Visual Imaging in the Electronic Age
ART 2107, ARCH 3702, CS 1620, ENGRI 1620

3D Printing
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Prof. Donald P. Greenberg
dpg5@cornell.edu
Types of 3D Printers

- Selective deposition printers
  - Polyjet printing
  - Laser Engineered Net Shaping (LENS)
  - Laminated Object Manufacturing (LOM)

- Selective binding printers
  - Stereolithography (SL)
  - Laser sintering (LS)
3D Printing

- The formal name for 3D Printing is additive manufacturing.
- Additive refers to the fact that fabrication occurs either by depositing or binding raw materials into layers to form solid 3D objects.
- Manufacturing refers to the fact that 3D printers create these layers in a predictable systematic process.
PolyJet 3D Printer
Polyjet 3D Printing

• Polyjet 3D printing works similar to inkjet printing. Instead of ink drops, the printers use a curable liquid photopolymer into a build tray.

• The 3D printer jets and instantly UV-cures tiny droplets of the liquid photopolymer. It can also use a removable gel-like support material.

• 15 micron layers with smooth surfaces and 0.1mm accuracy.
Laser Engineeered Net Shaping (LENS)

Advantages

• The LENS process can go from metal oxide powder to metal parts without secondary operations and thus can be used for repair.

• Objects created with this technology can be large (up to several feet)

• It can utilize a wide range of metallic materials including titanium, stainless steel, aluminum, etc.

• When multiple nozzles are used, it can fabricate composite materials.
Laser Engineered Net Shaping (LENS)

- A high power laser is used to melt metal powder supplied coaxially to the focus of the laser beam through a deposition head.
- The laser beam is focused to a small spot by one or more lenses.
- The x-y table is moved in raster fashion to fabricate each layer of the object.
Optomec LENS Print Engine
Laminated Object Manufacturing

- Layers of adhesive coated material (paper, plastic, metal laminates) are flued together and cut with a laser cutter.
- Objects can be modified by machining or drilling as a post-process.
- Layer resolution is defined by material feedstock.
Schematic of an LOM setup
Laminated Object Manufacturing

1. Foil supply
2. Heated roller
3. Laser beam
4. Scanning prism
5. Laser unit
6. Layers
7. Moving platform
8. Waste
Laminated Object Manufacturing

The process is performed as follows:

1. Sheet is adhered to a substrate with a heated roller.
2. Laser traces desired dimensions of prototype.
3. Laser cross hatches non-part area to facilitate waste removal.
4. Platform with completed layer moves down out of the way.
5. Fresh sheet of material is rolled into position
6. Platform moves up into position to receive next layer.
7. The process is repeated.
Stereolithography (SLA or SL)

- A method for making solid 3d objects by successively “printing” thin layers, usually using a liquid ultraviolet curable photopolymer resin.
- For each layer traces a cross-section of the part pattern on the surface of the liquid resin.
- Exposure to the ultraviolet laser cures and solidifies the pattern traced and joins it to the layer below.
- Then the SL’s elevator platform descends a small distance (usually 0.02″ - .006″) which determines the thickness of the layer.
Stereolithography (SLA or SL)
Stereolithography (SLA or SL)
Stereolithography (SLA or SL)

Advantages

• Speed. Most parts can be produced in hours or within a day

Disadvantages

• Expense. Not only are machines expensive but the cost of the photo-curable resin has also a high price per liter.
Laser Sintering (LS)

- Sintering is the process of forming a solid mass of material by heat (and/or pressure) without melting it to the point of liquefaction.
- This happens naturally in mineral deposits or manufacturing processes with metals, ceramics, glass, plastics, etc.
Selective Laser Sintering (SLS)

• An additive manufacturing method that uses a laser as the power source to sinter powdered material (typically metals) at points in space defined by a 3D model.

• Powdered material (sometimes made of two-components) is spread in layers and sintered selectively by the laser beam, building up the object by layers.
Selective Laser Sintering (SLS)
Selective Laser Sintering (SLS)
Laser Sintering

3D Systems
Squirt, Squeeze or Spray

• These are **selective deposition printers** that deposit some sort of raw material through a printhead or nozzle.
2D Food Printing
3D Food Printing

Enjoy your meal!
3D Chocolate Printer
MakerBot
Robotic Hand by MakerBot
Printed Ears

Larry Bonassar
Hewlett-Packard’s 3-D Printer
Hewlett-Packard’s 3D Printing System

• The technology called “Multi-Jet Fusion” can print 3D objects cheaply and quickly compared to existing methods.

• The technology employs an array of print heads to spit out an entire layer of a 3D object at once.

• The machine’s resolution of 1200 dots-per-inch (dpi) compares favorably to rival systems.
Impact of 3D Printing

The impact of 3D printing may be far greater than just the convenience and economics of the manufacturing sector.

Uncle Don
Examples of Possible Impact of 3D Printing

• Environmental Impact
  – Fewer wasted materials
  – Longer product life spans with 3D printed replacement parts
  – Less transport
  – Fewer unsold products

• 3D Printing in zero-gravity
  – Space missions become more self-sustaining with repair of parts
  – Lighter payloads
Examples of Possible Impact of 3D Printing

• Reaching disconnected markets worldwide
  – Eliminates some dependence on global supply chains
  – Allow local entrepreneurs to compete
  – Local design and repair shops
  – Domestic production

• Intellectual Property Issues
  – Sharing websites are bound to cause intellectual property issues.
  – Most designs are not patented
Calling All Makers: Announcing the First-Ever White House 3D-Printed Ornament Challenge

Office of Science and Technology, October 30 - November 10, 2014
Printed guns

AR-15-based .22 Pistol
Printed guns

• It is not illegal to print and make a gun in your own home.

• Owning a gun that cannot be seen in a metal detector would be breaking the Undetectable Firearms Act (1988).

• The House passed the bill to extend this for ten years but printing one of these guns is not a criminal act (December 2013)
End