Senior Design: Open-Platform 3D Printer

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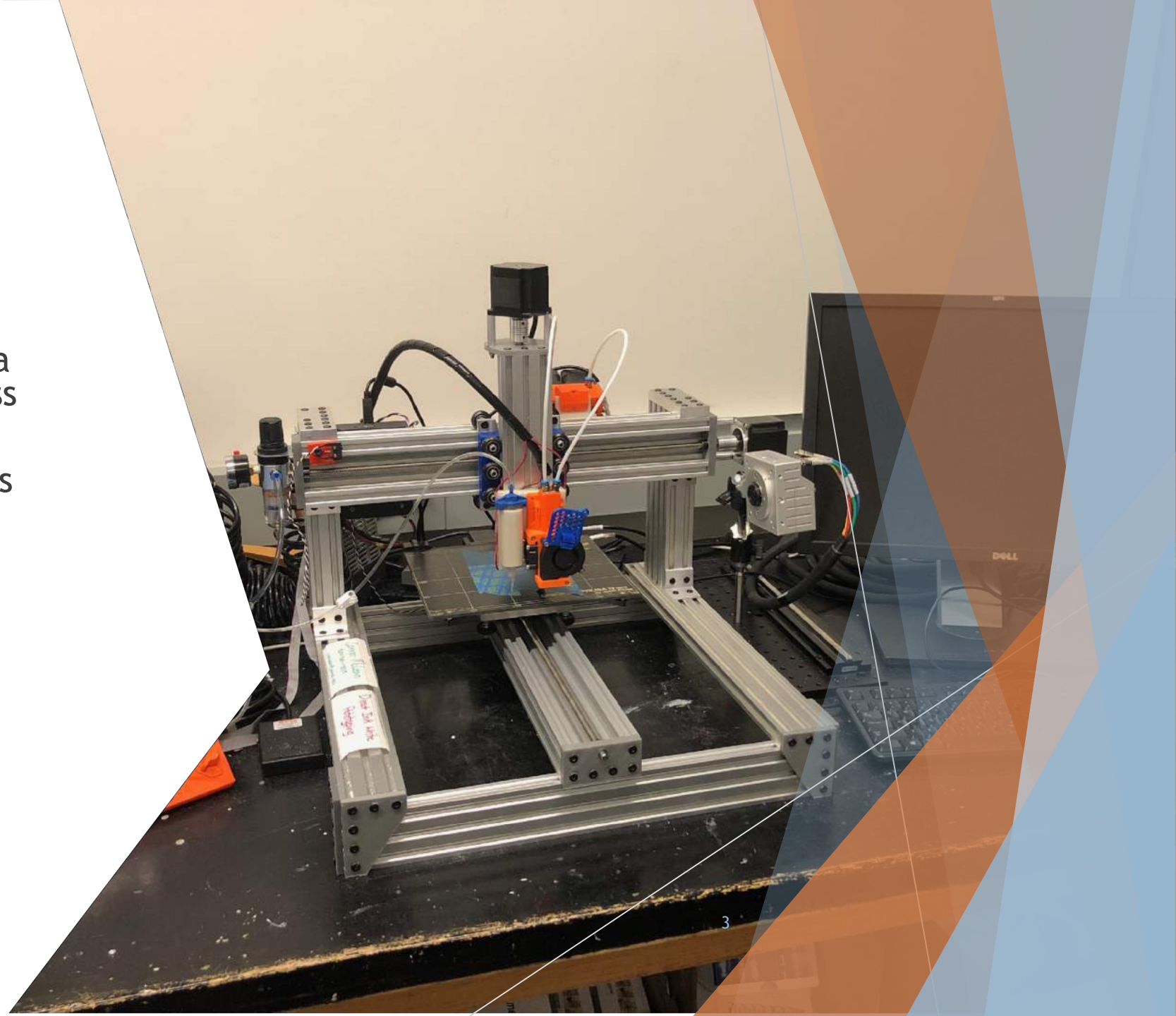
An Open Ended Design Project

- Objective
  - Design and build an open platform 3D printer
  - Teaching laboratory
    - ~ 400 undergraduate & ~150 graduate students
  - Advanced Manufacturing Interdisciplinary Program
- Learning Focus
  - Emphasize student learning
  - Implementation of devices and techniques to aid student understanding

Prototyping Process

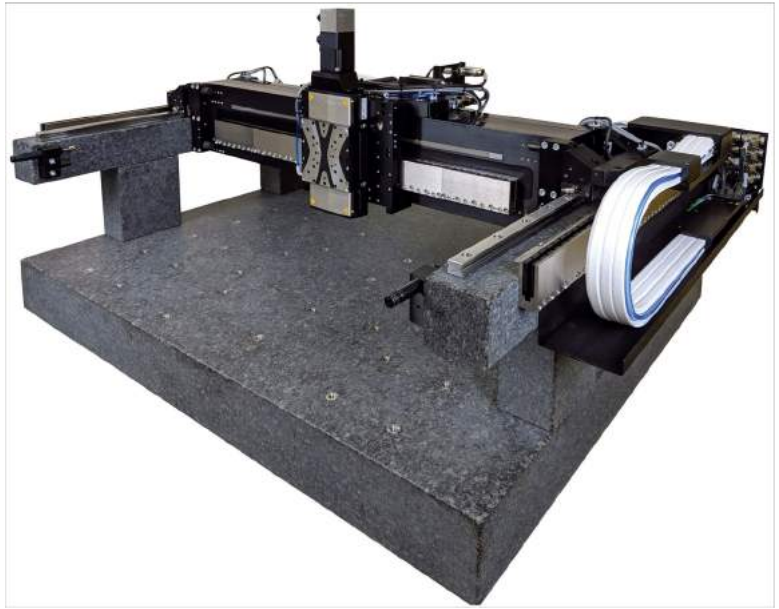
- Direct Ink Writing
  - Paste/ink extruded from a small nozzle moving across a platform
  - Wide range of applications
  - Wide range of materials
- Print Head
  - Pressurized
  - Syringes
    - Ability to quickly change out materials



Printer Specifications

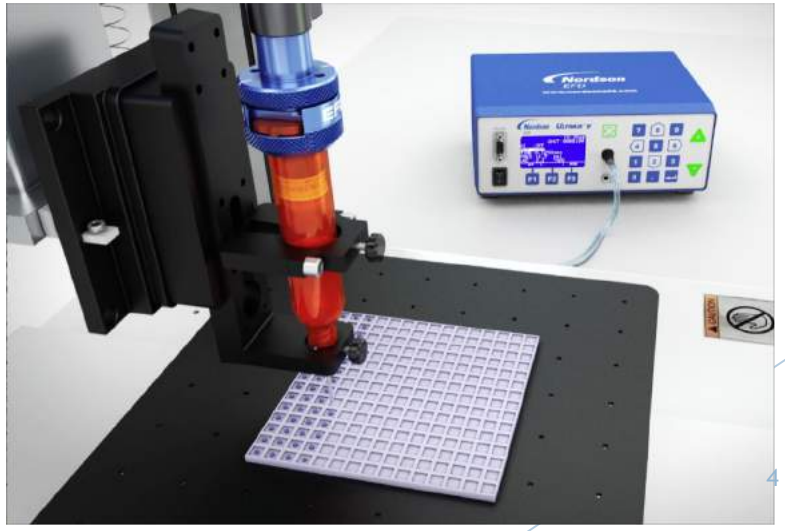
Physik Instrumente Gantry

- High Accuracy & Repeatability
- Minimum Feature Size: 50 µm
- 500 x 300 x 100 print area



Nordson Ultimus V Dispenser

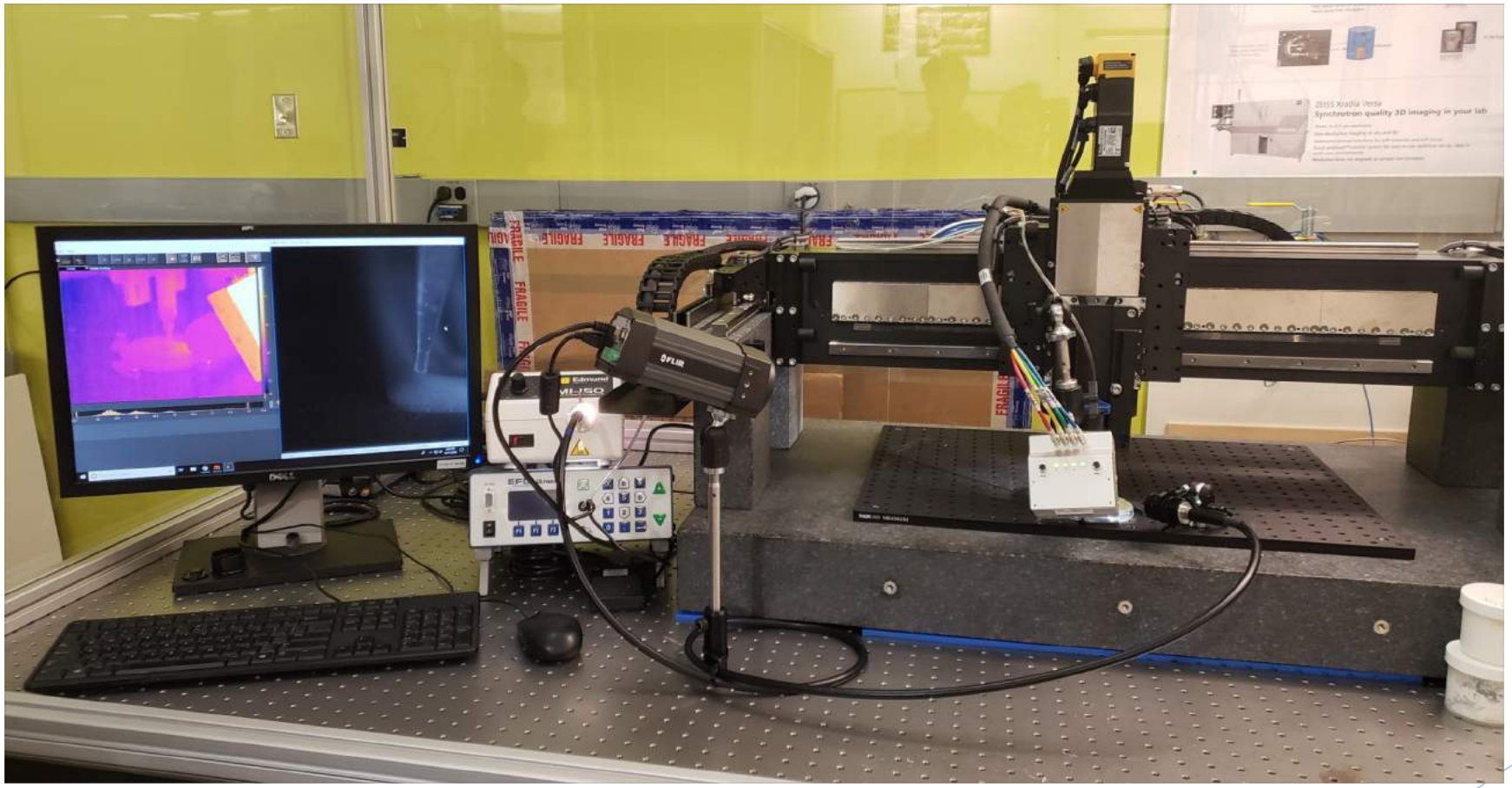
- Viscosity Range: 0 – 250,000 cP
- Pressure Range: 0 – 100 psi
- Add Ons: High-Pressure, 2 Part Materials



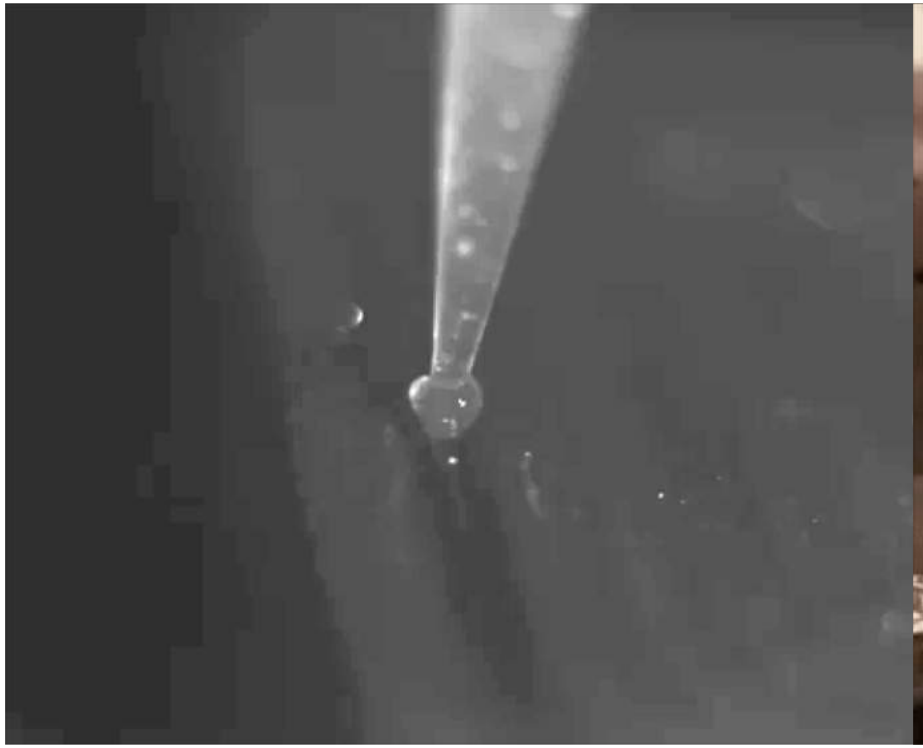
Observe While Printing

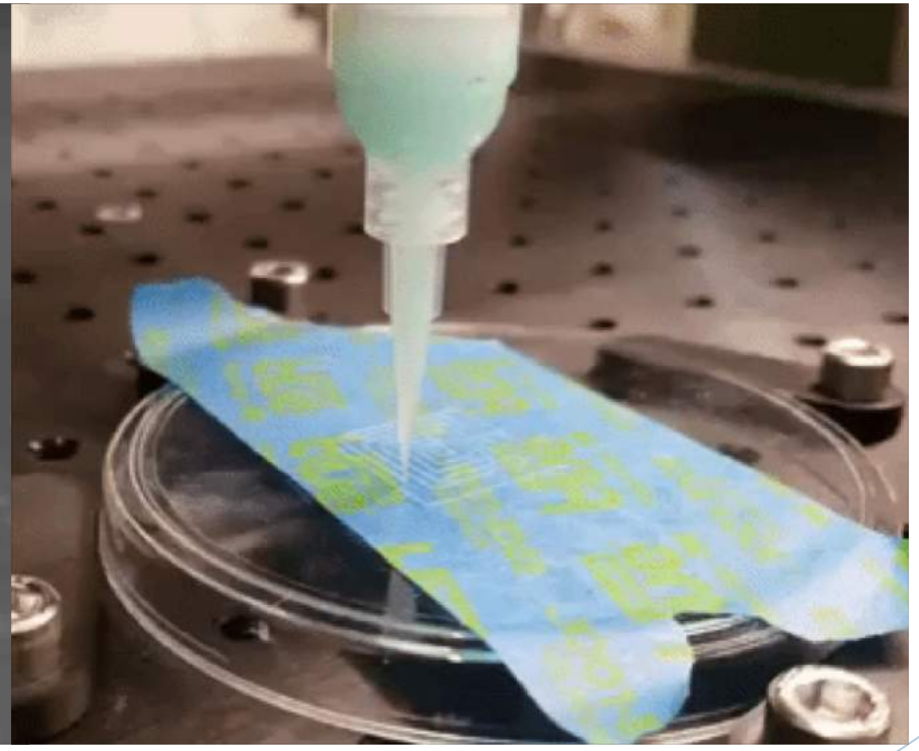
- Thermal Camera
  - FLIR A315
  - Lenses: 25° and 2x
  - Temperature Ranges:
    -20 - 120°C and 0 - 350°C
- High Speed Camera
  - Optronis CP70
  - Can view single bead of material
  - Max Frame Rate: >10,000 fps
  - Max Resolution: 1280 x 1024 p

Advanced Printing and Observation

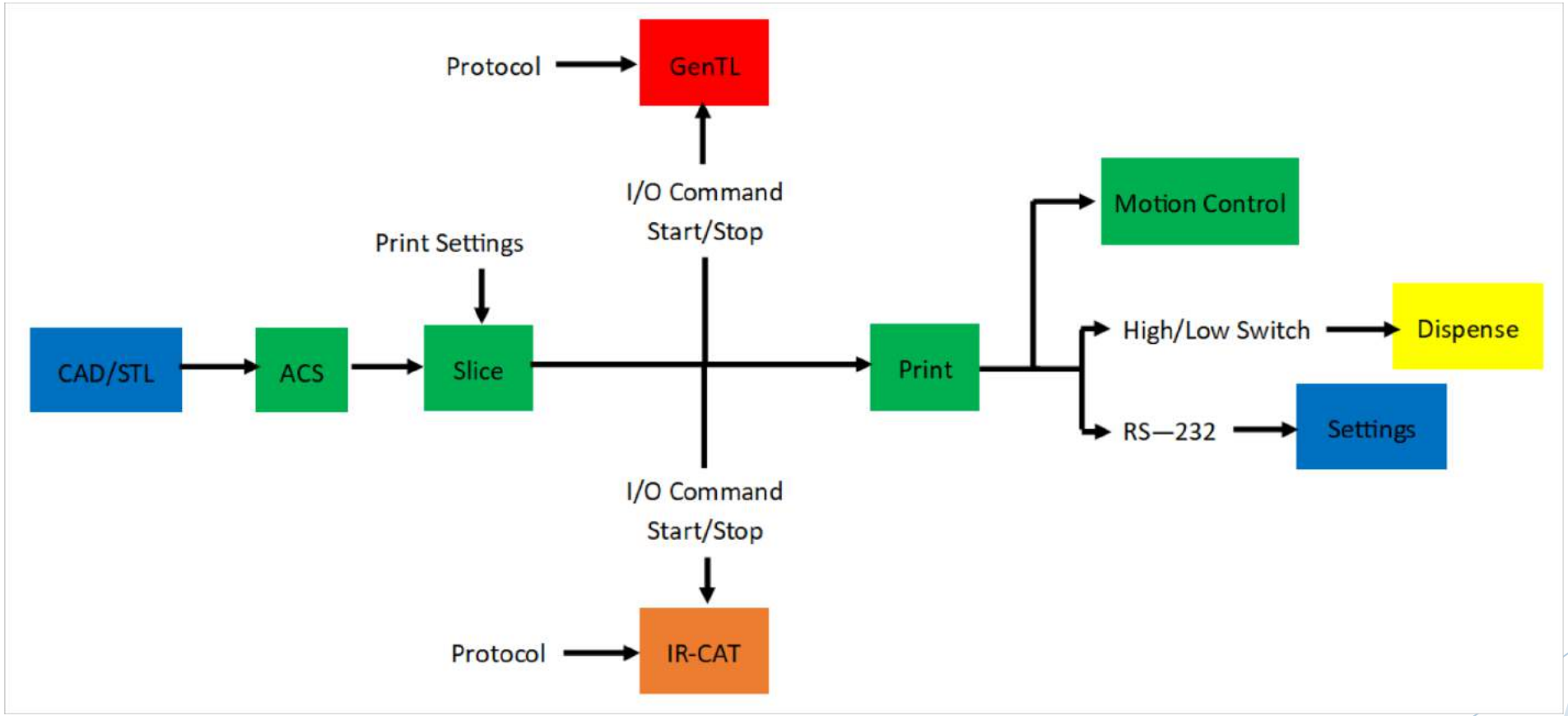


Printer Operation Video





Printer Operation



Learning Opportunities: Reactive Silver Ink

Print with ink of a low viscosity

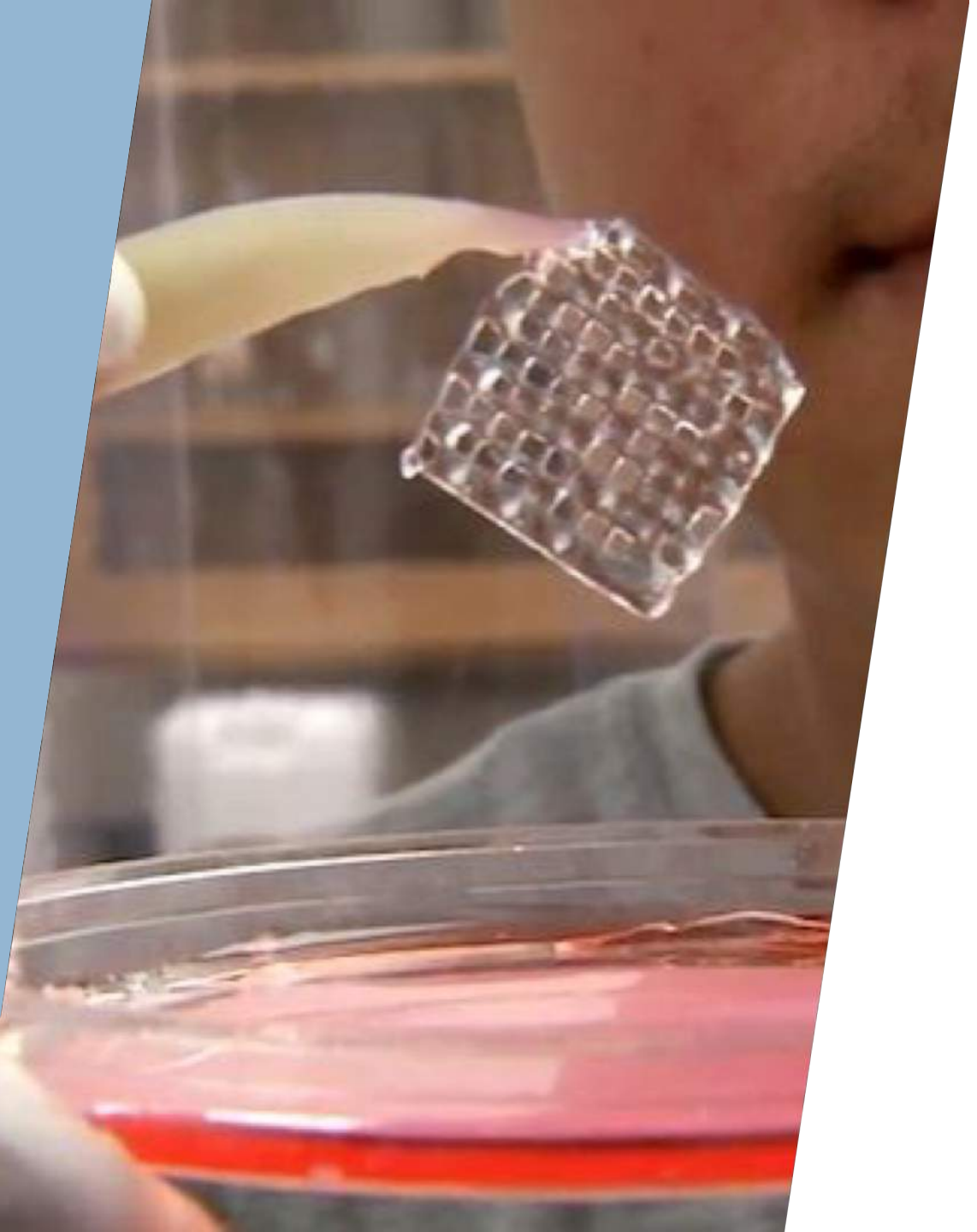
Variety of patterning techniques

Conductivity similar to that of bulk silver

Compatible with substrates used in flexible electronic and biomedical devices

Learning Opportunities: Ceramic Paste

- Print with high viscosity ceramic pastes
- Can print in complex geometries
- Scientific ceramics have numerous applications
- Ex. Tooling/heat exchangers



Learning Opportunities: Bioprinting

Combining cells, growth factors, and biomaterials to fabricate biomedical parts

Replicate organic structures to study and eventually replace

Printing gelatin methacryloyl (GelMA)

Future

- Immediate use by students and faculty
- Artificial Intelligence for Accelerating and Improving Additive Manufacturing
  - Increased use of sensors and information
  - Defect detection and correction for more accurate, complex, and qualified parts
- Enabled to explore new technology and methods

Thank you!

Any questions?