Open Ended 3D Printer Design

3D Manufacturing

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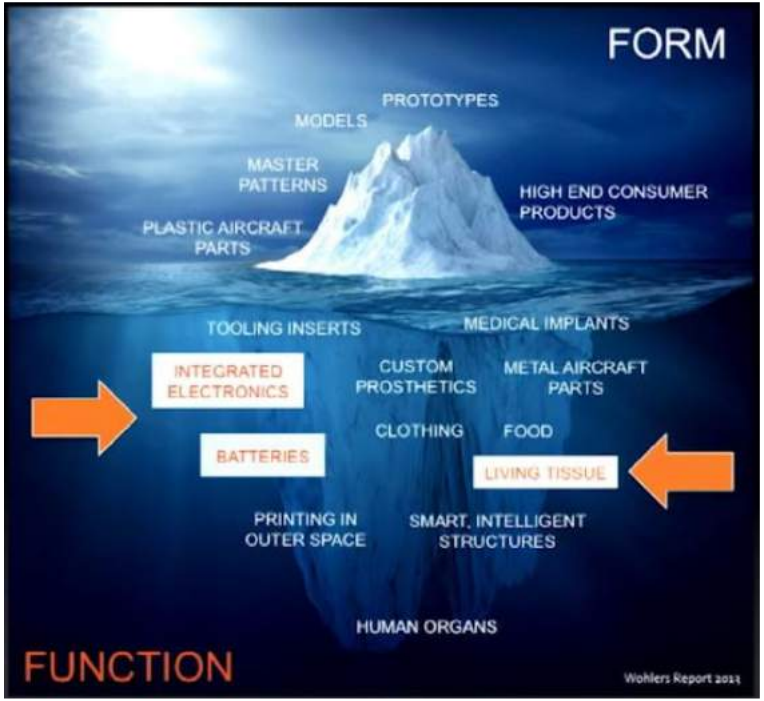
What's the Project?

- New Advanced Manufacturing Interdisciplinary Program
  - New teaching laboratory
  - Educating ~400 undergraduate and ~150 graduate students
  - Departments: ME, EE, CS, Phys, Materials, Chem, Math
- Promote learning in additive manufacturing
  - Simple printer use
  - Work on/upgrade/replace components
  - Upgradable software
- We have freedom of choice - technology and material system

Advanced Learning Environment

- Can teach “tip of iceberg” topics
  - Give familiarity with AM process
- Suitable for what’s “under the water’s surface”…
  - Future advances/applications
  - High level research
    - PhD and Research Faculty

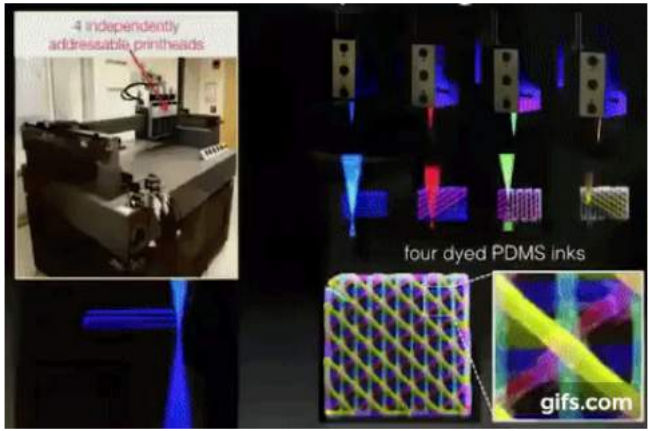


Direct Ink Writing (DIW)

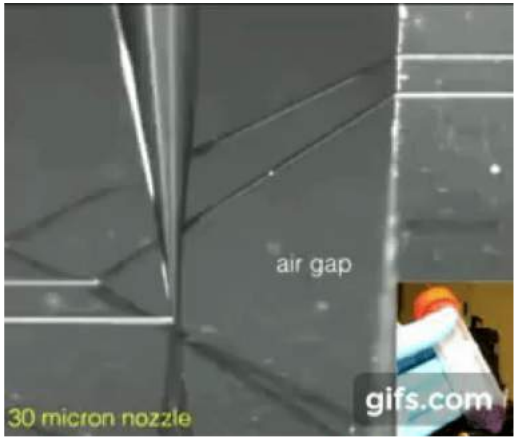
- What is it?
  - Material extrusion process - Paste/ink extruded from small nozzle
  - Nozzle moved across a print surface and dispenses material
  - Process relies on:
    - Shear thinning - material flow through small nozzles without clogging
    - Viscoelasticity - printing of self supporting materials
- What makes it so great?
  - Wide range of applications - medical, energy, manufacturing, electronics, machine learning
  - Wide range of materials - metals, ceramics, Polymer, organic, multi materials, etc.
  - Printing of micro structures

DIW Examples

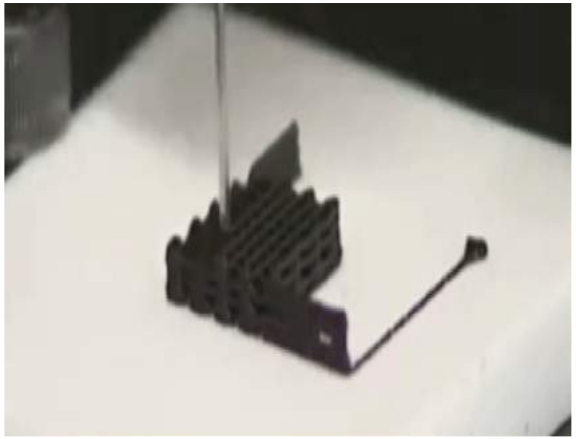
Multi Materials:



Reactive Inks:



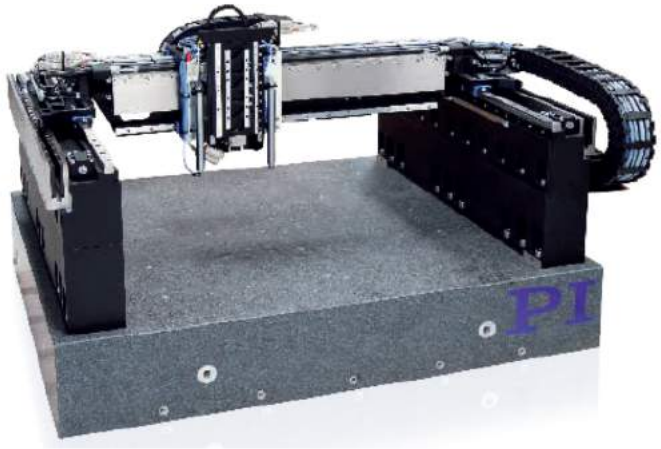
3D Structures:

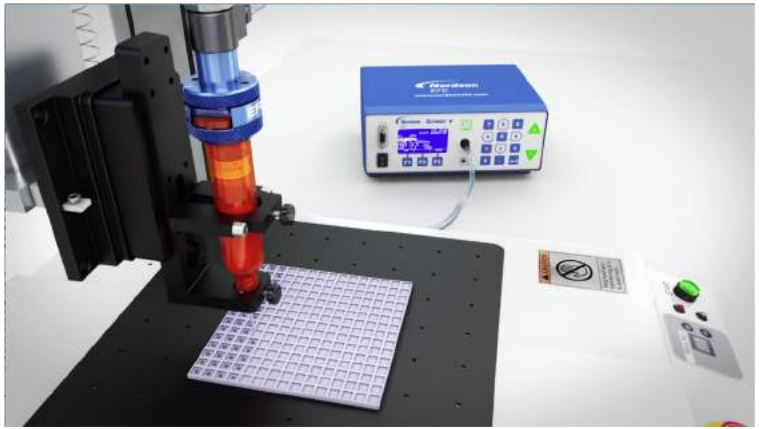


DB Kolesky, R Truby, S Gladman, T Busbee, K Homan, JA Lewis, Adv. Mater. (2016)

Printer Specifications

- PI motion/positioning and Nordson EFD Dispensing
  - High Accuracy + High Repeatability= Minimum Feature sizes of 50 microns
  - 500x300x100mm print area, max load of 10kg, max speed 300mm/s
  - Programming capabilities: Matlab, C++, Python, Labview, etc.
  - Ultimus V Dispenser: Initially print silicons and conductive silver reactive ink





Additional Educational Benefits

- Machine Vision
  - Camera on gantry system - follows nozzle
  - Observe print at over 4000 fps with a field of view as small as 1x1.25 mm at 640x480 resolution
- Thermal Imaging
  - View reactive inks as they are printed
  - Thermal Imaging Software
- Lighting
  - Configurable RGB LED strip
  - Potential for UV curing

The Whole Package

- Observe printing process in action
- Upgrade and work on entire system
- Incorporate custom software and controls
- Work with automation and machine learning
- Work with and develop new materials
- Perform advanced research

Where We Are... Where We Will Be!

- Finalizing design and acquiring CAD drawings from collaborating companies
- Begin procurement of all components
  - Already started on machine vision camera, gantry system, dispensing system
- Over summer:
  - Get dispenser and cameras up and running
  - Order remaining components
- Next semester:
  - Gantry system integration
  - Work out imperfections

Thank You

Any Questions?