Week 4 - 3D printing and 3D scanning

PREP WORK

1. Ensure at least one of the 3D printers is operational
2. Ensure host machine(s) for 3D printers are operational and loaded with appropriate slicing engines
3. Ensure there is enough filament for each student to print small objects
4. Gather personal Prusa Mendel i2 to bring in for show
5. Gather 3D printed objects for demonstration
6. Ensure that enough iPads are operational for each student
    a. Ensure they have 123D Catch installed
    b. Ensure they have appropriate apps for Structure sensor installed
    c. Ensure enough Structure sensors are operational and fully charged

Outline

1. *Discussion of Curiosity Handbook work since last class session*
2. Introduction to 3D printing
3. *3D printing activity*
4. Introduction 3D scanning
5. *3D scanning activity*

Introduction to 3D printing

1. How a 3D printer works = hot glue gun analogy
2. Overview of workflow = design -> slice -> print -> post-processing
3. Discussion of 3D design
    a. *Beginners* = 123D Design, Tinkercad, openSCAD, Sculptris, Sketchup (with STL plugin + patience)
    b. *Intermediate and advanced* = Inventor, Rhino, Solidworks, AutoCAD, Blender
    c. Use different programs for different projects and forms.
        i. Organic vs functional modeling
        ii. Mesh vs solid modeling

4. Designing for 3D printing
    a. Avoid overhangs - automatic supports, build in custom supports, add more curves
        i. Always best to design such that no supports are necessary
    b. Understand printer and materials limitations and design around them.
        i. Build in proper thicknesses depending on material strength
    c. Make mesh manifold (watertight) = ideally done in CAD, but may be possible in repair stage
    d. Sectioning models for easier printing and stronger parts.
5. Cleaning and repairing models = meshmixer and netfabb
6. Slicing a model
    a. For Makerbots and Afinias, use provided slicing engines
    b. For most other hobbyist to prosumer printers, use MatterControl, Cura or Slic3r
    c. Slicing parameters to know about
        i. *Layer height* = smaller height means better surface quality, but also longer print times.
        ii. *Infill* = more infill means more strength. Generally 40%
        iii. *Supports* = automatic external structure used to support model during print
        iv. *Raft* = uniform layer of material printed on bed before model. Used to overcome bed and printer defects/weaknesses. Causes bottom of print to be very low quality.
7. Printing the model
    a. Load desired filament = unload any other filament, load new filament and run for at least 30 seconds to clear nozzle
    b. Preheat bed and nozzle, if using ABS filament
    c. Level the bed or calibrate printer
    d. Load G-code through SD card or through host interface
8. Post-processing the model (optional)
    a. *General techniques* = sanding, painting, tumbling
    b. *ABS techniques* = acetone welding, vapor polishing

3D printing activity

1. Locate a model on Thingiverse -- keep it small and simple
2. Select a printer to use
3. Slice using appropriate slicer
4. Load a different filament for practice
5. Prepare printer, if appropriate = preheat bed/nozzle, calibrate or level bed
6. Print the model using host interface or via SD card

Introduction to 3D scanning

1. Overview of 3D scanning methods
    a. *Photogrammetry* = 123D Catch and Photoscan
    b. *Laser-based methods* = Roland scanner, Makerbot Digitizer
    c. *Structured light* = Kinect, Asus Xtion Pro, DIY David Systems and Structure sensor for iOS
2. Photogrammetry demo with 123D Catch
    a. Photos can be taken with any camera or smartphone
    b. Recommend using mobile app for learning only, not for serious mesh editing
    c. Talk about appropriate geometry
    d. Describe appropriate use scenarios = good lighting, unmoving subject/background, abundance of distinct reference points, consistent camera settings
    e. Introduce personal scans
3. Structured light demo with Structure sensor
4. Processing meshes and preparing them for 3D printing
    a. Make manifold
    b. Create flat bottom

3D scanning activity

1. Choose or create an object to be scanned
2. Create 3D scans using both 123D Catch and Structure sensor
3. If there is enough time left, process the mesh and prepare for 3D printing.
    a. Begin 3D print before end of class if they succeed.