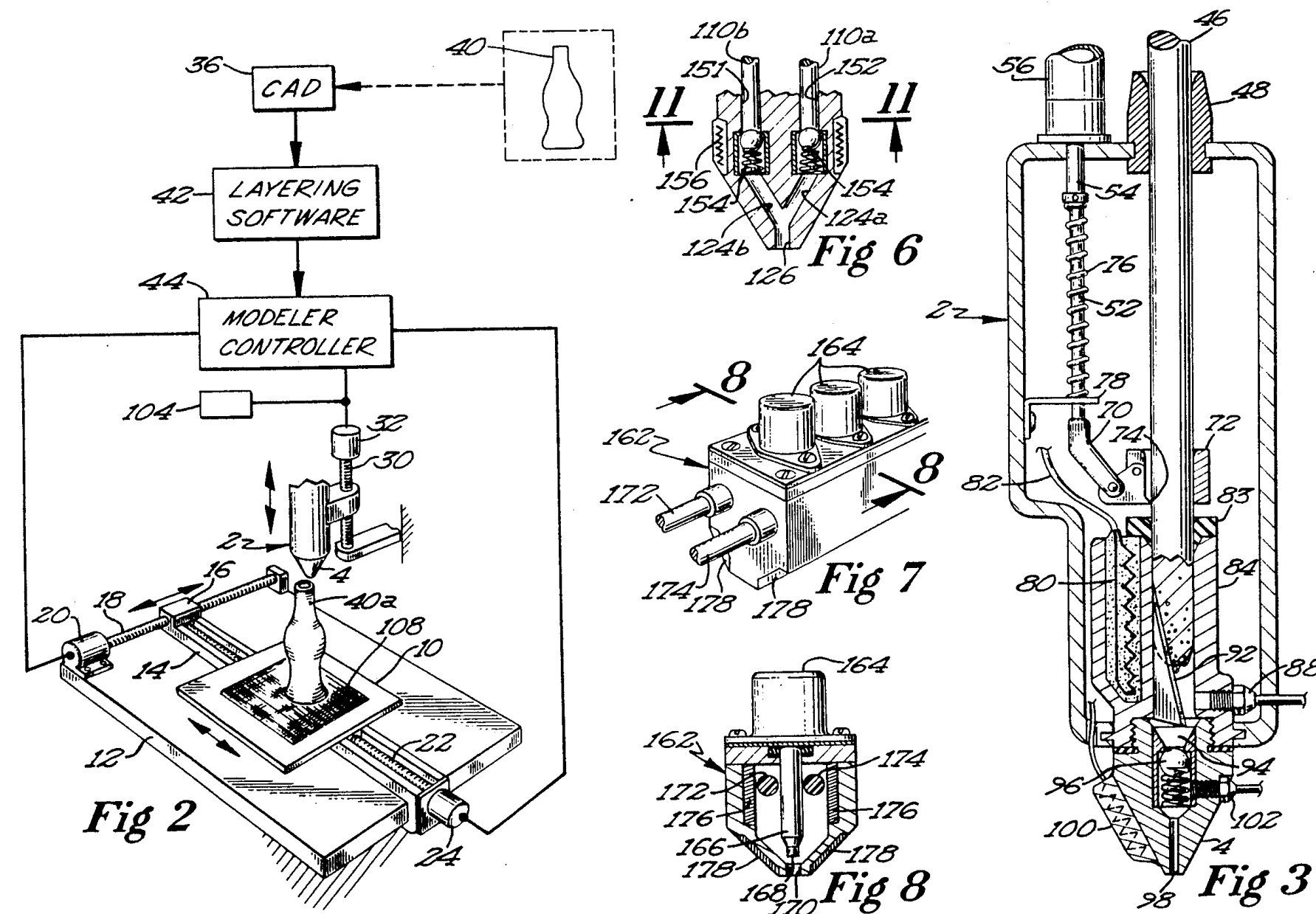
Trek's prototype development department uses multi-material 3D printing to achieve final-product realism.



Bionic Handling Assistant: A gripping tool that can reliably pick up and safely put down objects gently and flexibly. (Source: Festo AG & Co.KG).



Old School Ideas vs. New School Challenges



U.S. Patent

June 9, 1992

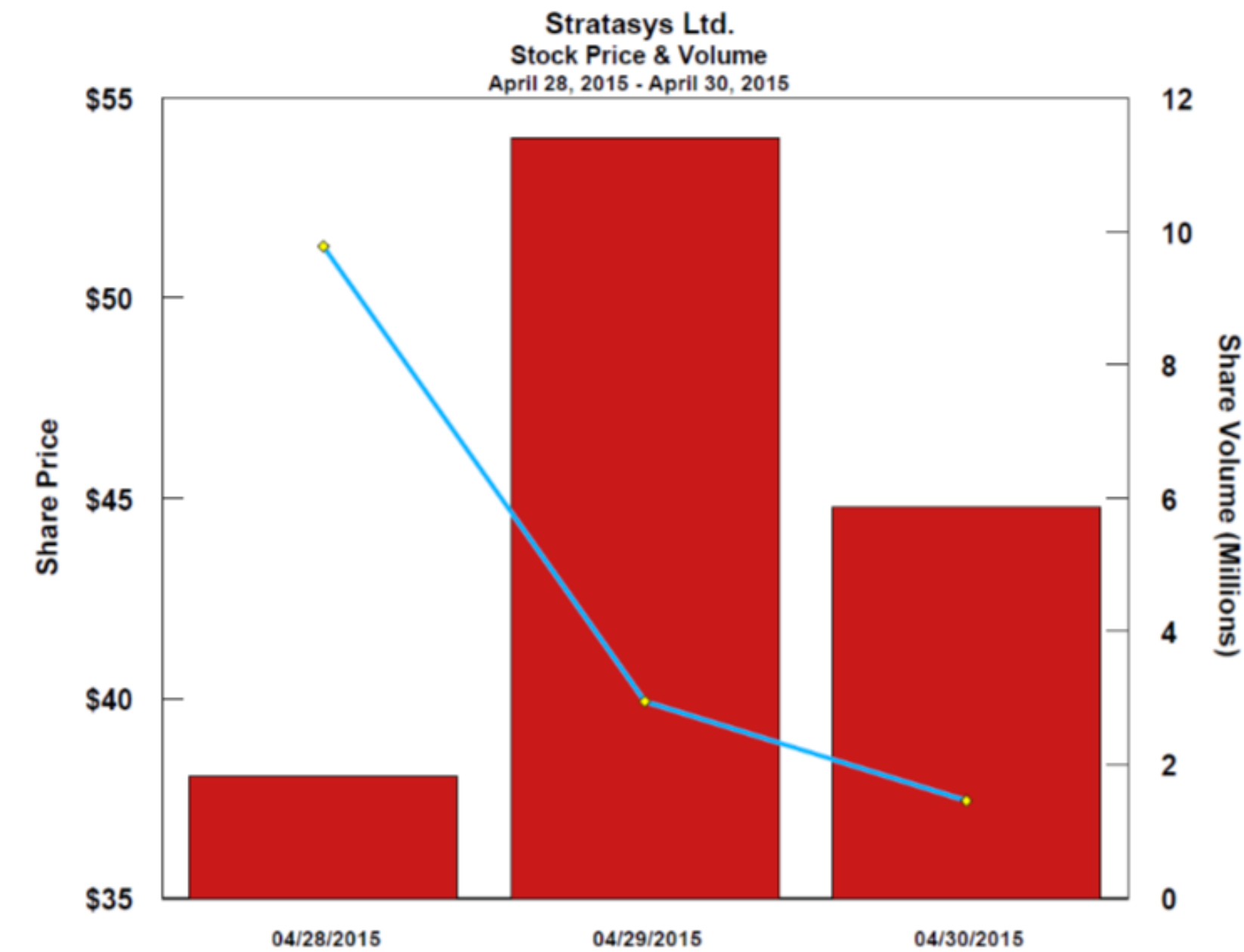
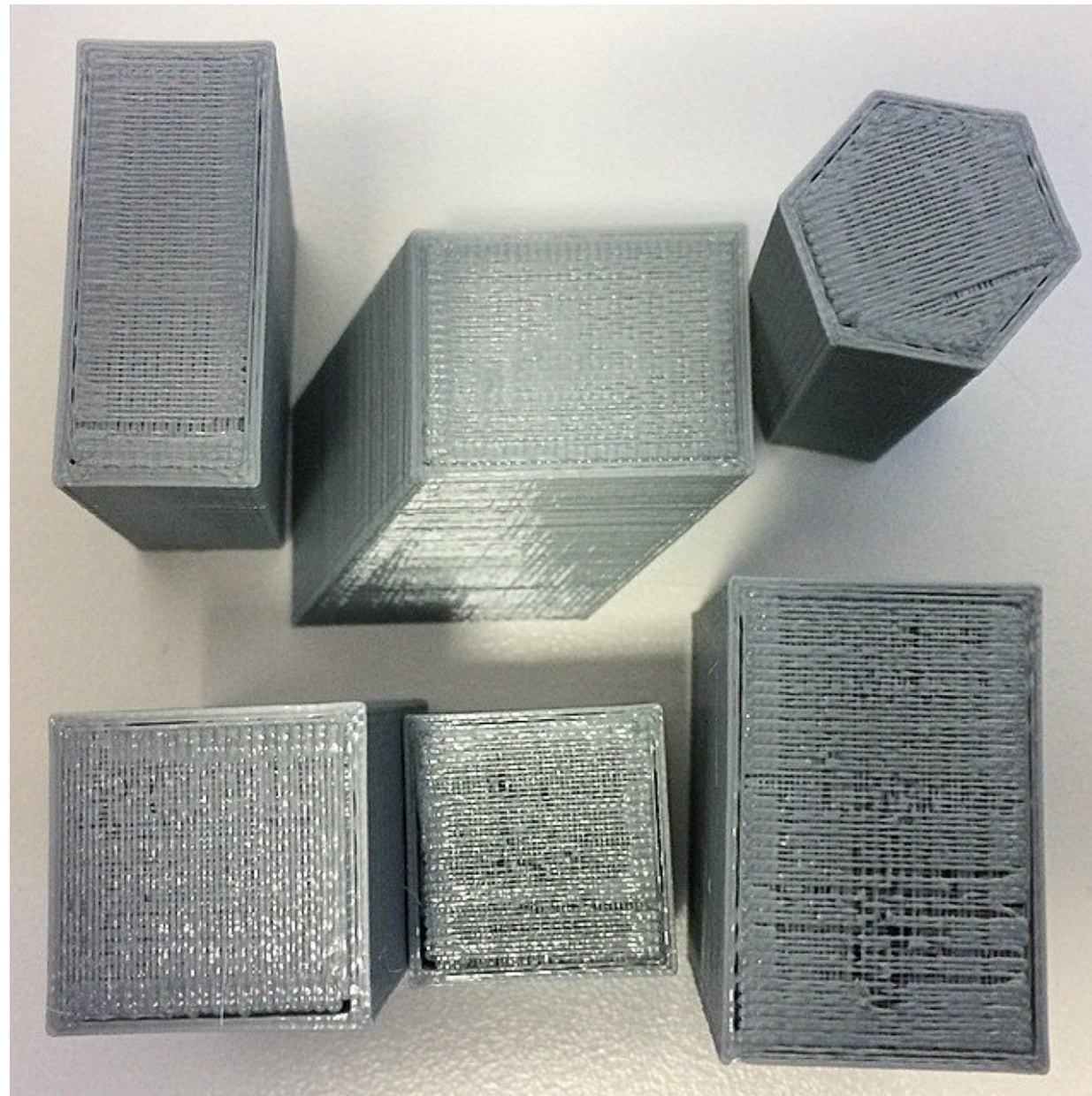
Sheet 2 of 3

5,121,329



222. The decline in the Company's stock price by approximately 27% on April 29 and April 30, 2015, was the direct result of the nature and extent of the revelations made to the market regarding the severity of the financial and operational issues facing Stratasys and its MakerBot unit that had been concealed or misrepresented by Defendants.

Old School Ideas vs. New School Challenges

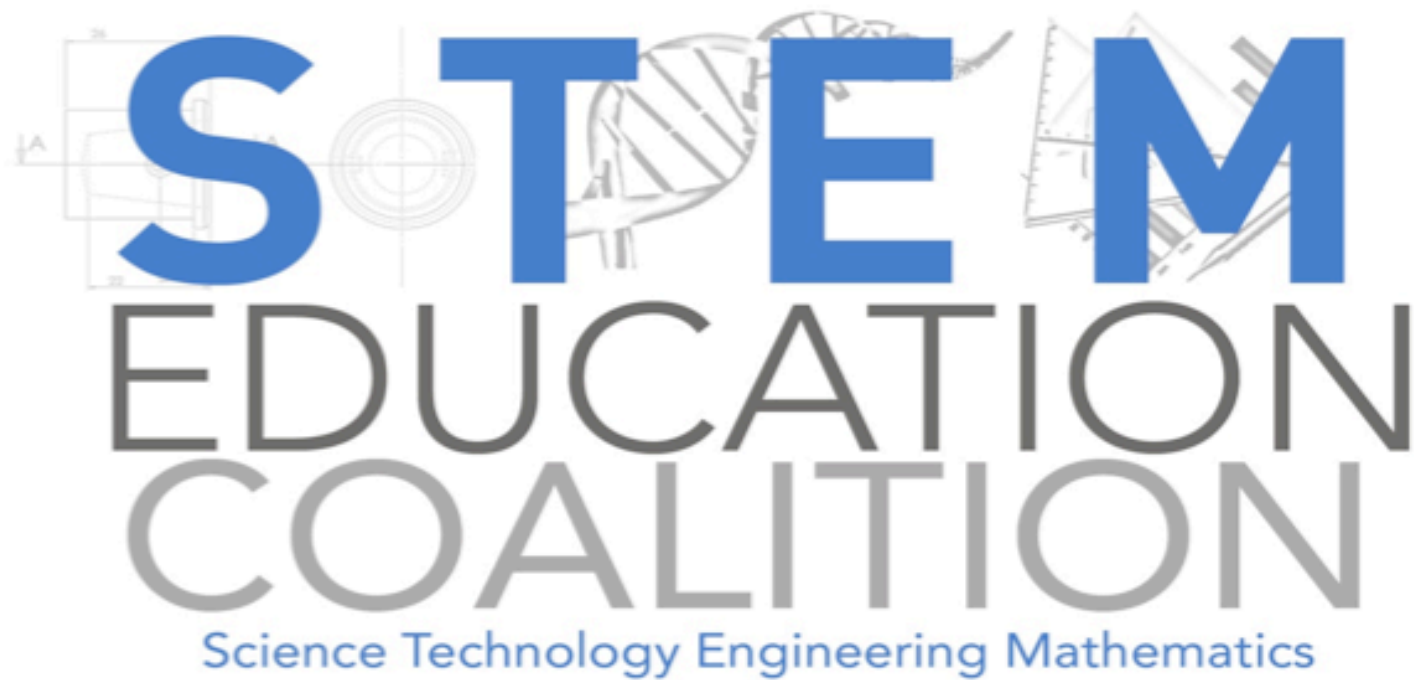


222. The decline in the Company's stock price by approximately 27% on April 29 and April 30, 2015, was the direct result of the nature and extent of the revelations made to the market regarding the severity of the financial and operational issues facing Stratasys and its MakerBot unit that had been concealed or misrepresented by Defendants.

The Next Industrial Revolution?

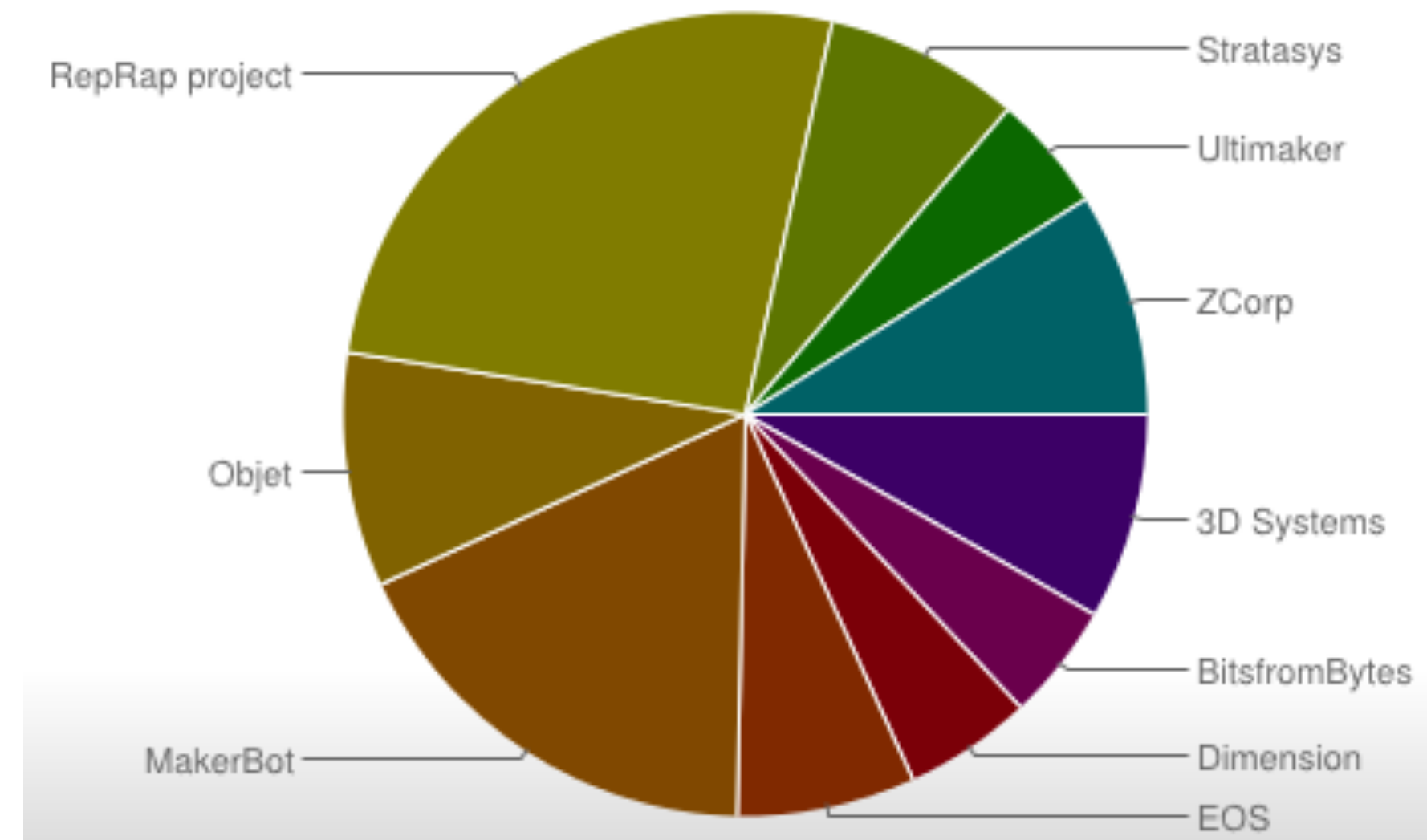
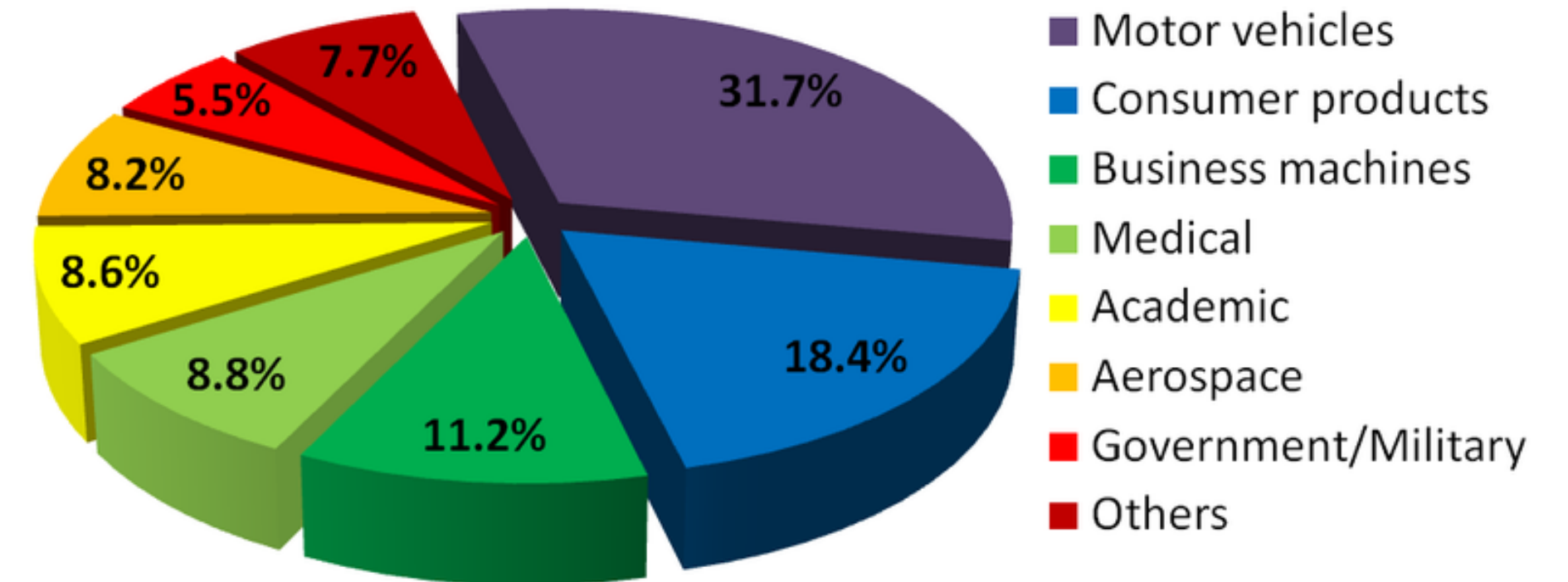
3D printing has the potential to revolutionize the way we make almost everything. The next industrial revolution in manufacturing will happen in America. We can get that done.

BARACK OBAMA



3 Create an Innovative 3D Printing Curriculum

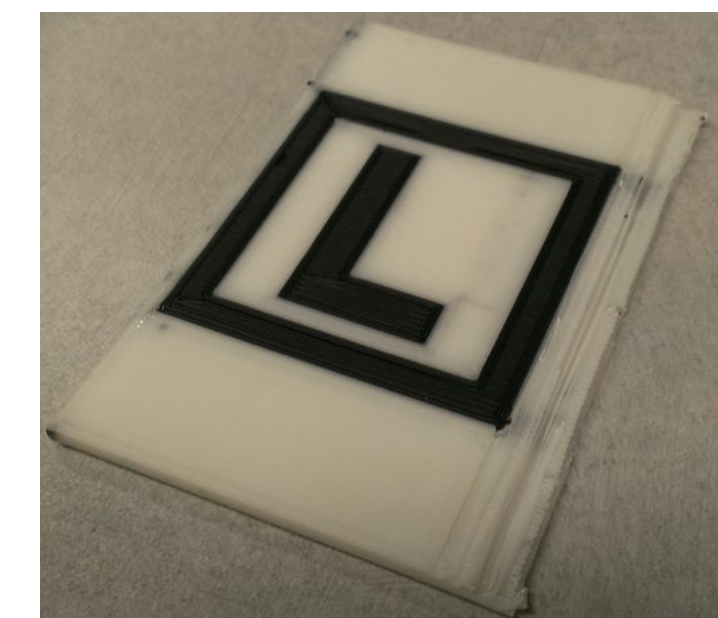
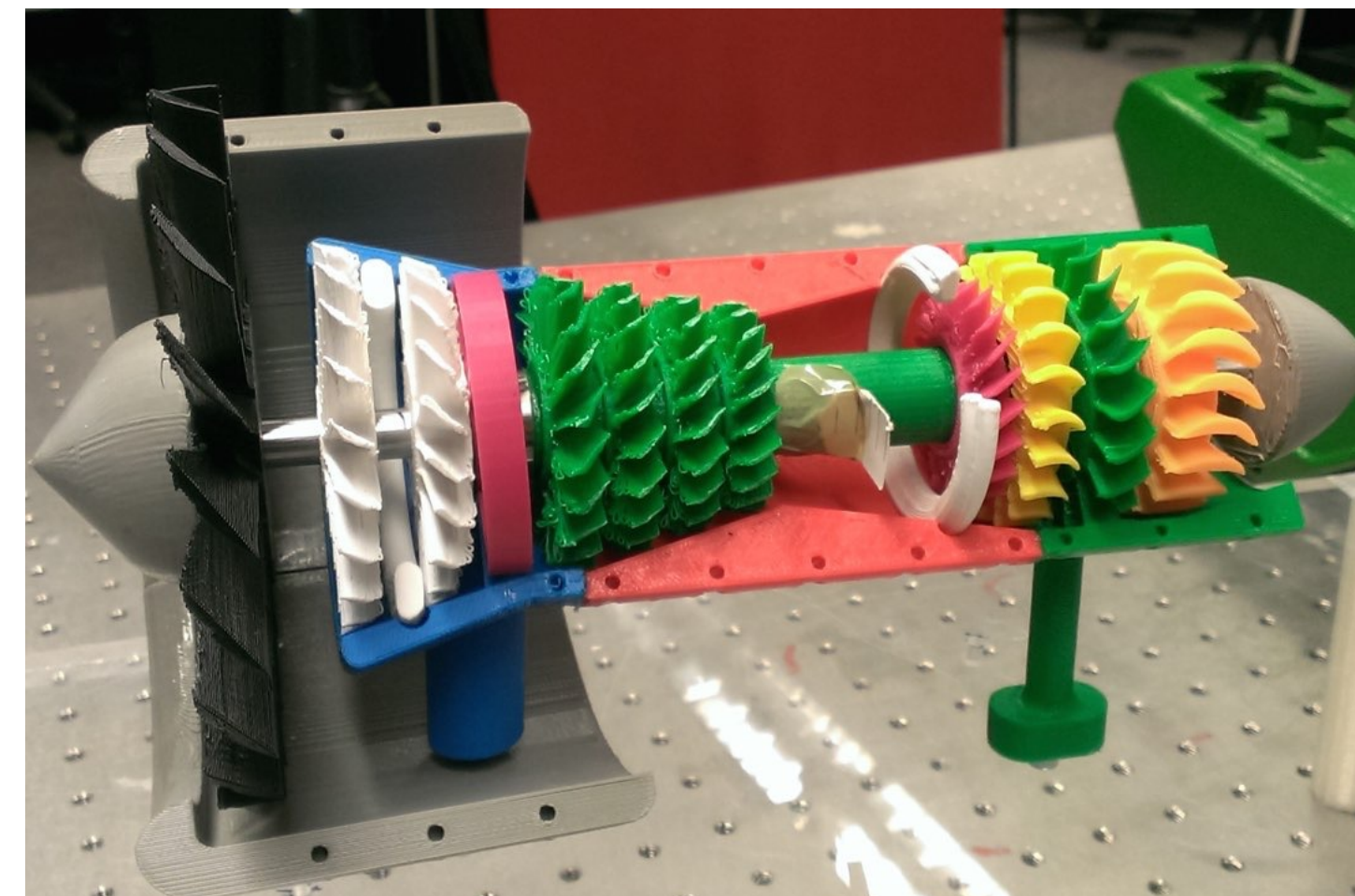
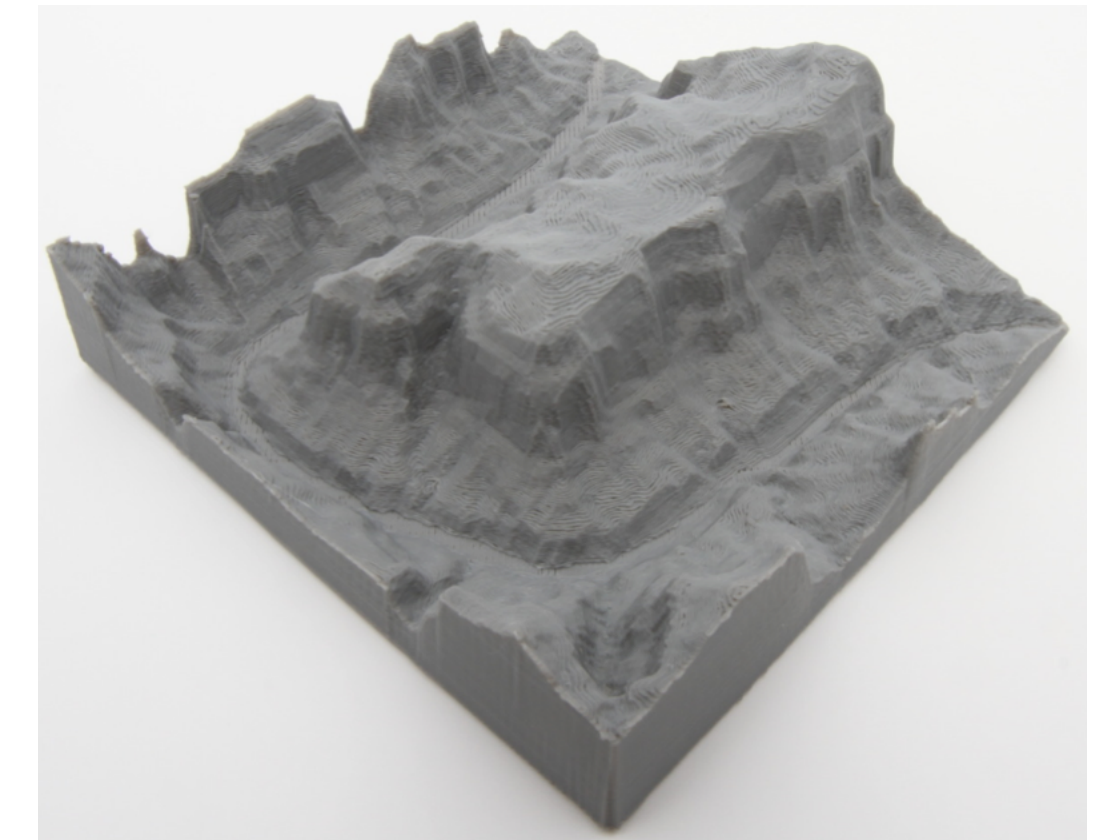
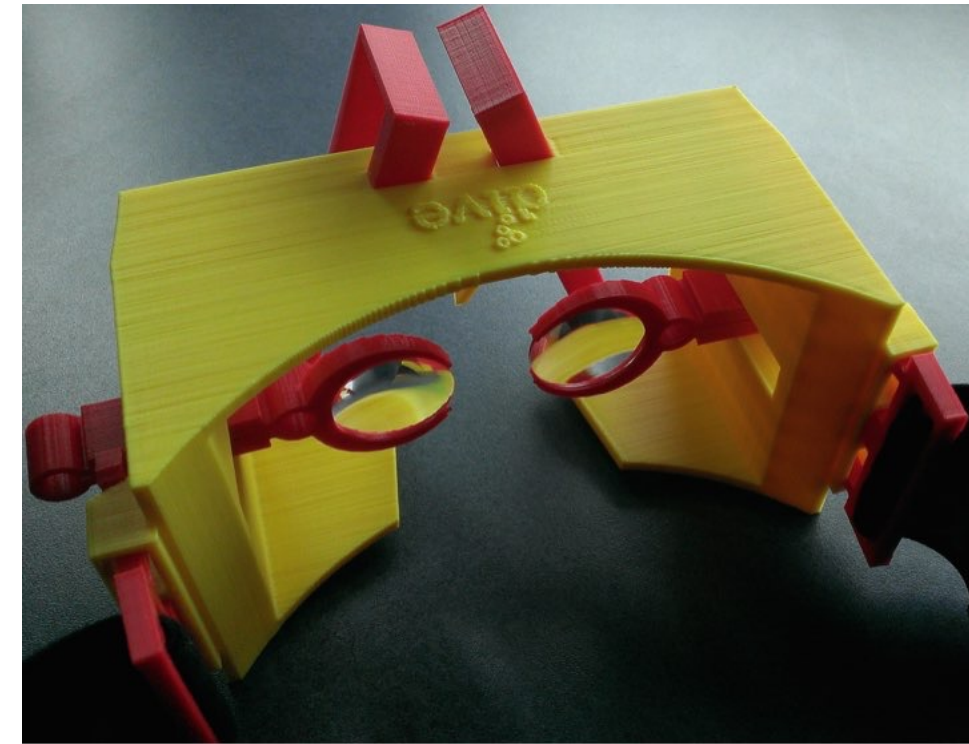
MakerBot Academy is working on a curriculum to help American teachers and schools integrate 3D printing into their lesson plans. We'll be sure to have more initiatives and Thingiverse design challenges in the future and can hardly wait to share them with you.



10 Minute Break

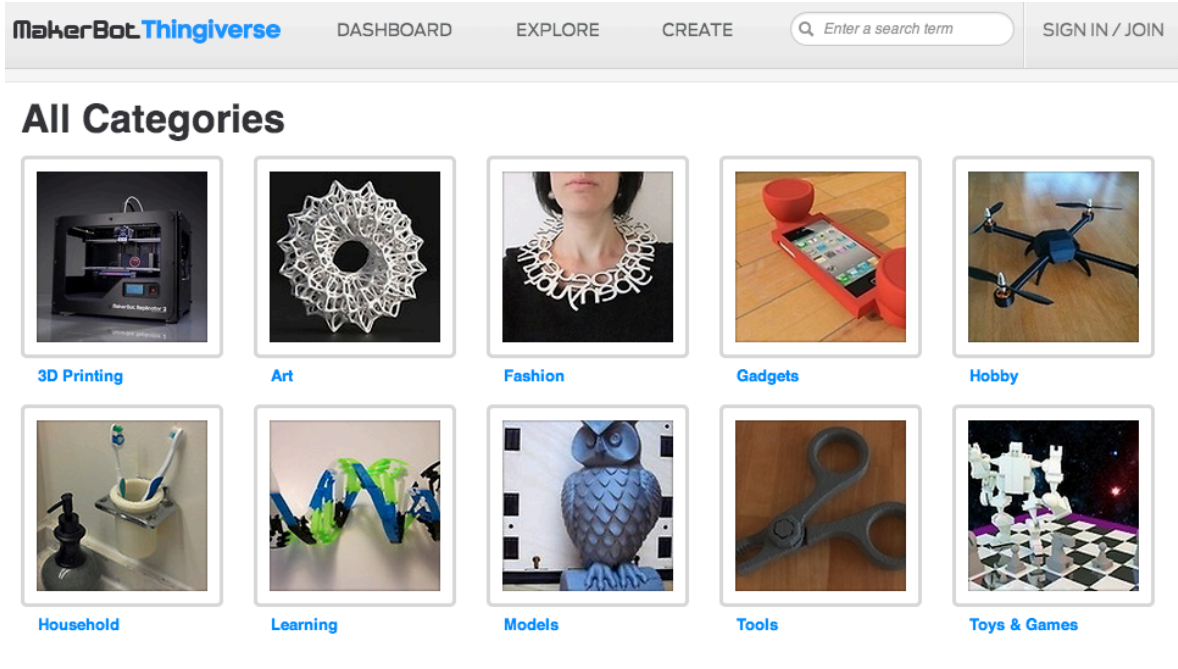
(Human + Printer) * (Human + Application) = Success

- Low-cost VR HMDs
- Geographic Information Systems (GIS)
- Product Design Curriculum development using Constructionism Theory
- Augmented Reality (markers and feature-based)

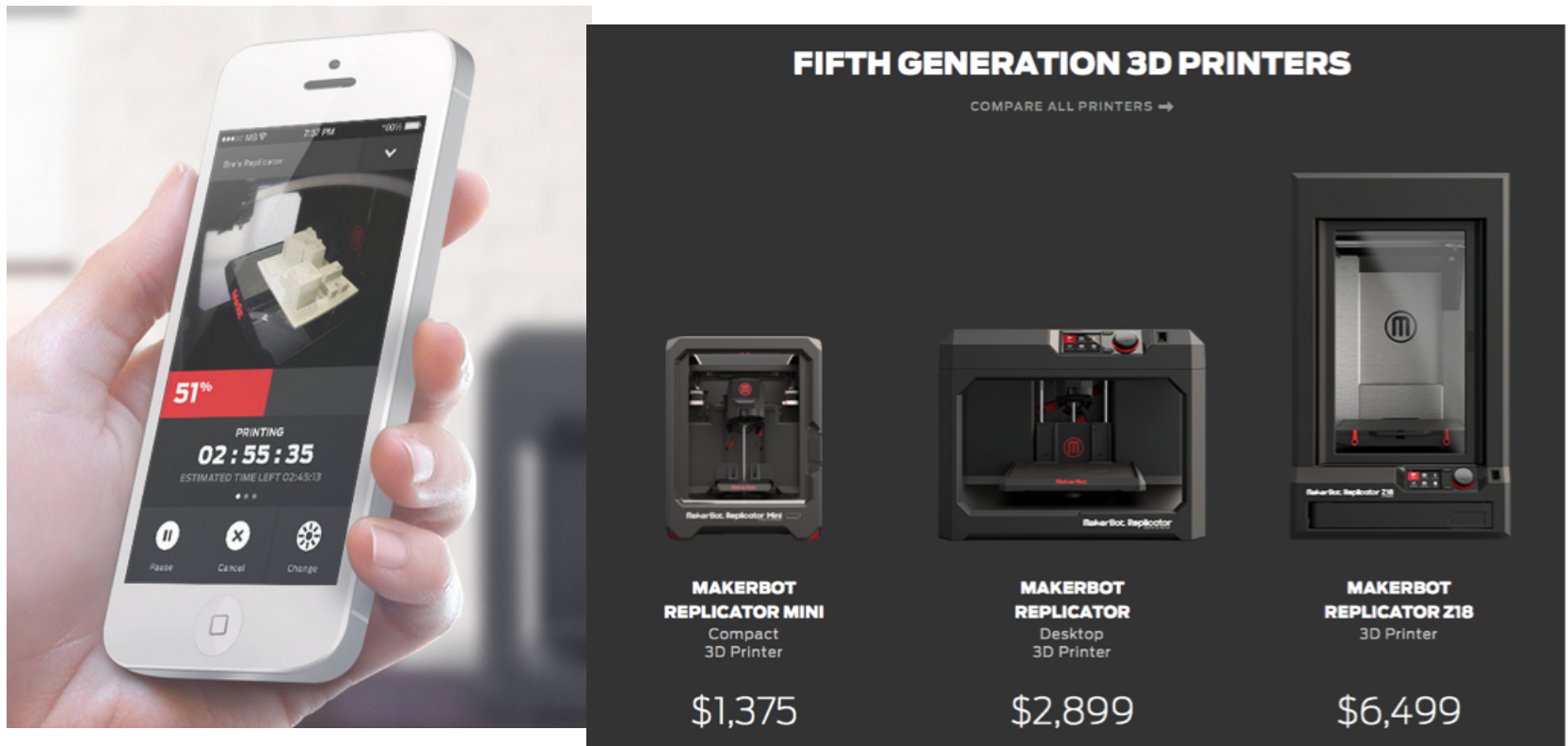


“Human Printer Interaction” (HPI) or HCI?

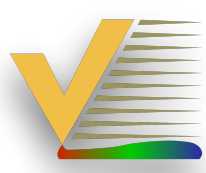
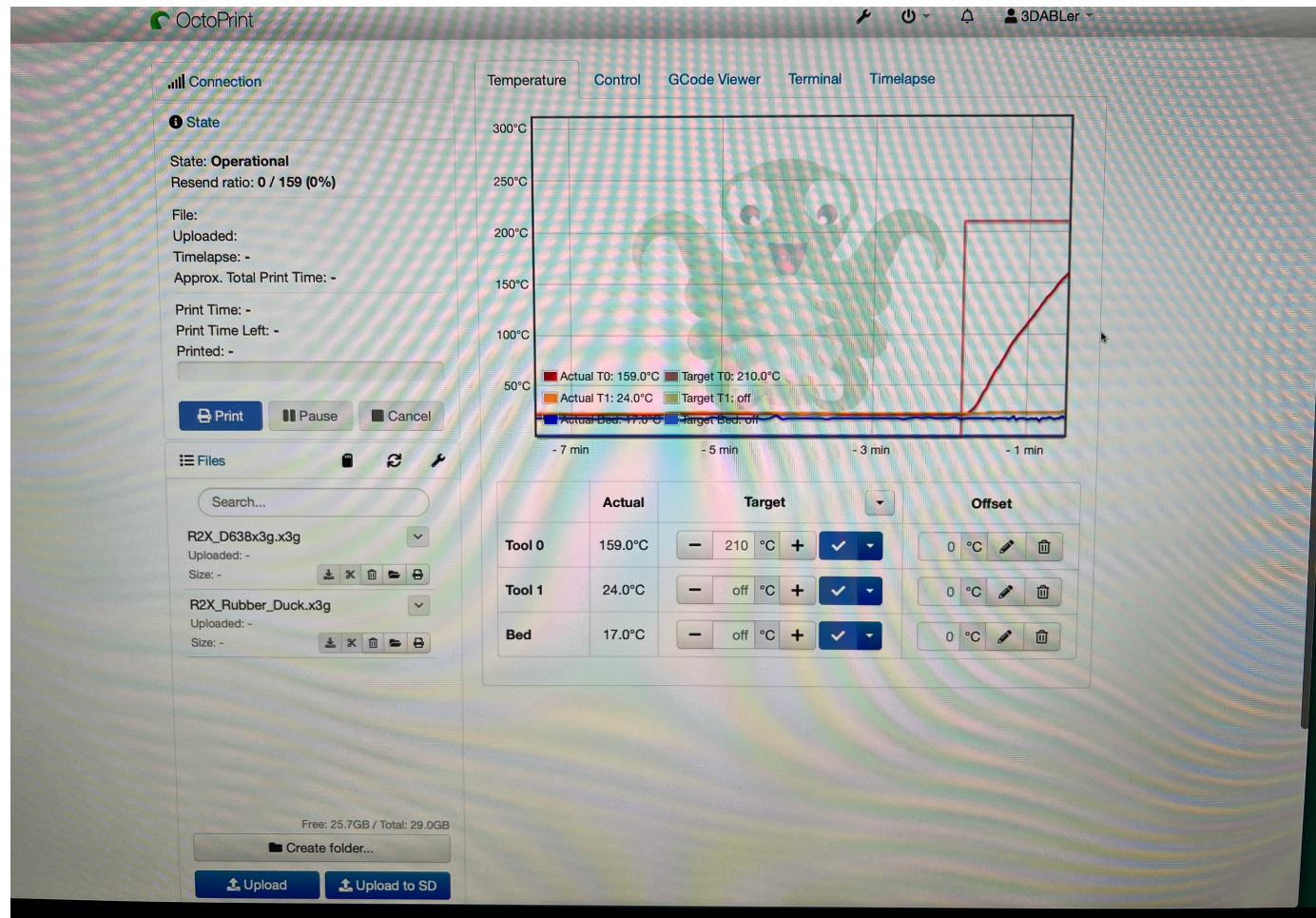
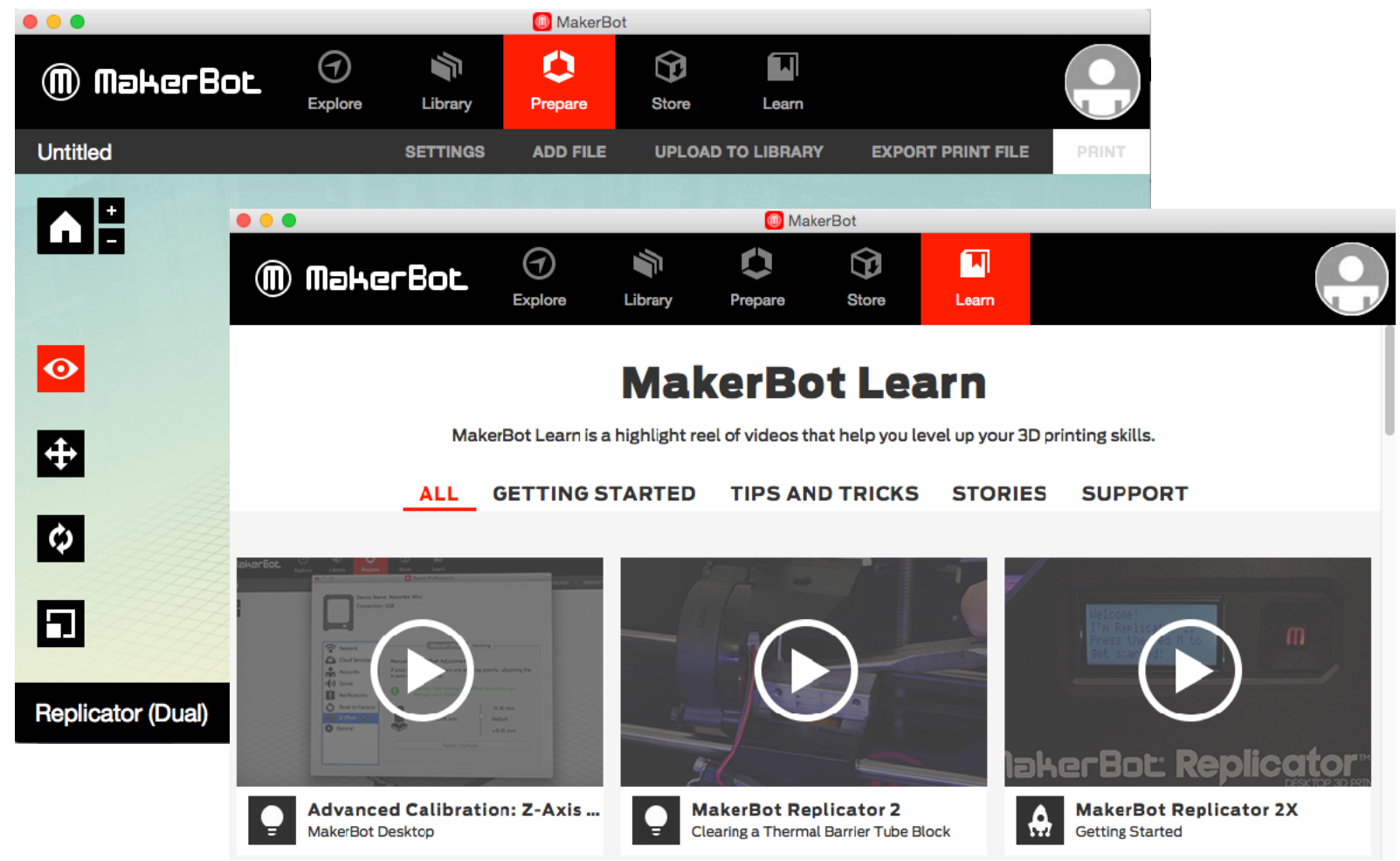
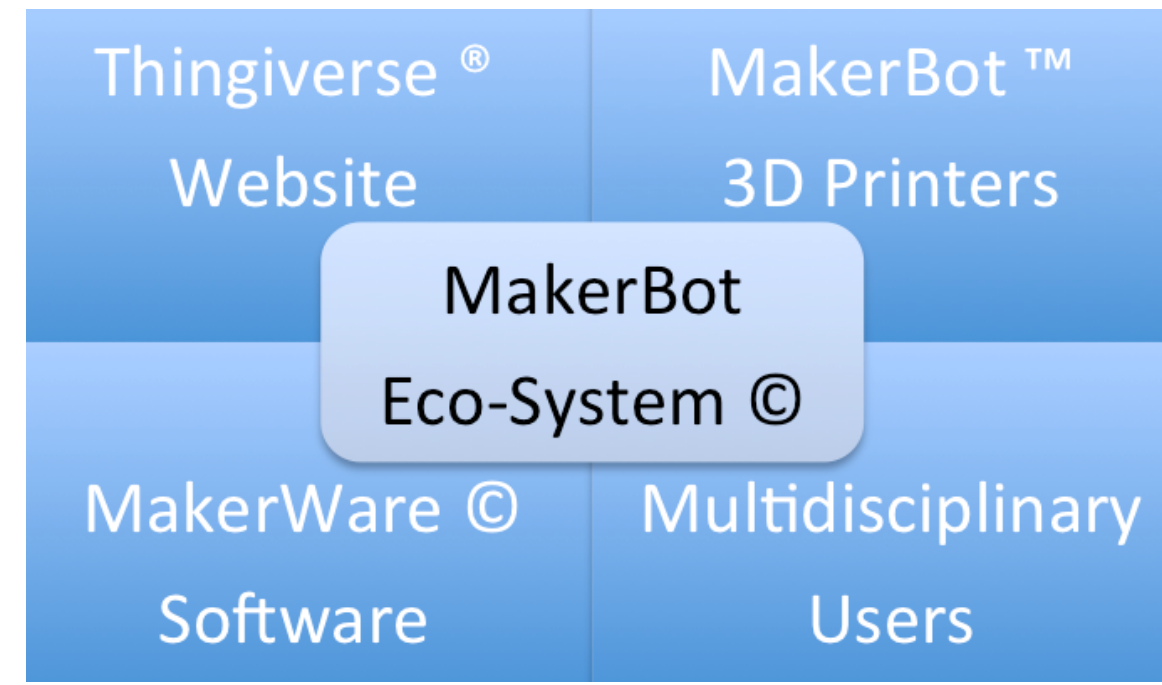
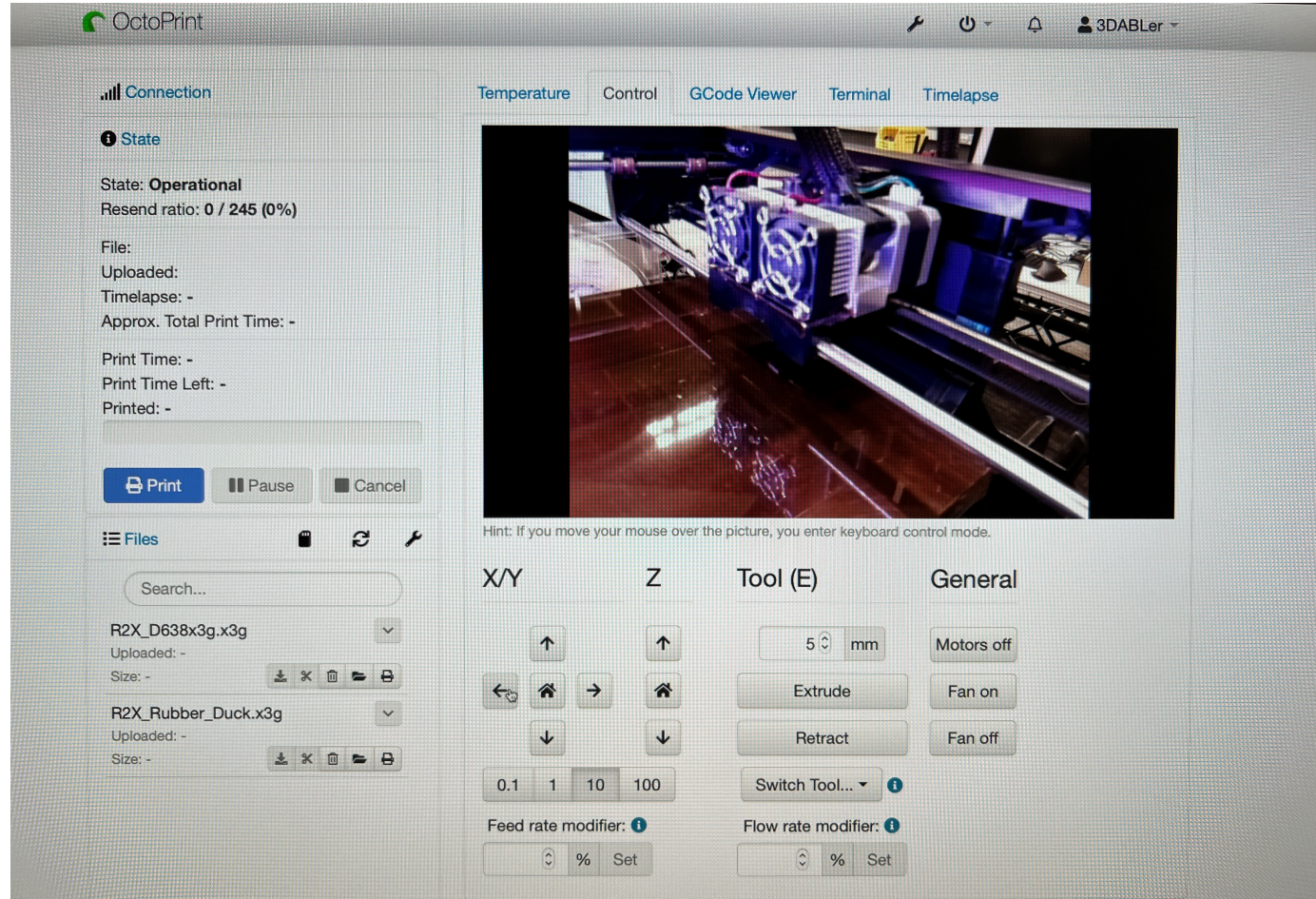
2014



2015

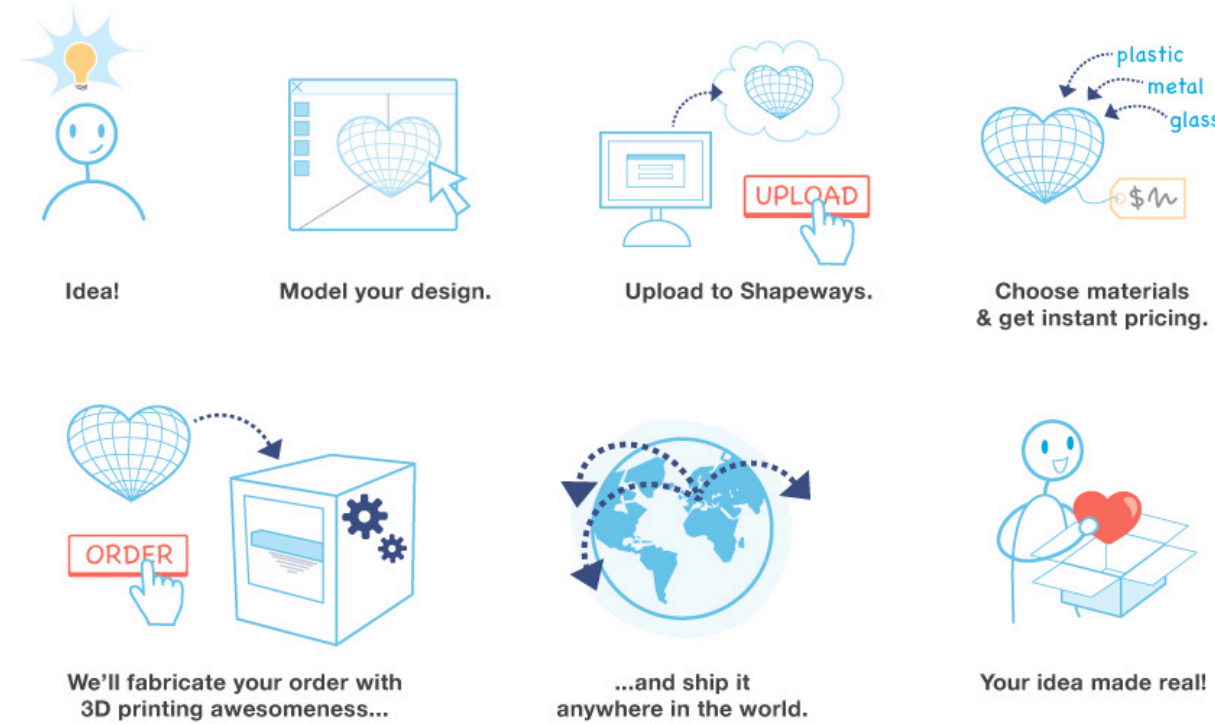


2022



Printing Without Shipping

shapeways



AUTODESK 123D + sculpteo

Good for Everyone... ..Great for Business

- Repair your files easily
- Transparent Pricing
- Rapid delivery
- See and share your design
- Use almost any format
- Hosting included
- Unlimited stock
- No startup costs
- White label solution
- Secure & confidential
- Dedicated support

[Learn more...](#)



3D HUBS 3D PRINT TALK LEARN LOG IN 3D PRINT

Select a printer

Your location: Ames, United States

Hub can provide shipping Within 250 KM

ADVANCED OPTIONS

Which material is right for me? Check out the 3D Hubs' Materials Guide

TITLE	DISTANCE	RATING	MATERIALS	RESOLUTION	RESPONSE TIME
Nate's Hub CTC-3D	12.8 km	★★★★★ (1)	ABS and PLA	Medium	Within the hour

Hub Reviews based on 1 review

Print Quality: ★★★★★

Service: ★★★★★

Speed: ★★★★★

Communication: ★★★★★

About Nate's Hub:
VIEW PROFILE

I have a CTC-3D Replicator Printer, currently it is running MakerWare Firmware.

Printing options

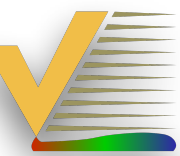
Pick material: ABS

Choose color: brown

Delivery: pickup

[ADD FILES FOR PRICES](#)

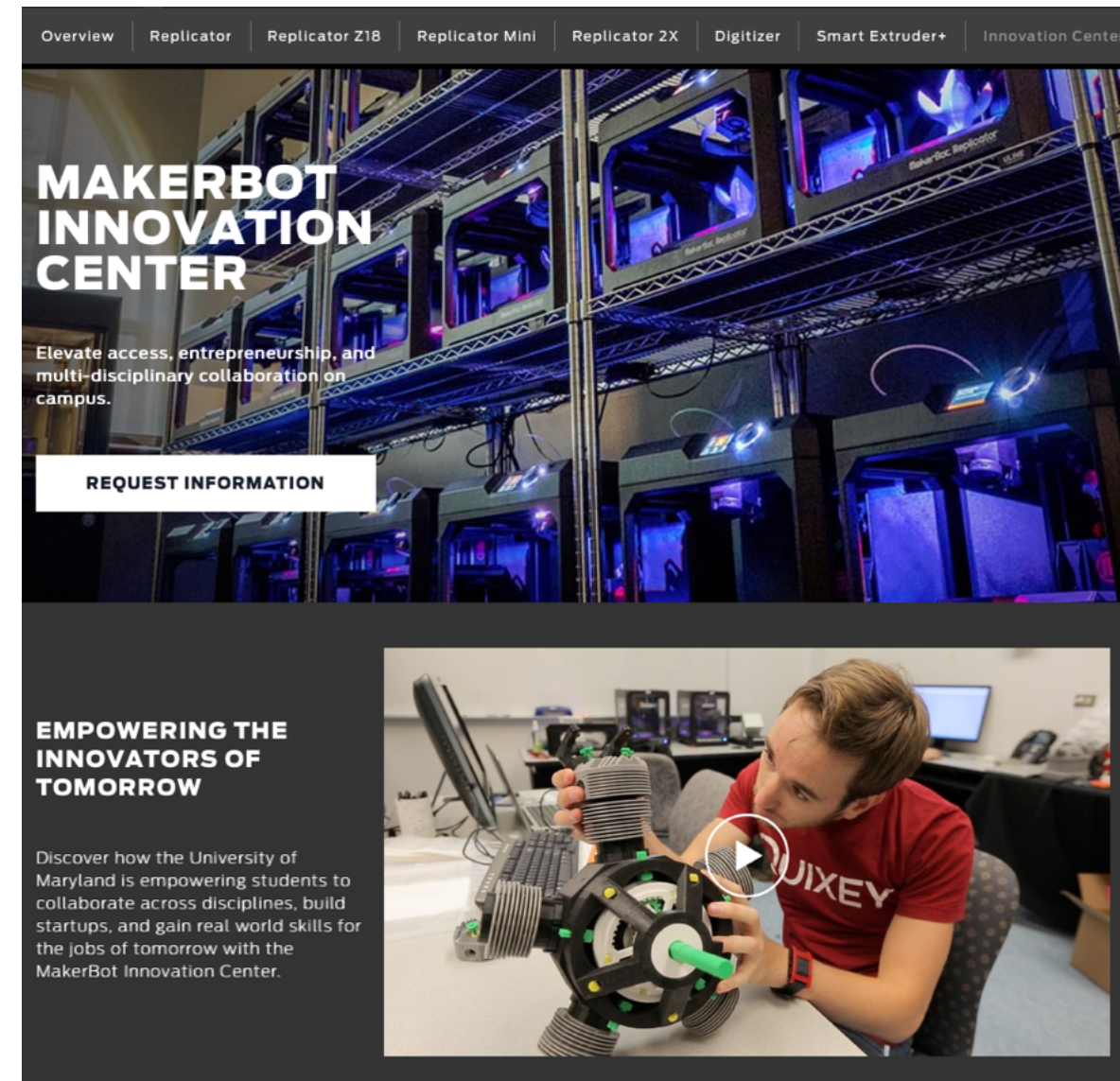
RL	Ryan's Hub Rostock MAX	56.6 km	★★★★★ (2)	ABS, PLA, T-Glase, Ninjaflex and 2 more	Medium	Within the hour
PW	Patrick's Hub Prusa i3	141.3 km	★★★★★ (1)	ABS, PLA and bronzeFill	Medium	Within the hour
RR	Rapids Reproduction's Hub Projet 3500 HD	149.4 km	★★★★★ (1)	VisiJet Crystal	Ultra	Within the hour
RR	Rapids Reproduction's Hub Projet 660	149.4 km	★★★★★ (1)	VisiJet PXL	Medium	Within the hour
	Ben's Hub Kossel	163.8 km	★★★★★ (1)	ABS	Medium	Within the hour
BT	Tecton Ind., Inc.'s Hub Fortus 400mc	183.6 km	★★★★★ (2)	ABS M30 and ULTEM	Medium	Within the hour
JD	Jimmy's Hub Makerbot Replicator 2	212.1 km	★★★★★ (1)	PLA	Medium	Within two hours
CH	chorob's Hub Printbot Simple Metal	217.3 km	★★★★★ (1)	PLA	Medium	Within the hour
JP	James's Hub Prusa i3	224.8 km	★★★★★ (2)	ABS, ABS Conductive and PLA	Medium	Within four hours
JP	James's Hub RepRap	224.8 km	★★★★★ (2)	ABS, ABS Conductive, PLA, TPE and T-Glase	Medium	Within four hours
KL	Tethon 3D's Hub Zcorp	230.1 km	★★★★★ (1)	Porcelain	High	Within the hour



3D Printer Training

- Training Modes (Example: MakerBot)

- Innovation Center
- Webinars
- Video Tutorials



Reach a new level of cutting-edge innovation [REQUEST A QUOTE](#)

Case Studies

White Papers

Webinars

Videos



Leveling Up: Starting Points for 3D Printing in the Classroom

INDUSTRY: Education

A discussion with 3D printing education power user Laura Taalman on why you might want to use 3D printing in your classroom and how you can start learning about 3D design and printing.

[View Webinar](#) →

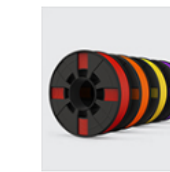


Education Stories: An Overview of Customer Success Stories

INDUSTRY: Education, K12-Schools

A MakerBot education expert discusses the many uses of 3D printing in the classroom, stories of success, and features of MakerBot Replicator Desktop 3D Printers.

[View Webinar](#) →



Product Webinar: MakerBot Filament

INDUSTRY: All

A walk-through of the filaments MakerBot offers and the importance of using high quality filament to ensure successful prints.

[View Webinar](#) →



Commercial Applications of 3D Printing: Revolutionizing Design and Prototyping

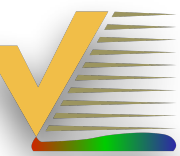
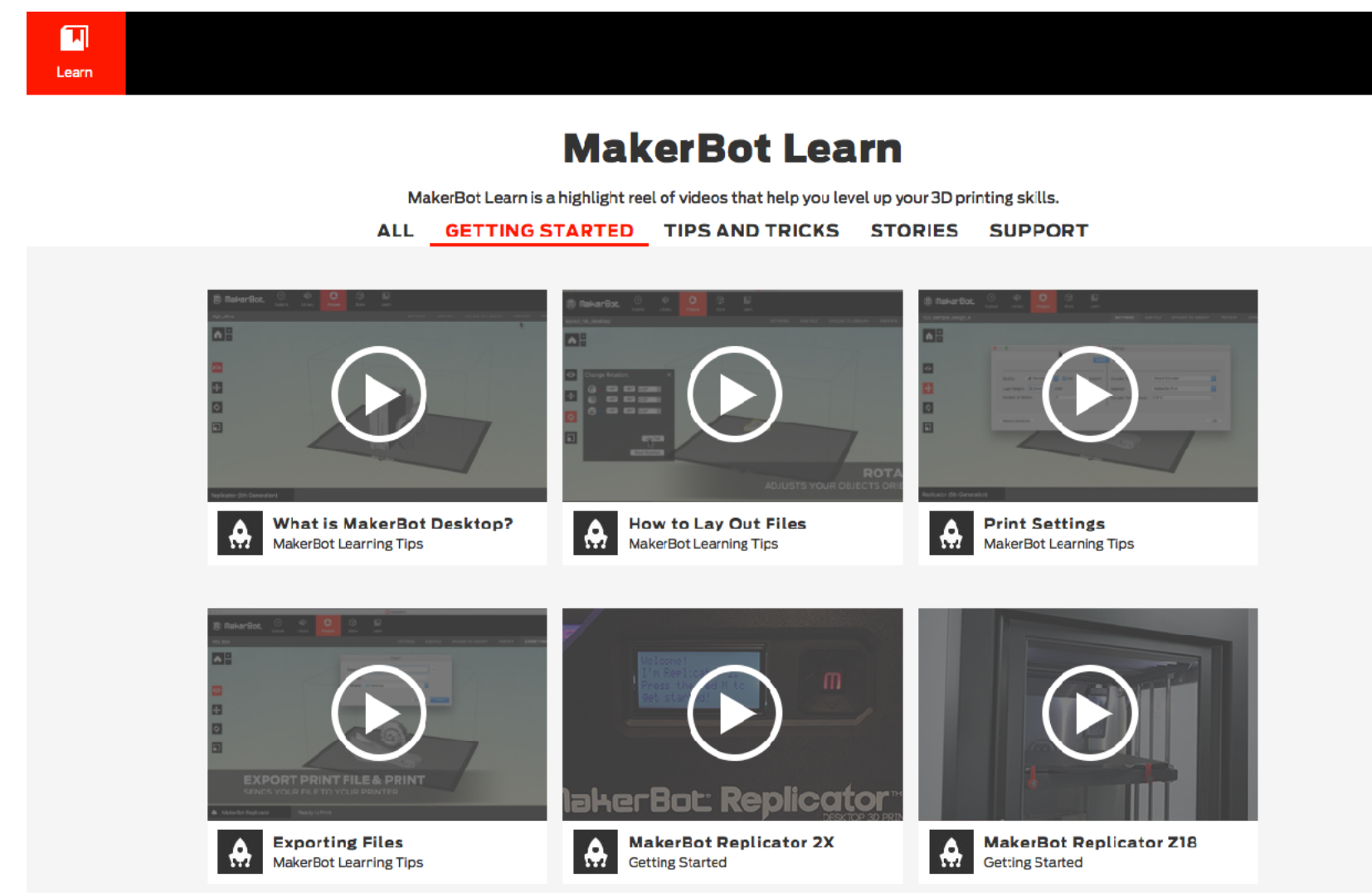
INDUSTRY: Commercial

MakerBot customers are revolutionizing the design and prototyping process in the commercial space with MakerBot's ecosystem of hardware, software, designs, and support.

[View Webinar](#) →

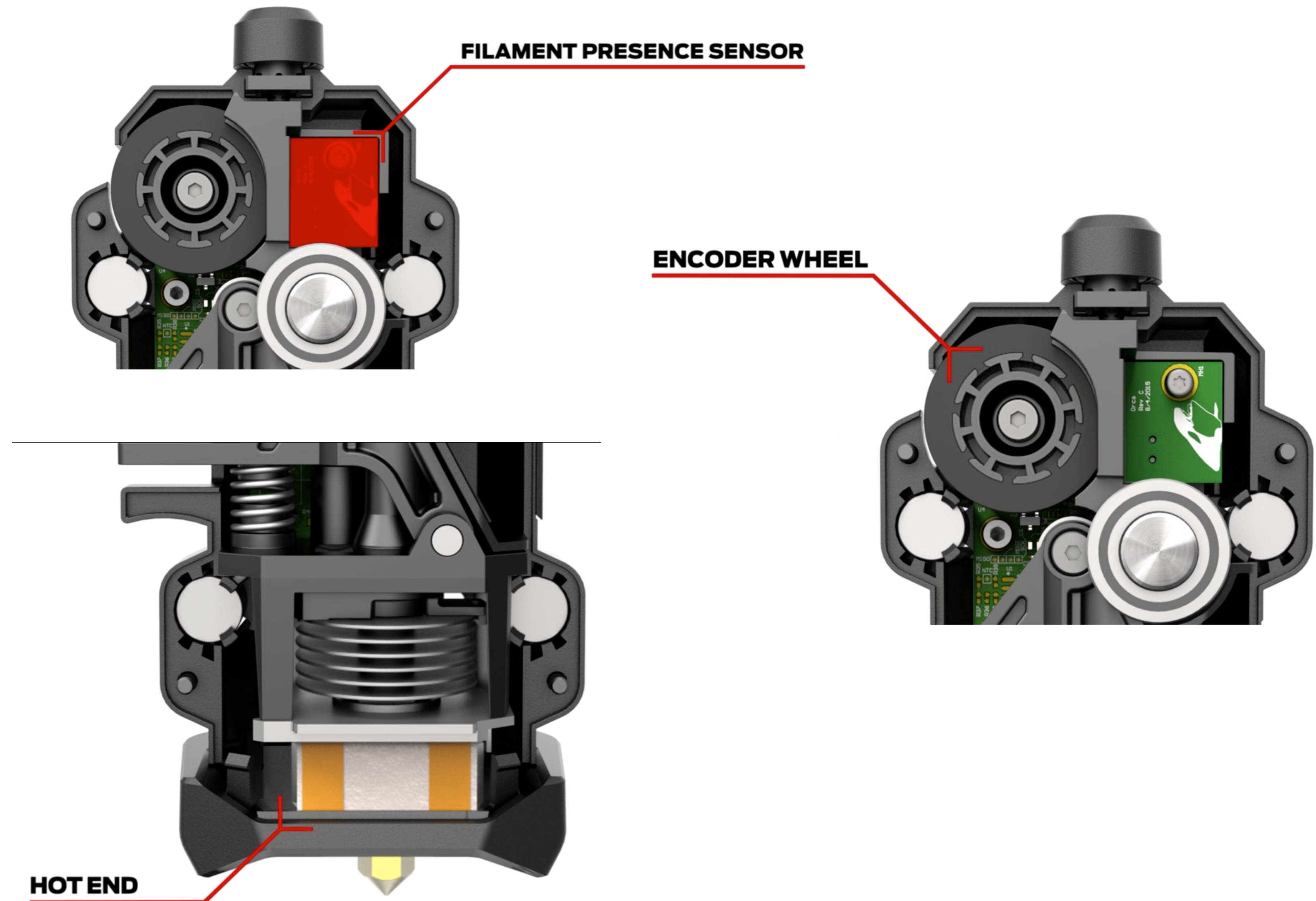
- Which part is the best one to use for Training in any Mode?

- Which material is the best one to use for Training in any Mode?



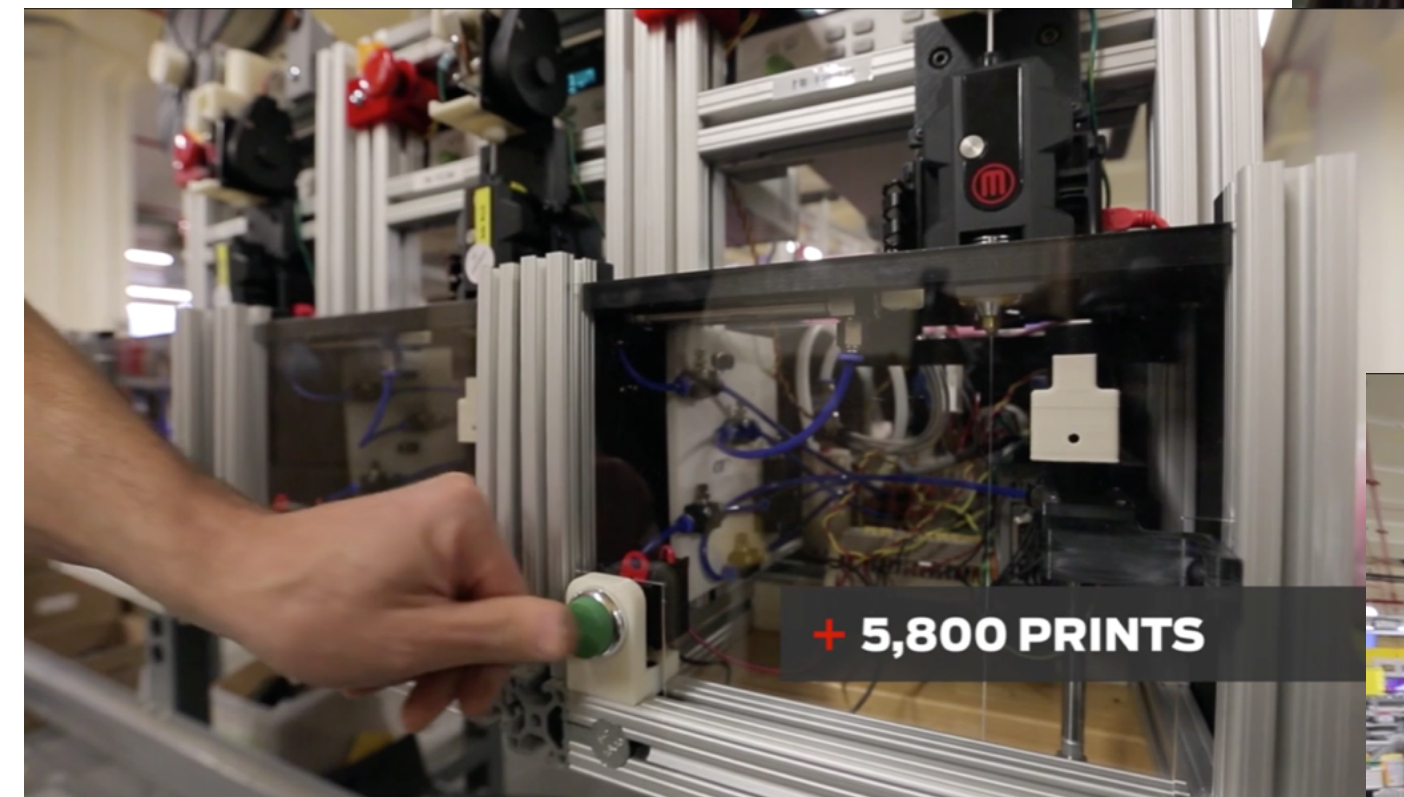
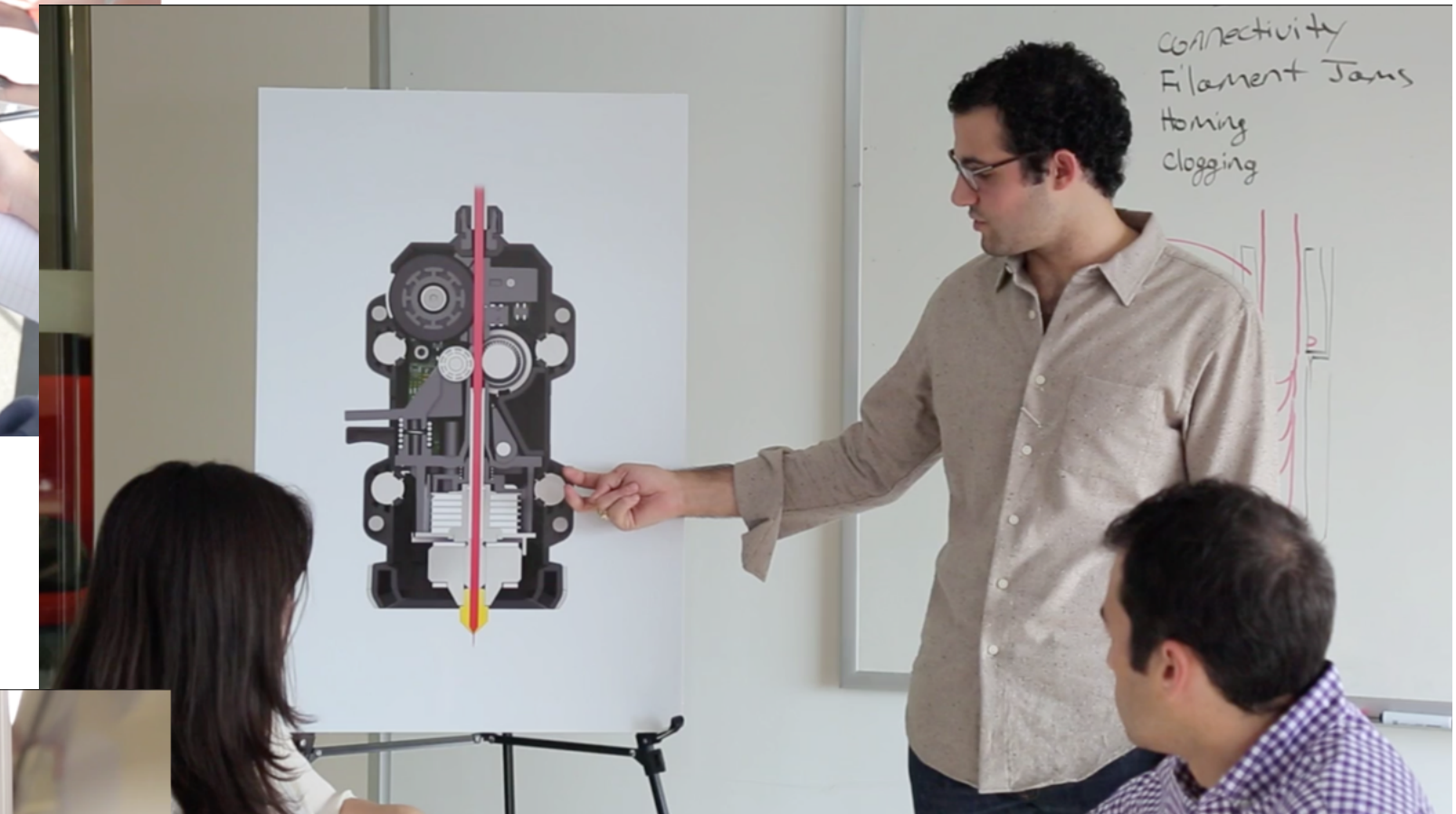
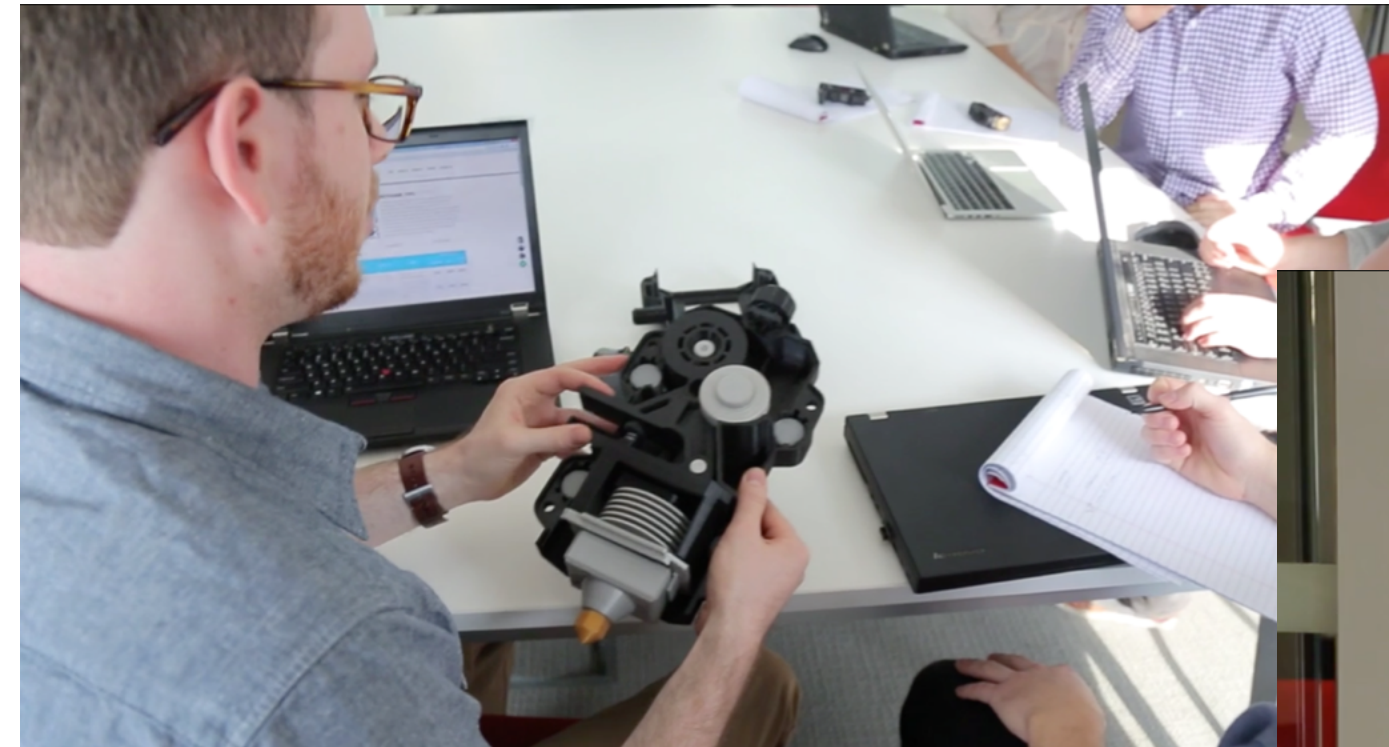
Who's Smarter? You or the Extruder?

- How can you test if there's filament present in an extruder?
- Can an encoder test if filament is going through the nozzle?
- What temperature(s) do you want the hot end of a FFF machine to be exposed to?



Prototype Testing, Production, or Quality Assurance?

- Prototype of a Rapid Prototyping machine
- Actual Engineering of a machine component that makes things
- Lots of very controlled testing of 3D printing
- #hours * #prints = 3D printer or “3D copier”?



MCA Session 3, In-Class Activity #2

- Terminology / component labels: describe in your own words
- Common component terminology to be added after the in-class activity
- Focus on function - what does each component do to help 3D print parts?

