3D Printing and Agriculture

2026 Ohio Ag Ed Summer Conference

June 9-11, 2026

The Ohio State University – ATI

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CFAES Entomology & OSU - ATI

Agenda

- Session overview - goals
- Introduction to 3D printing
- Hardware
- Software
- Resources
- Agricultural uses
- 3D Print Lab tour
- Local Makers, ATI Class, Survey

Where are You?

Do you have a 3D printer in your classroom?

Do you have a 3D printer at home?

Overview and Goals

- Introduction to 3D printing
- How to get started
- Local and online resources
- Examples of uses in agriculture

3D Pens

- Handheld filament pens
- Manual
- Low cost

3D Printing Hardware

Two basic types

- **FDM (Fused Deposition Modeling)**
  - Filament extrusion
  - One layer at a time
  - Most common
  - Low cost entry and operation

3D Printing Hardware

Two basic types

- **Resin**
  - Liquid
  - Generally higher quality
  - Lower strength
  - Needs cleaning

Resin vs. Filament

- Choose resin for superior fine details, smooth surfaces, and intricate geometries.
- Select filament for stronger, more durable functional parts and larger prints.
- Filament printing generally offers a lower initial investment and cheaper materials.
- Factor in resin’s mandatory, messy post-processing (washing and curing).
- Prioritize safety and ventilation when considering the Filament VS Resin 3D Printing debate.
- FDM (filament) offers a wider range of engineering-grade and aesthetic materials.
- Match the technology to your primary application: resin for models, filament for tools.

Options to generate a 3d print file:

Printable items are defined in .stl files (Standard Tessellation Language)

(There are other file formats.)

- Download existing model from an Internet share site
  - Makerworld
  - Thingiverse
  - Printables
  - Lesser known
    - Smithsonian
    - NASA
    - Yeggi - 3d Print Search EngineYou can generate an .stl representation of object
- Create model using Computer Aided Design (CAD) Program
    - TinkerCad
    - Fusion 360 - www.cadclass.org
- Scan existing object using a 3d scanner
- Use software to convert a 2d image to a 3d .stl using AI

Preparing the G-code File
(Geometric Code)

- The .stl file defines the object to be printed.
- 3D printers come in all configurations.
- The .stl file needs to be sliced into layers.
- The G-code needs to be specific to the printer.
- Slicer software creates the G-code.

Getting the G-code into the printer

- Memory card
- Cable
- Wireless

Agricultural Uses for 3D Printing

- **Ag Teacher: Agricultural / classroom uses off the top of my head:**
  - Items for a greenhouse (repairs, potted planters, plant ID tags, etc.)
  - FFA fundraising items (keychains, locker decorations, coasters, etc.)
  - Agriscience fair experiments and/or projects
  - Mini Makerspace for workshop participant's schools
  - Bee feeders and other items

3D Printing for Research & Extension

Ashley Leach, Andy Michel, Yami Ngona & Natalie Constancio

Ohio State University, Department of Entomology

Applications of 3D printing

- Frankly, there are many applications of 3D printing, but for this session we're going to focus on their application in extension/education.

- Literature primarily pedogeological research has indicated a significant application of 3D printing in increasing the comprehension of complex ideas.

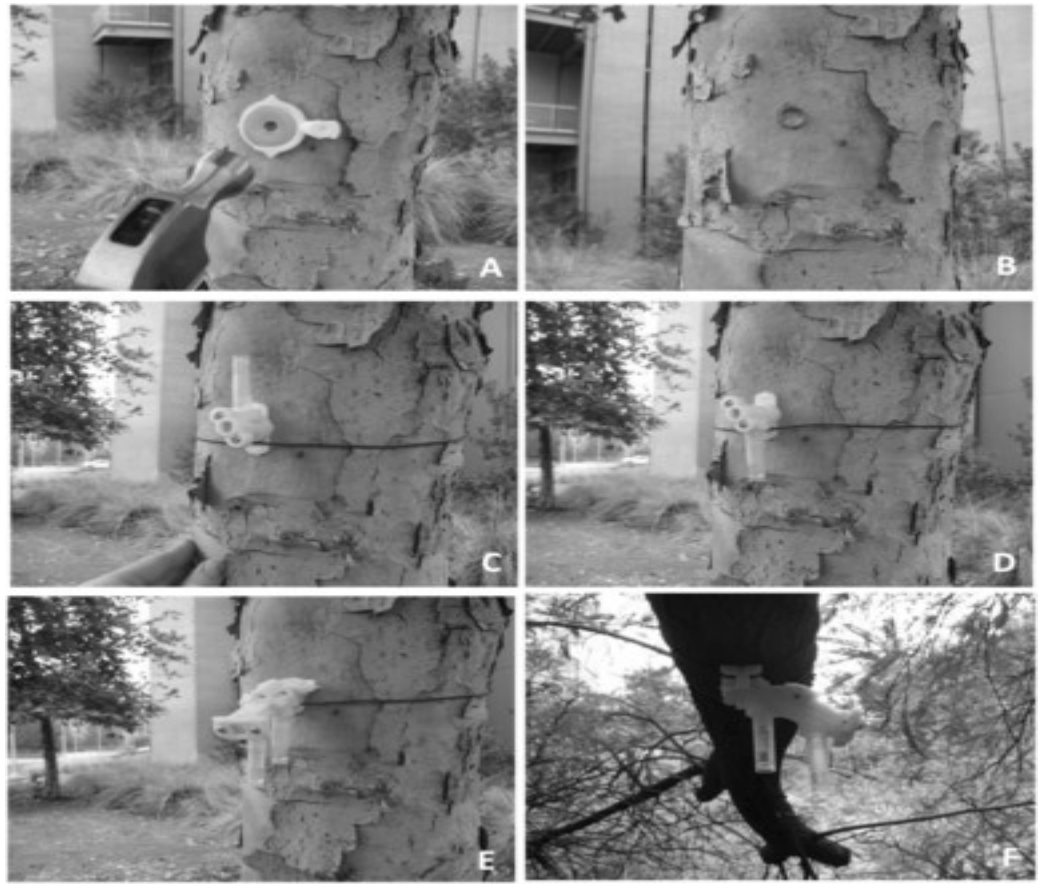
- Often, 3D printing demonstrates a "**surrogate-like**" application, in which we can create something that is just as good as "the real thing".

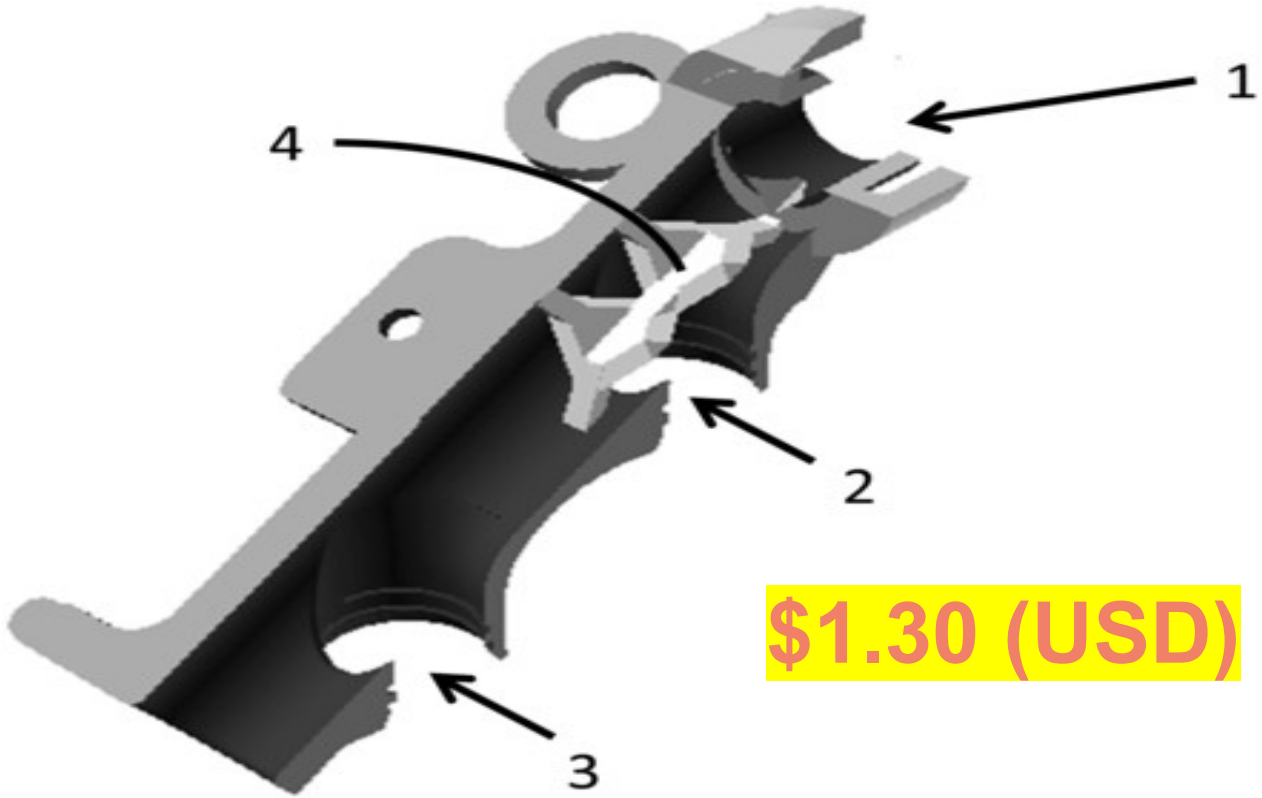
Applications of 3D printing

JOURNAL ARTICLE

A Modular System of 3D Printed Emergence Traps for Studying the Biology of Shot Hole Borers and Other Scolytinae

Daniel Berry, Roger D. Selby, Joan C. Horvath, Rich H. Cameron, Diego Porqueras, Richard Stouthamer ✉





$1.30 (USD)

Fig. 2. Cross-section of trunk emergence trap showing the bridge that allows beetles to cross the opening of the first collection vial, while allowing frass and sawdust to be collected in this vial. 1. Opening of the trap attached to the tree. 2. Opening in which the first vial is screwed. 3. Opening in which the second vial is screwed. 4 Bridge crossing opening for first vial.

Applications of 3D printing

Field testing of a lightweight, inexpensive, and customisable 3D-printed mosquito light trap in the UK

Tomonori Hoshi[1,2,3], Victor A. Brugman[1,4], Shigeharu Sato[3,5], Thomas Ant[1], Bumpei Tojo[3], Gaku Masuda[3], Satoshi Kaneko[2,3], Kazuhiko Moji[2,3], Jolyon M. Medlock[6] & James G. Logan[1]

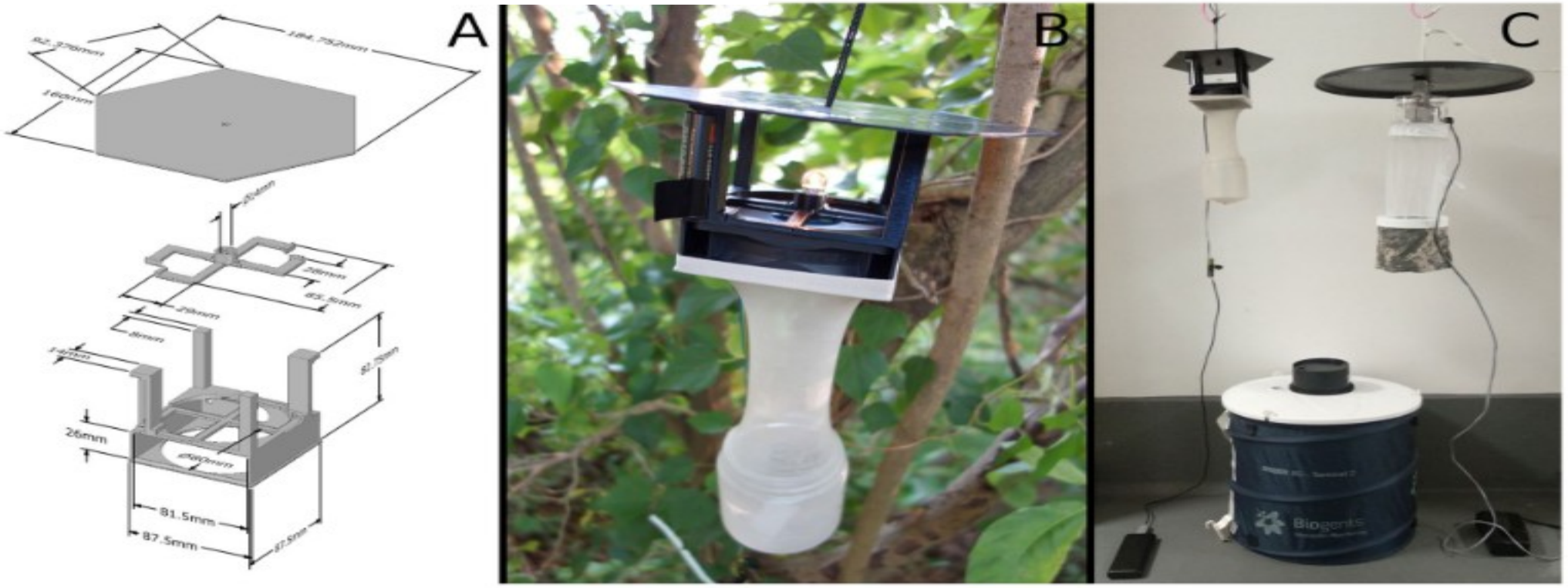


Figure 1. The panels show: (**A**) the 3D-printed trap blueprint comprising three pieces; (**B**) the 3D-printed trap in field operation; and (**C**) trap size comparisons between the 3D-printed trap, CDC light trap, and BG-Sentinel 2 trap.

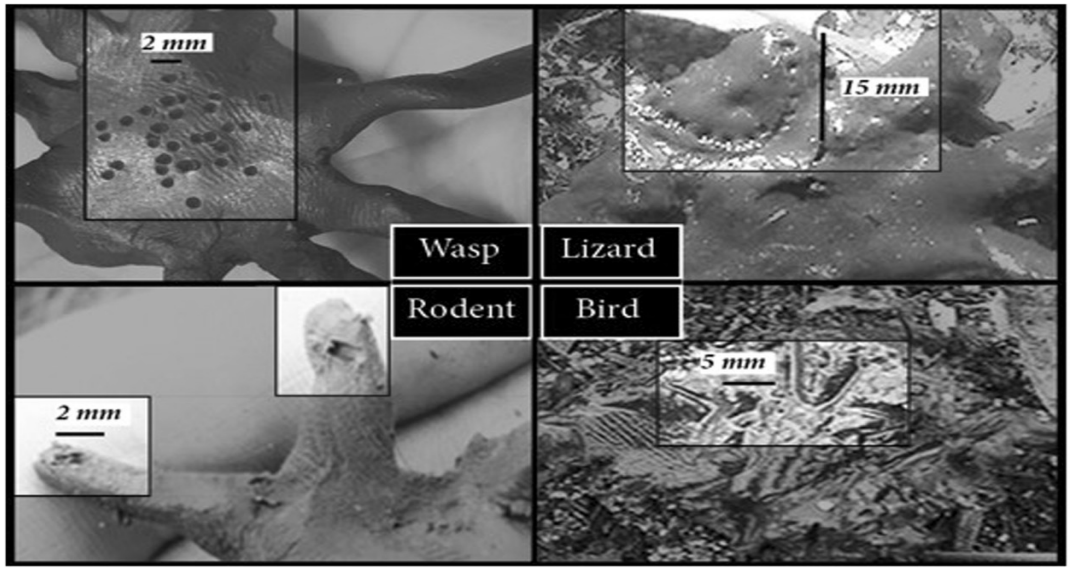
Applications of 3D printing

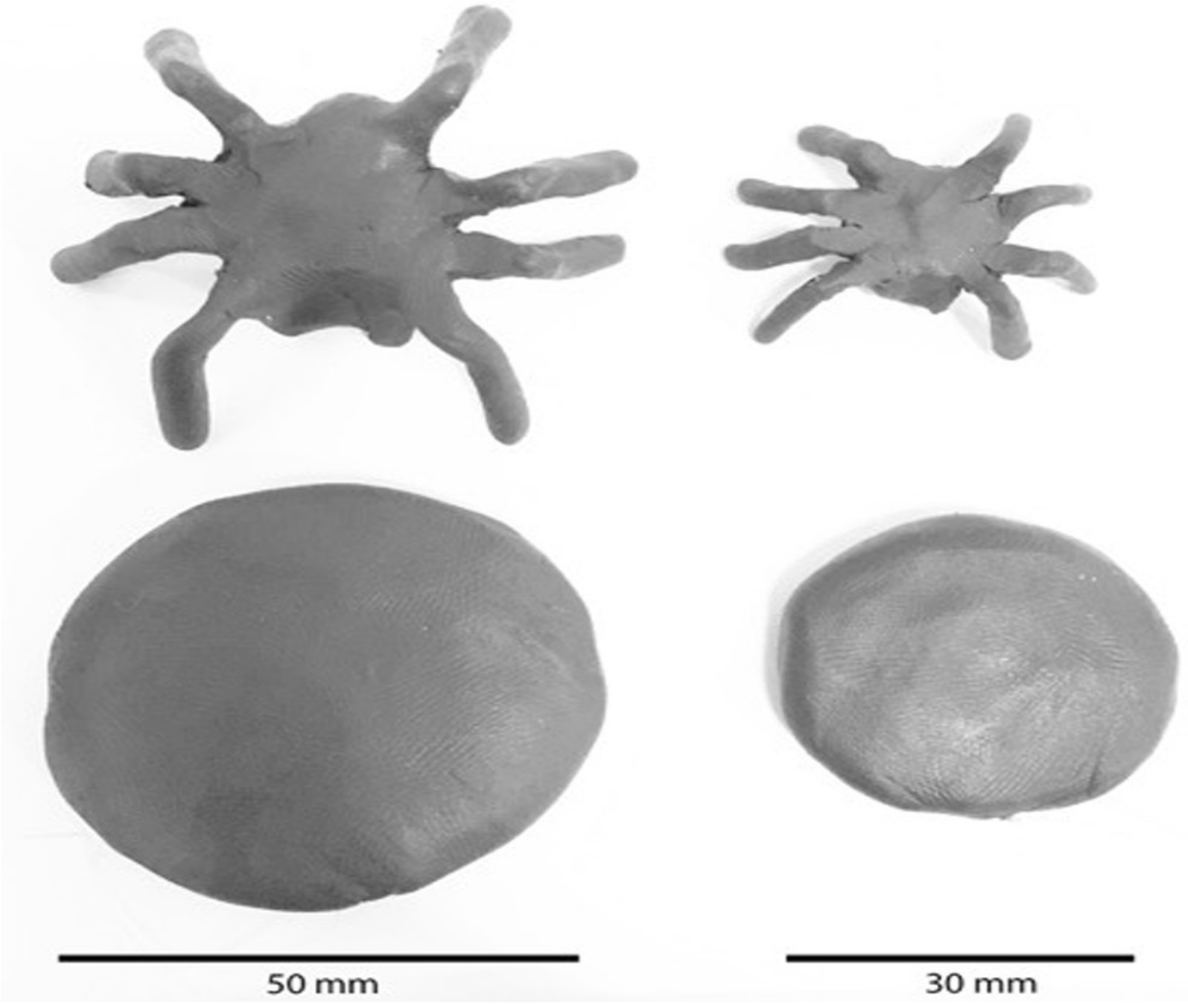
Predators Show Seasonal Predilections for Model Clay Spiders in an Urban Environment

L. D. Mason ✉, G. Wardell-Johnson, S. J. Luxton & P. W. Bateman

Plasticine models

Predation rates were assessed using 2400 clay models of two size classes (3 cm and 5 cm) (Fig. 4) and types (spider and control) during two sampling periods. To standardise, spider models were printed with plastic resin using a 3D printer using TinkerCad and UP! Software. This 3D model is available online through TinkerCad as "Spider Model by Leanda Mason". Metal washers of similar size classes were used as controls. Models and washers were uniformly coated with a layer of black plasticine (Flair Leisure Products). Models were connected by transparent fishing wire to a nail pushed into the earth, securing both the model's location and a numbered tag.





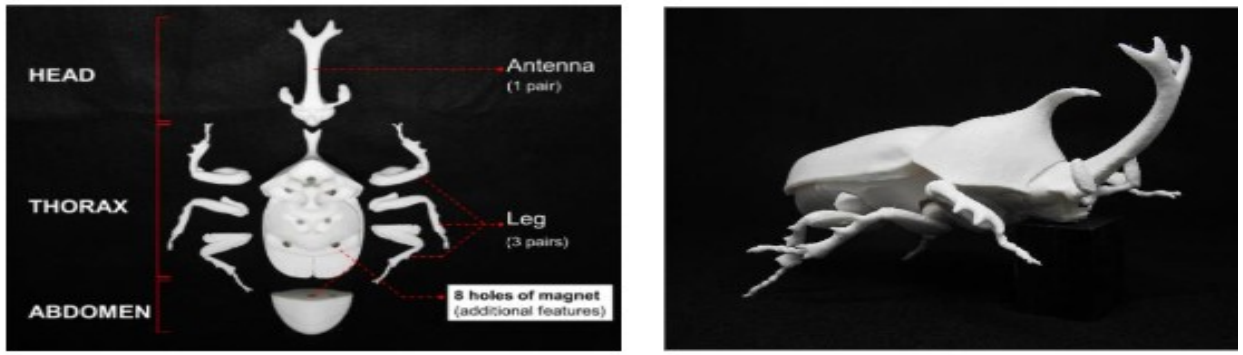
Applications of 3D printing

Article

The Role of Digital-Media-Based Pedagogical Aids in Elementary Entomology: An Innovative and Sustainable Approach

Su-Ju Lu [1], Ya-Hui Chen [2], Hazel Huang [3] and Ying-Chieh Liu [4,5,6,*]

Figure 1. A fixed insect prototype, using a monochrome yellow bee as an example.



(a) (b)

Figure 2. The assembled insect prototype, using a white beetle as an example: **(a)** component parts of assembled insect prototype; **(b)** complete assembled insect prototype.

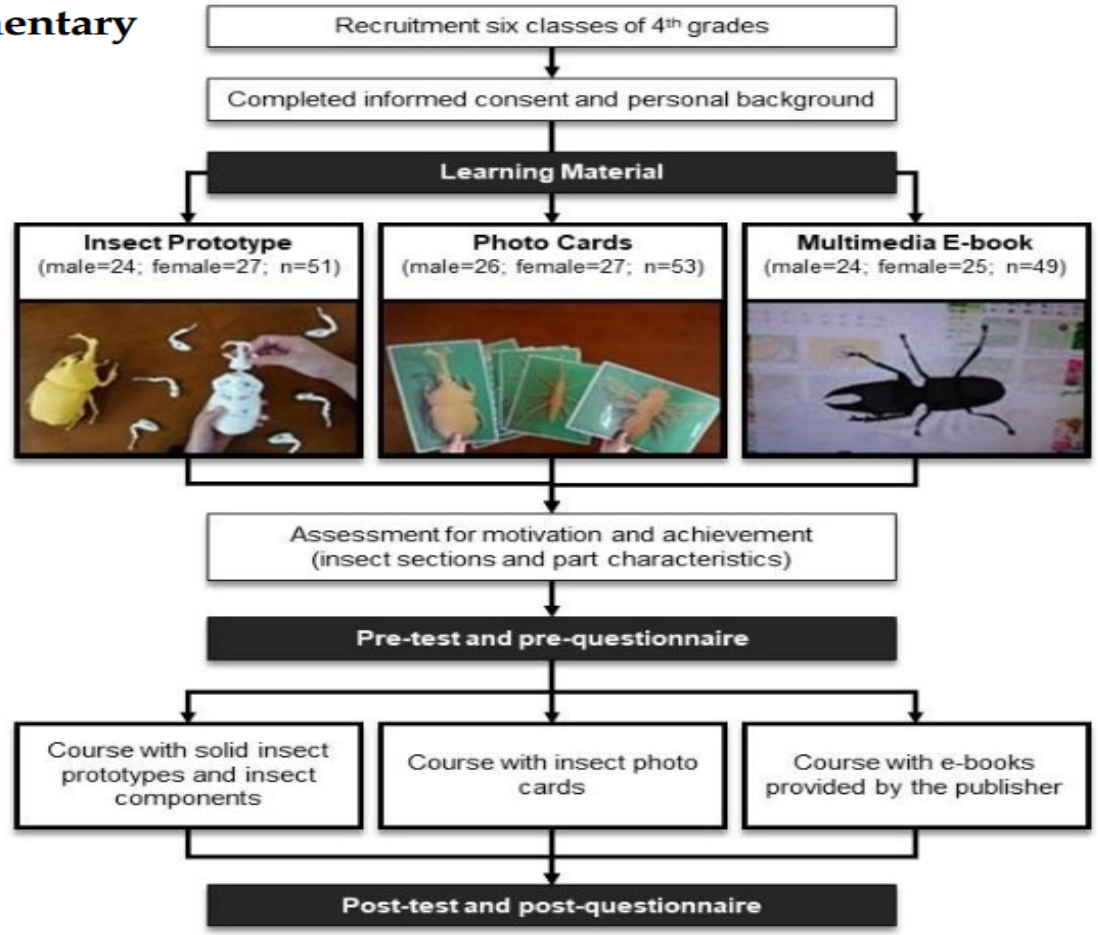
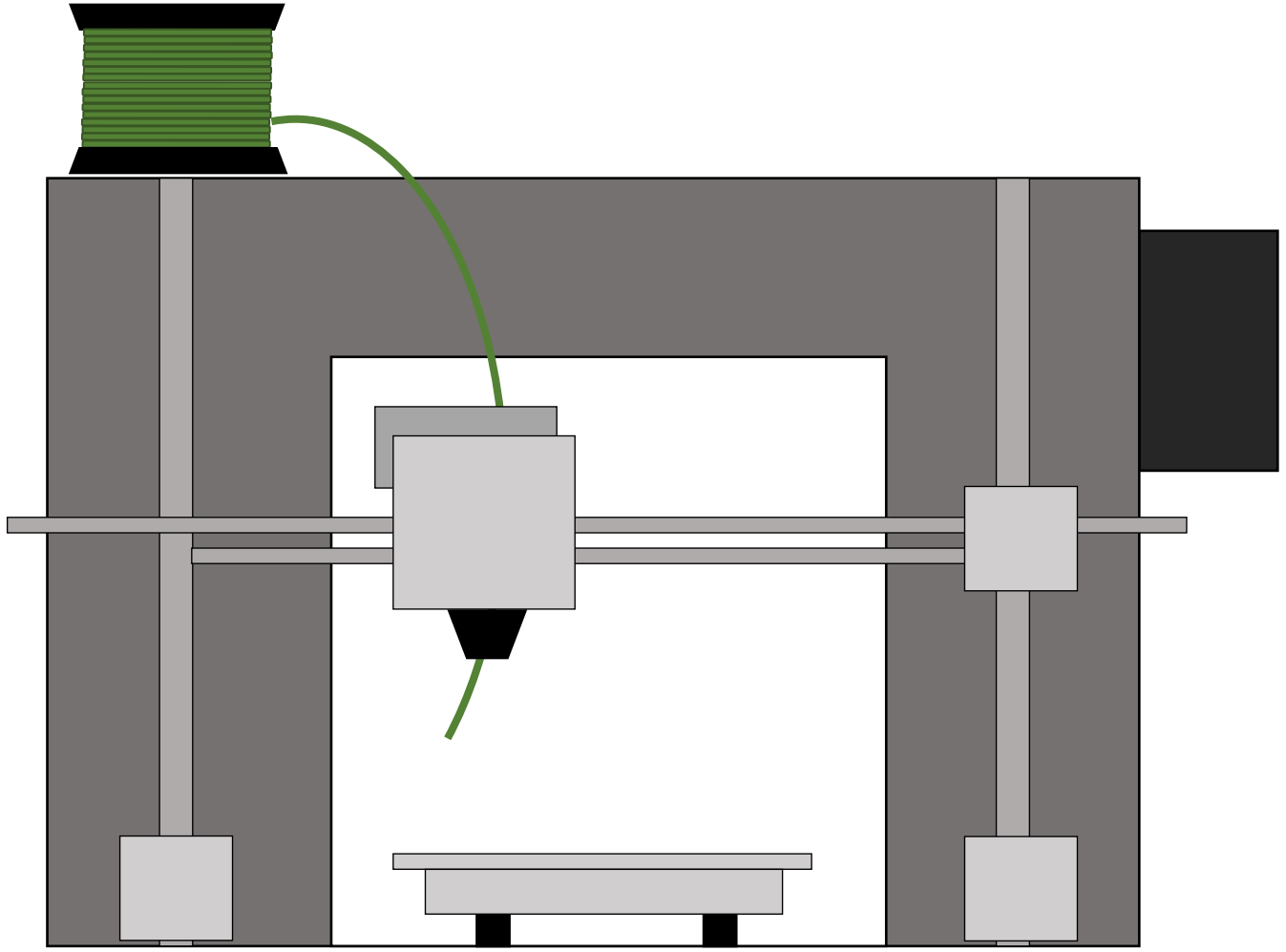
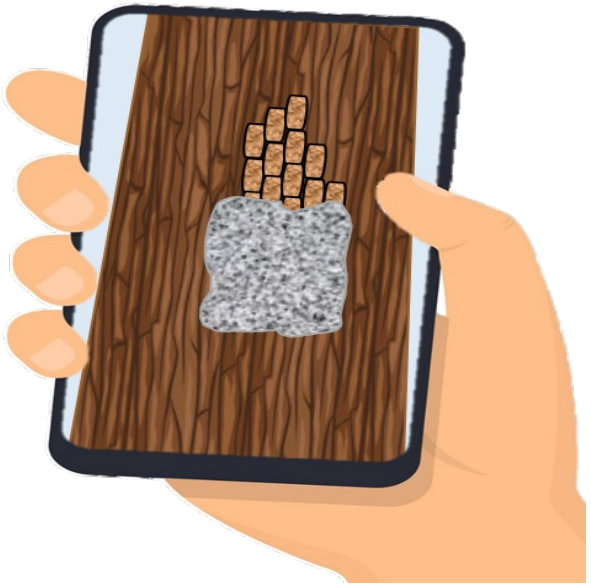


Figure 4. Experimental procedures.

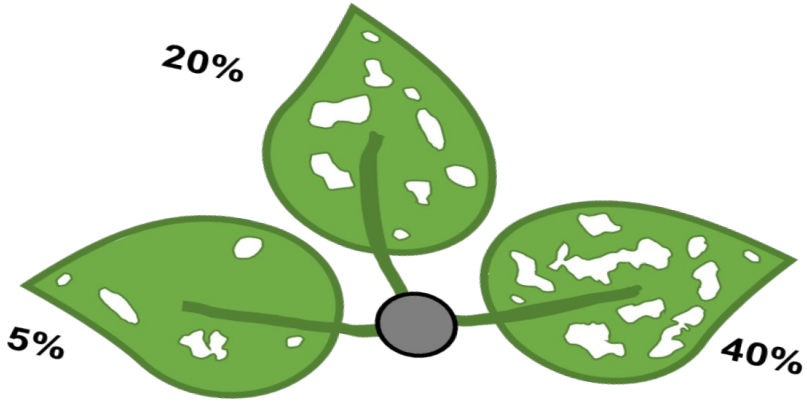
What has Ohio State done?



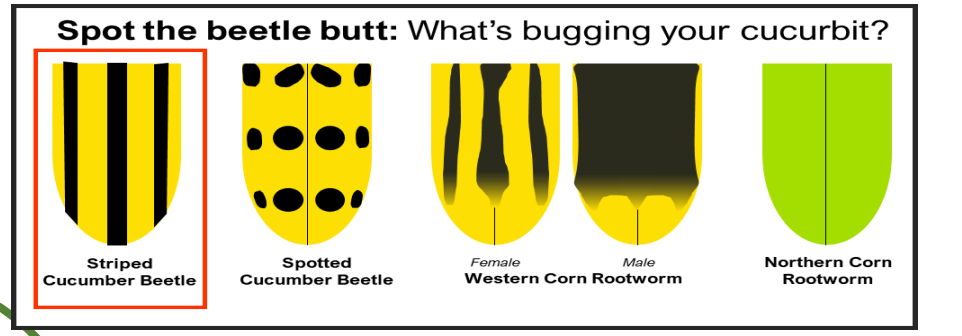
Slowing the spread of invasive species



Using a threshold



Spraying for the right pest



Slowing the spread of invasive species

Using a threshold

Spraying for the right pest

What has Ohio State done?

Three examples of 3D printing to enrich extension efforts.

3D Printing for Pest Injury Identification and Scouting

- Bt corn has effectively controlled European corn borer (ECB) for over 30 years.
- As a result, many newer farmers have never seen ECB damage and may not recognize it in the field.
- This project evaluates whether 3D-printed frass models improve understanding and identification of ECB damage.

3-D printed frass

Frass in the field

Spotted Lanternfly (SLF)?

Planthopper insect

Native to Asia, estimated to be in PA since ~2012

Also invasive in Korea (2004) and Japan (2009)

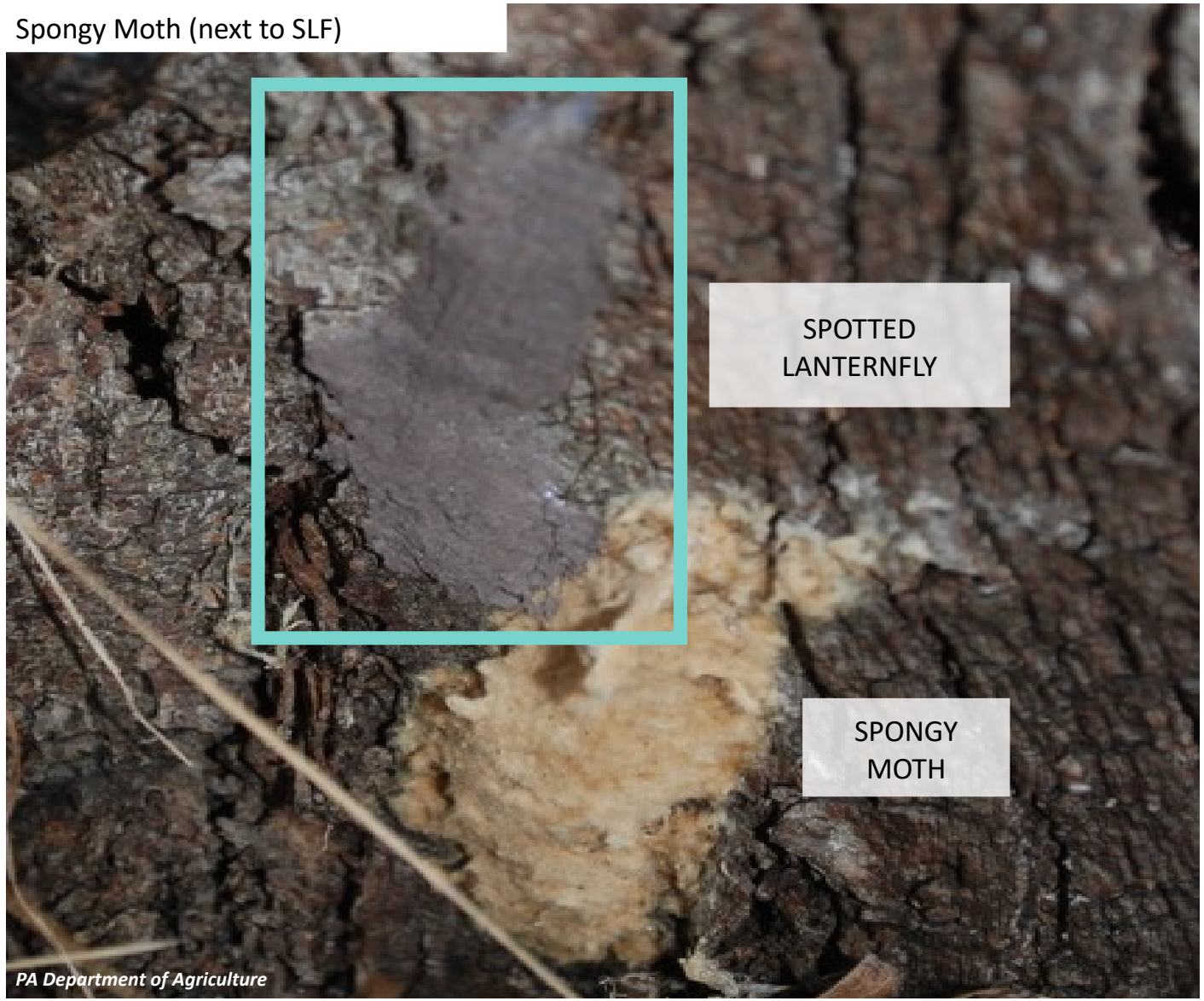
Recently found in Ohio (2020)

Heather Leach

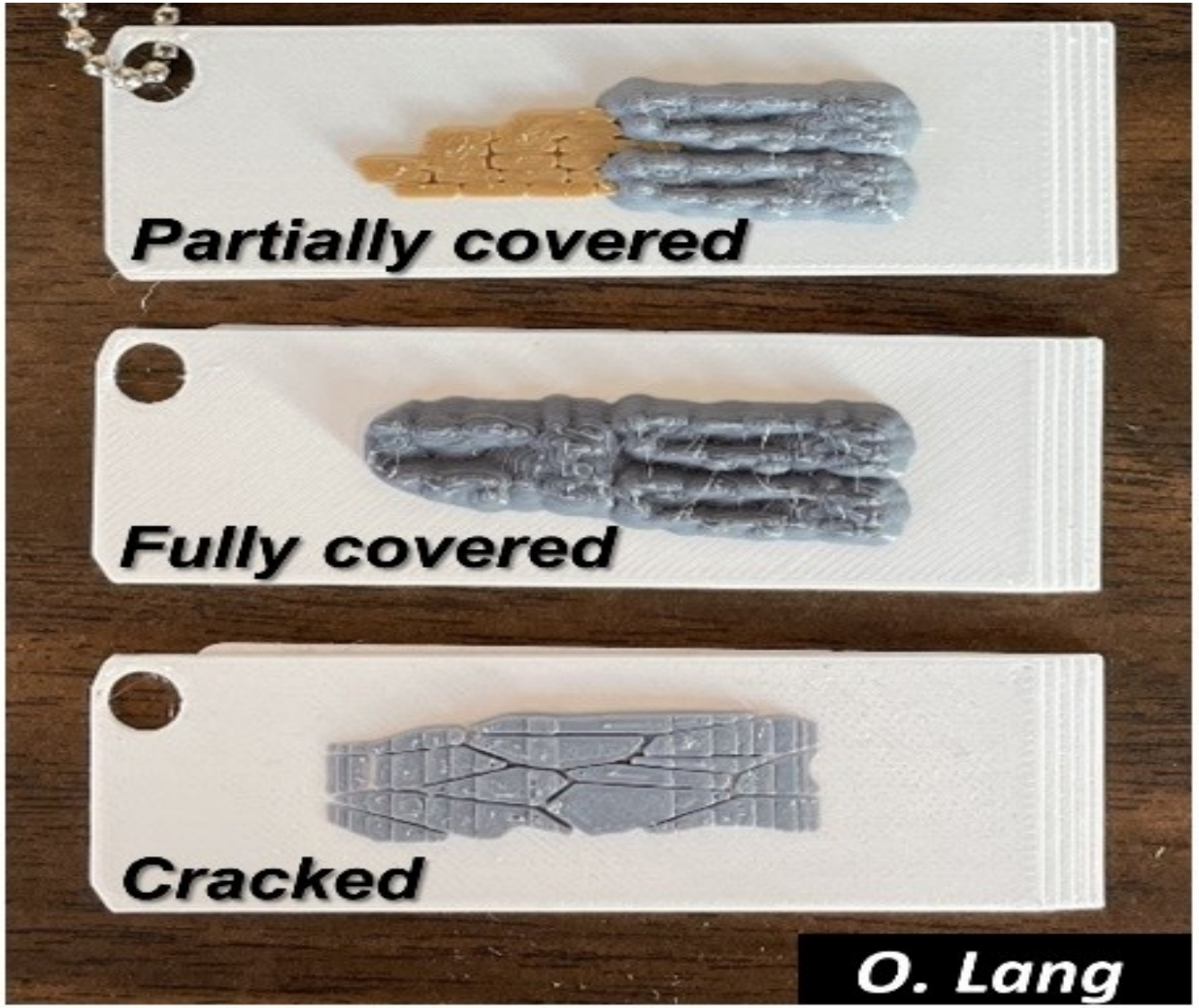
Egg masses are hardest to ID.

Described as:

- *“mud-like”*
- *“grey putty-like”*
- *“light grayish splotches of mud, cement, or lichen”*

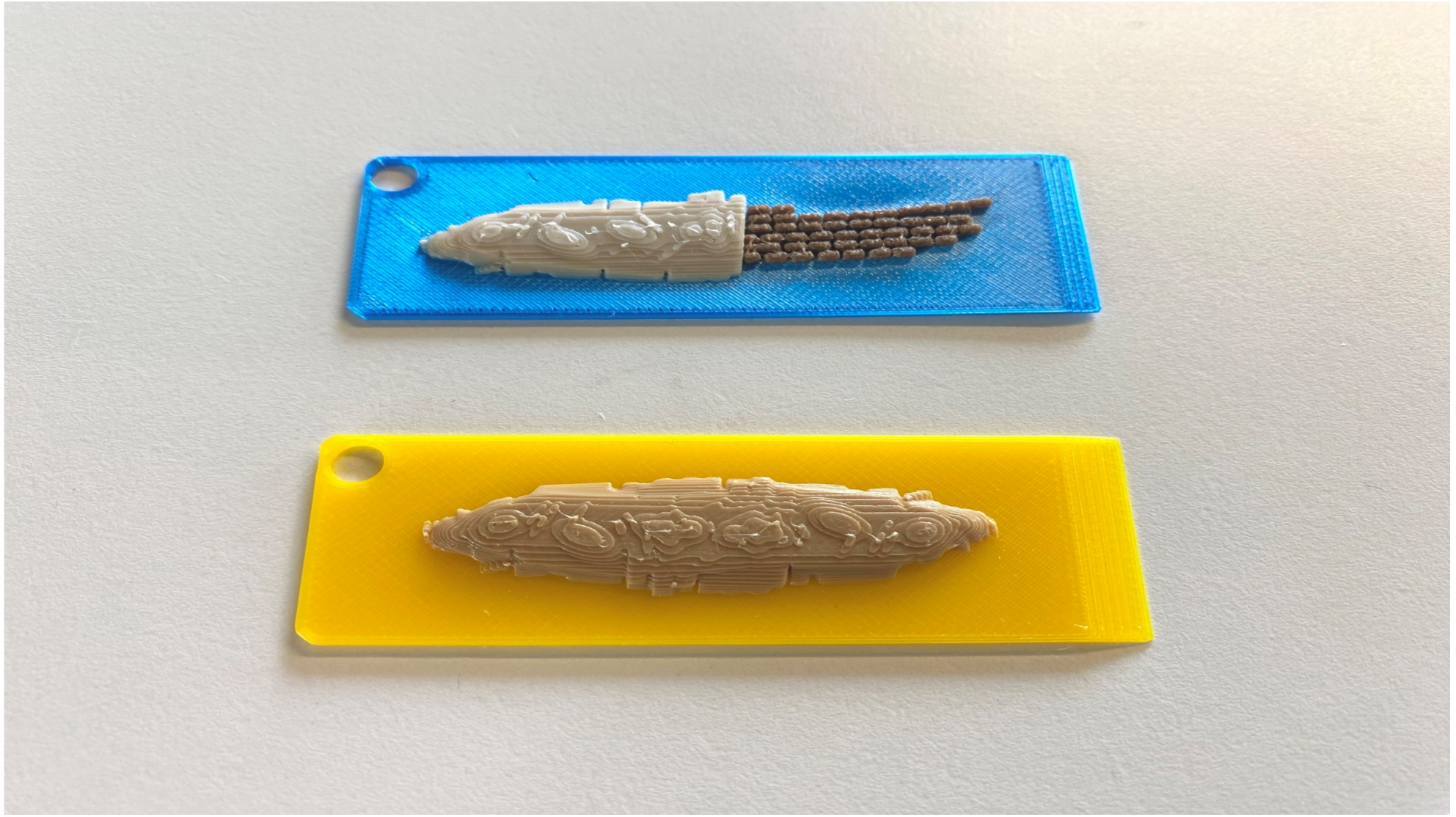


Can we 3D print them?



3D printing for training

Updating designs

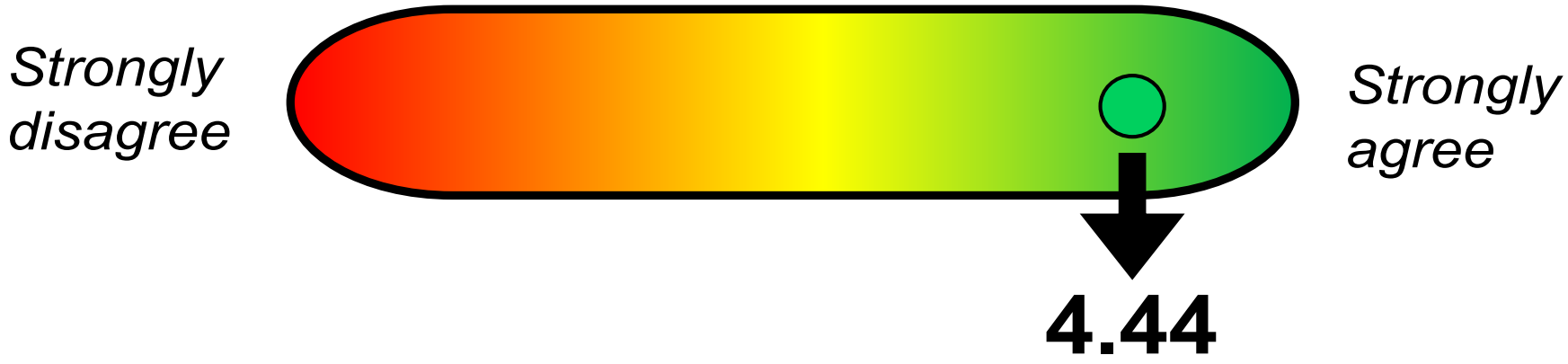


S. Basnagala

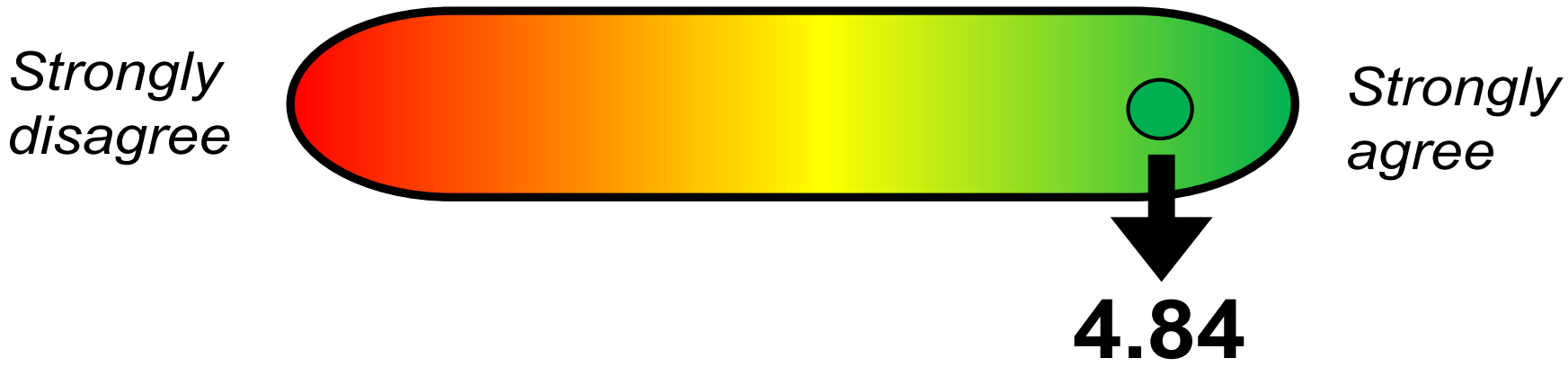

DO YOU LIKE GRAPES, APPLES MAPLE SYRUP AND/OR BEER?
WHERE IS SPOTTED LANTERNFLY NOW?
STOP THIS BUG!
WATCH OUT FOR SPOTTED LANTERNFLY
Look for SLF egg masses!
WHAT CAN YOU DO ABOUT IT?
SCOUT IT!
Spotted Lanternfly Life cycle
SPECIALTY CROP ENTOMOLOGY

Participants seem to like it.

“I learned new information from this program"



“I plan to use the information I learned in this program"



After the training exercise…

Identify Adults

100%

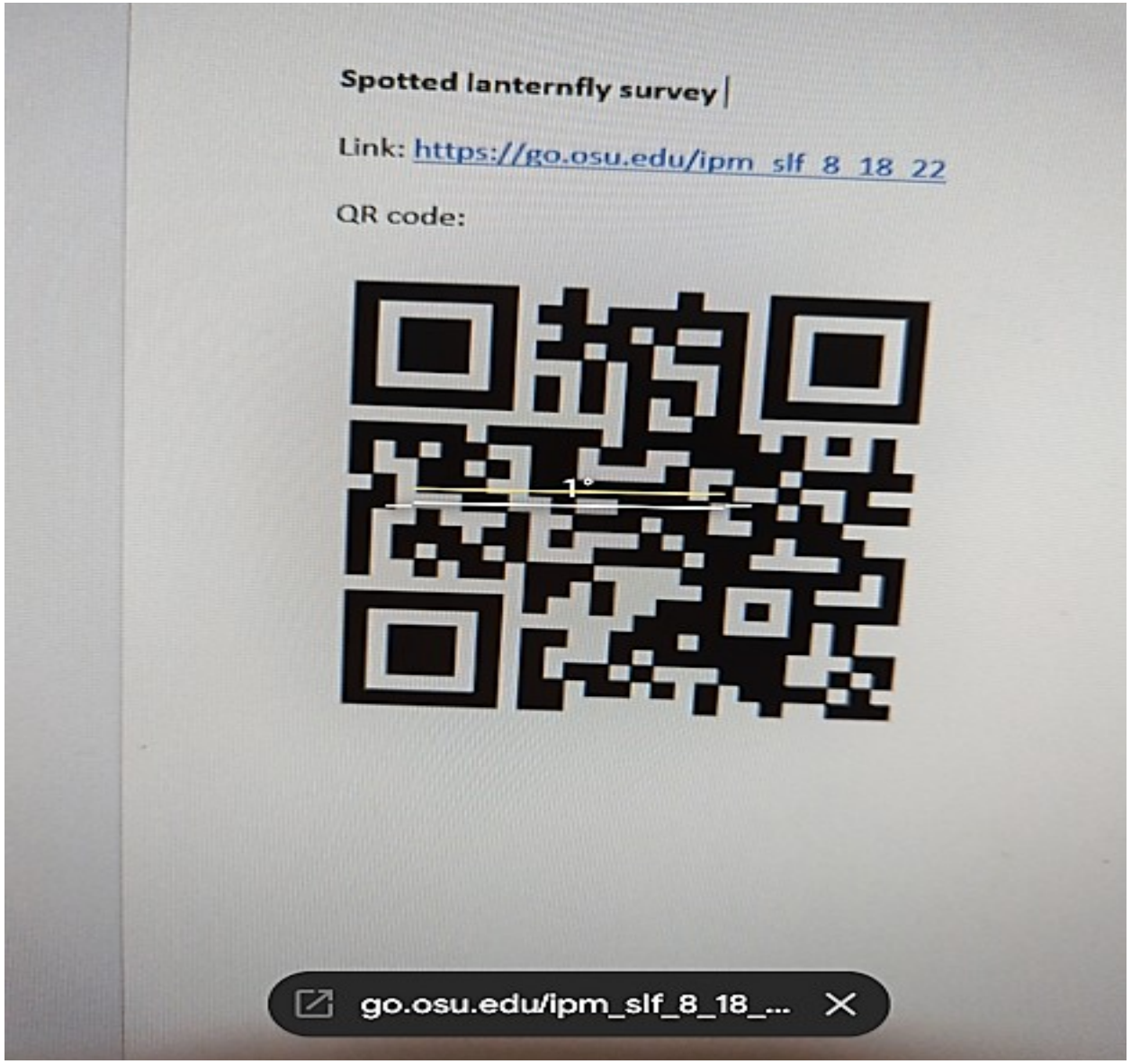
Identify Eggs

95%

Identify Signs

86%

SLF Scavenger hunt

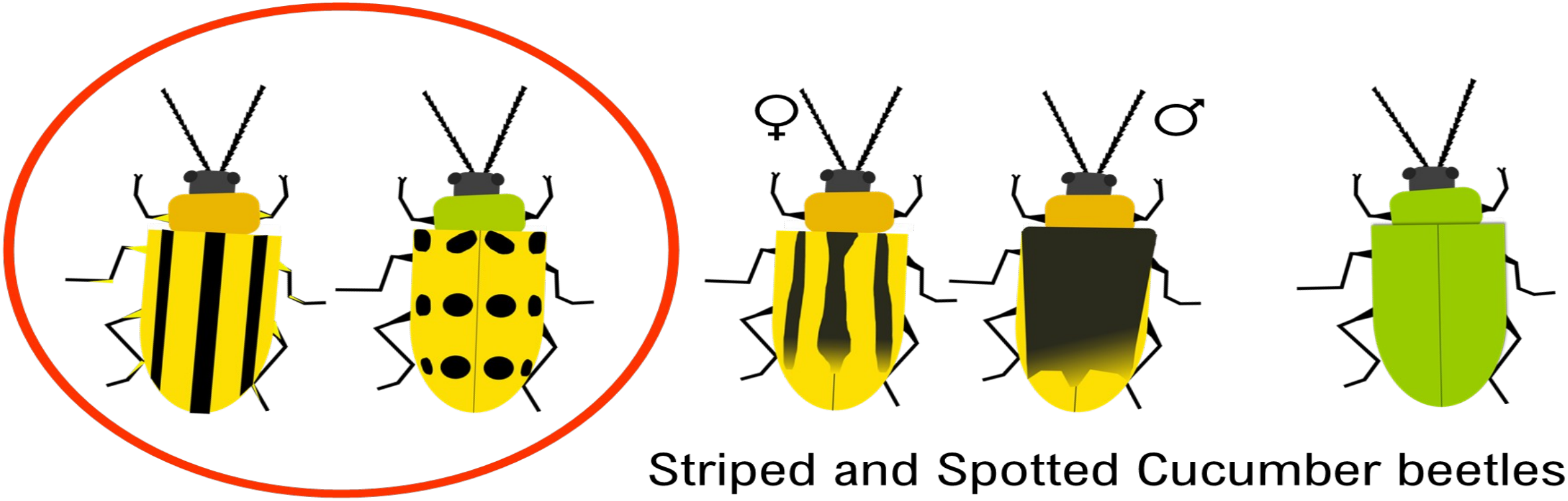


Slowing the spread of invasive species

Using a threshold

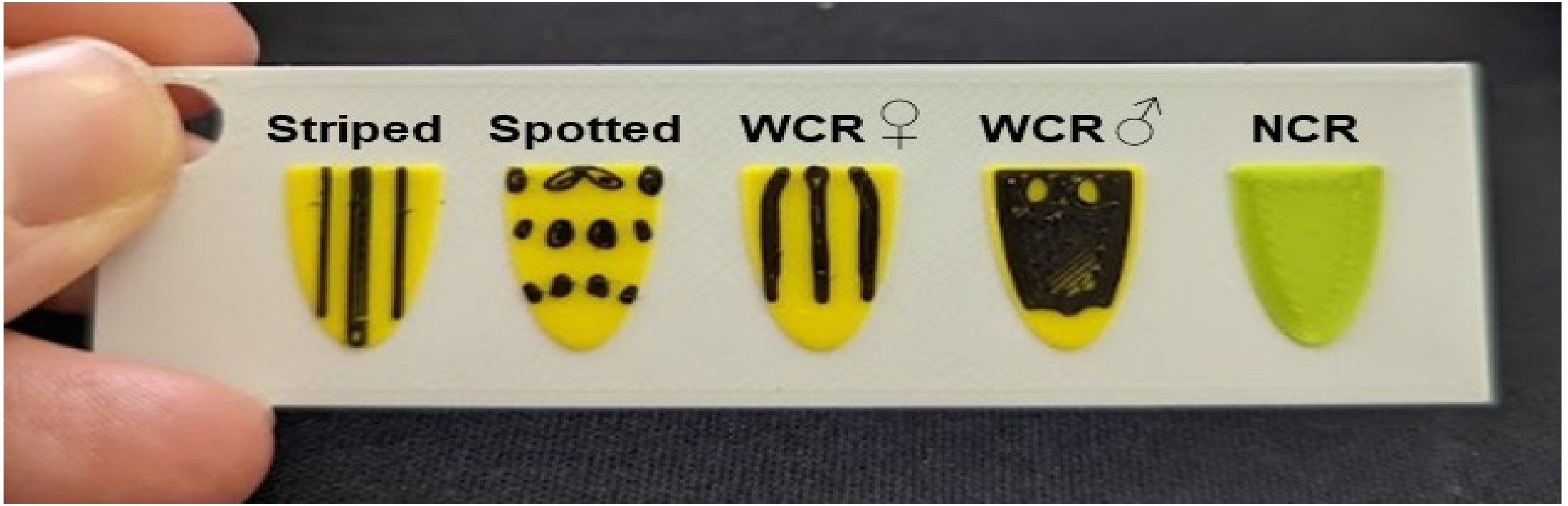
Spraying for the right pest

Beetle butt card.



Striped and Spotted Cucumber beetles= highest risk for bacterial transmission

Beetle butt card.



Beetle butt card.

ENGTECH 2608T Applied CAD Course at Ohio State ATI

or

What Exciting Things are We doing with CAD and 3D printing at ATI?

F. Paul Lee, Jr.
Associate Professor of Engineering Technology

Presented for the 2026 Ohio Ag Ed Summer Conference

June 9, 2026

Shisler Conference Center, Wooster, Ohio

In this talk...

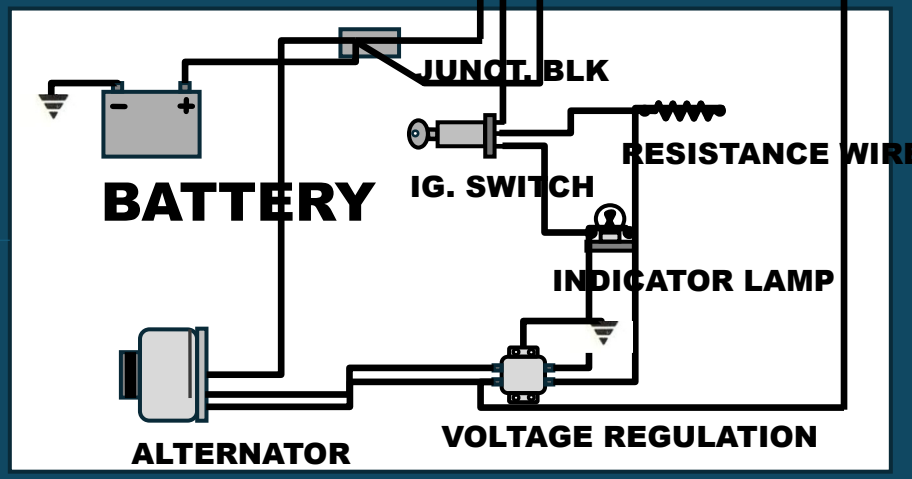
I am presenting one of our courses that includes 3D Printing Technology

- Why? Background rationale
- What? Course content and progression
- How our students are served

Context of Technical Drawings

- *Graphical communication* has always supported idea development.
- Drawings (and models) are succinct means for *communicating* detailed ideas.
  - Maps
  - Schematics
  - Technical Drawings and Prints
- Until the late 20th Century, the process was manual, utilizing ordinary but specialized graphic production materials and equipment.
- Now: CAD

Source: *Dave Rumsey Map Collection*, https://www.davidrumsey.com/luna/servlet/detail/RUMSEY~8~1~324449~90093657



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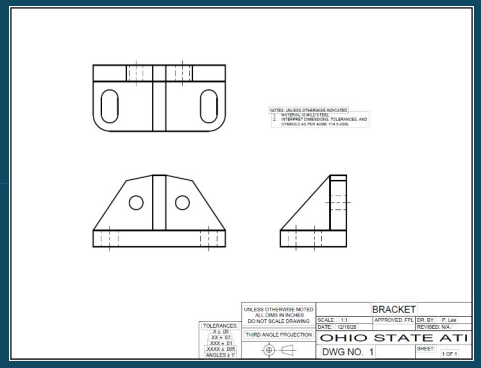
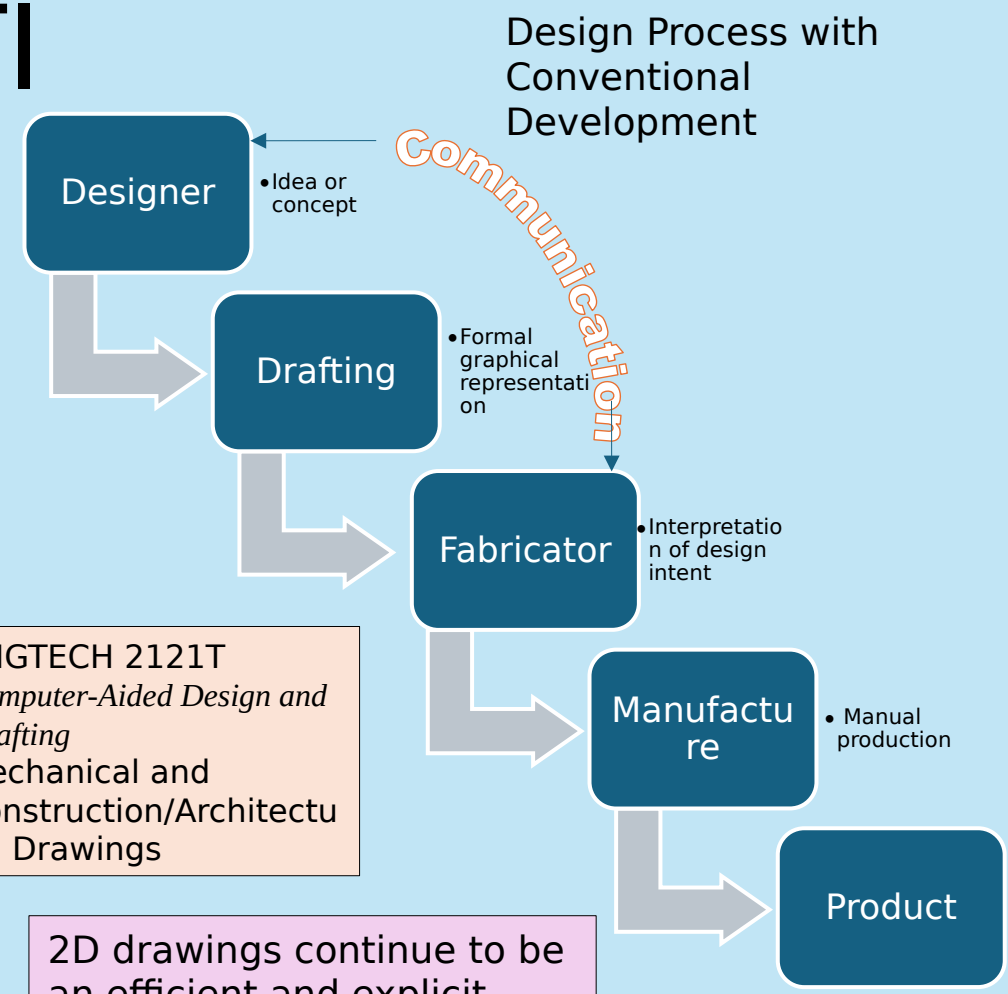


Our Past Approach at ATI

- Embraced Computer-Aided Design/Drafting as a modern incarnation of technical drawing concept.
- For a time, ATI utilized traditional hand drawings and 2D drafting software.
- Makes sense for our students:
  - Agriculture/Technology-oriented:
    - Focus: in-house development rather than commercial development (no hi-volume scale)
    - One-off fabrication and repair
  - Drawings used for *planning* and *reference*.
  - Appropriate for *human-driven* processes



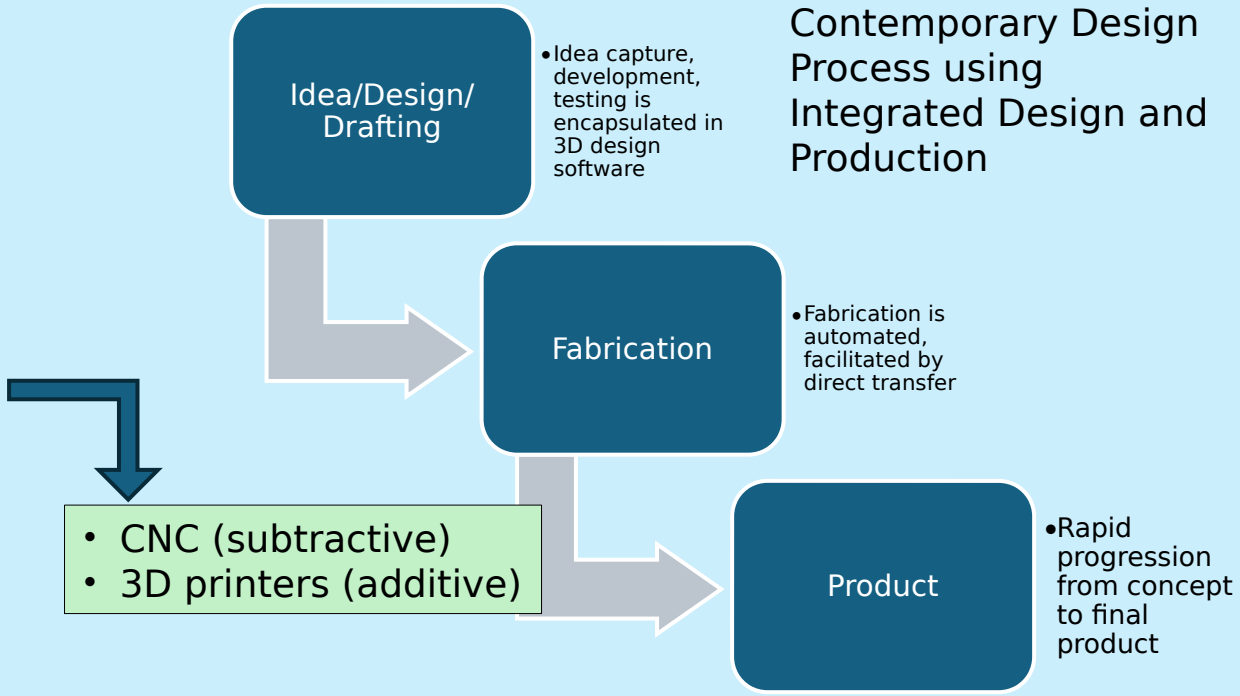
- ENGTECH 2121T *Computer-Aided Design and Drafting*
- Mechanical and Construction/Architectural Drawings

2D drawings continue to be an efficient and explicit means of conveying detail from person to person:

- Dimensions/tolerances
- Production notes
- Symbology

Innovations in Industry and New Paradigm

- Thanks to technological advancements, modern product development is computer-driven:
  - 3D digital modeling introduced *rapid prototyping*- virtual design and experimentation
  - 3D models are the direct input to manufacturing
- Industry has experienced a paradigm shift.
- Developments: manufacturing in hi-volume, has driven automation capability
  - Computer: Idea/Design/Drafting are all one process
  - Manufacturing technology was scaled down—3D modeling software & printers available with low capital investment



Technology moves fast in industry—educators need to keep pace, duplicate practice…

Spring 2026 → ENGTECH 2608T *Applied CAD*

What are the needs?

- Students need to understand and appreciate:
  - The role of graphic communication in contemporary agricultural and technical careers.
  - The design and development processes involved in modern production.
- Students need to develop skills in:
  - Interpreting technical drawings
  - Basic drafting in 2D and 3D
  - Generating and producing 3D models with appropriate equipment

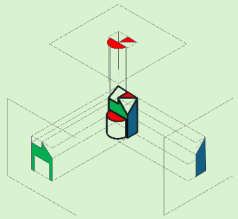
ENGTECH 2608T *Applied Computer Aided Design*

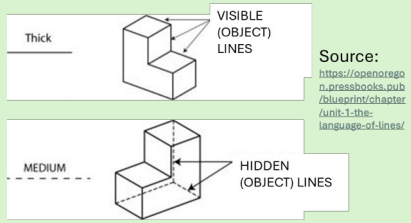
- To address these developments, ATI developed a new course.
- 3-credits: Consists of a 1-hour lecture and two 2-hour labs per week.
- Designed to progress from:
  - Module 1: 2D drafting *to*
  - Module 2: 3D modeling *to*
  - Module 3: 3D (additive) production/manufacturing.

Catalog Description:
"This course will equip students with the essential skills used in Computer-Aided Design (CAD) for practical applications in power equipment and fluid power technologies. This course will emphasize reading, understanding, drafting, and applying designs (2D and 3D) to diverse types of equipment commonly found in mechanical industries."

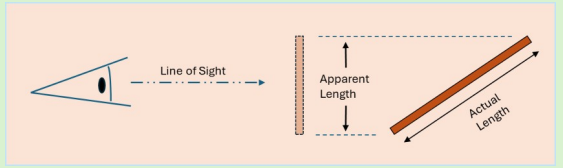
Module 1: Technical Drawing Basics in 2D

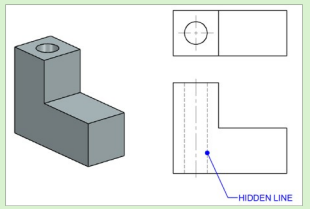
- Conventional 2D CAD text
  Technical Drawing 101 by SDC Publications
- Focus on format and standards
  - Traditional visualization concepts
  - Line types and Multiview drawings
  - Common part/component features
  - Size and position aspects
- Autodesk AutoCAD® software
  - Commands: Draw/Modify/Snap
  - Drawing with precision
  - Dimensioning



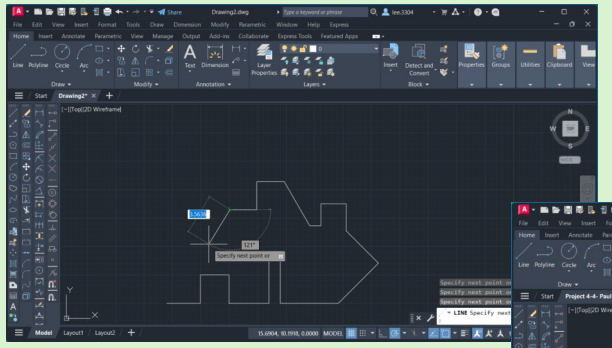


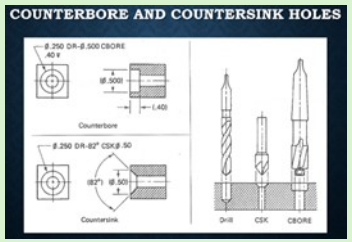
Source: https://openoregon.pressbooks.pub/blueprint/chapter/unit-1-the-language-of-lines/

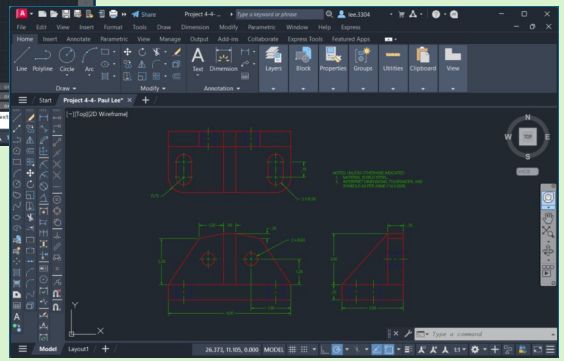




Source: https://engineeringtechnology.org/engineering-graphics/line-conventions-and-lettering/hidden-lines/

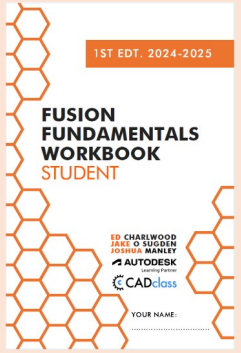


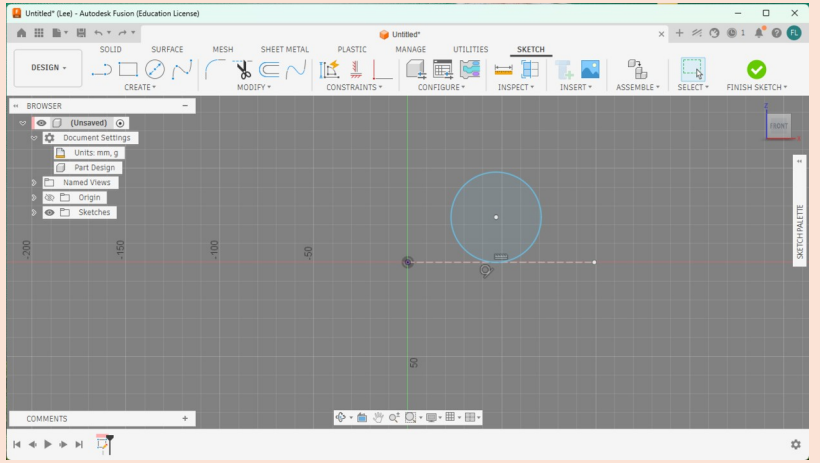


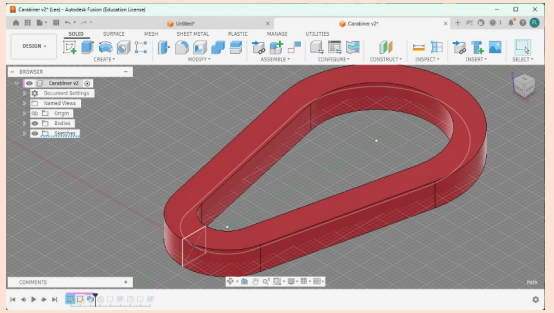


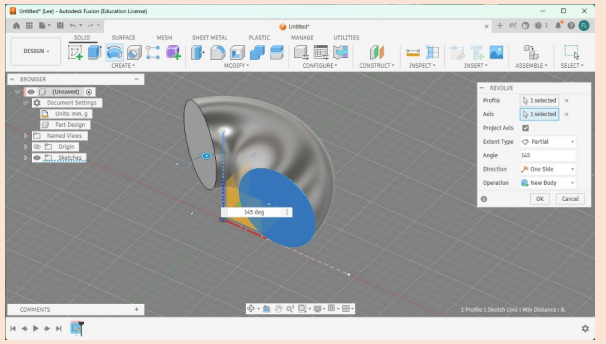
Module 2: 3D Design

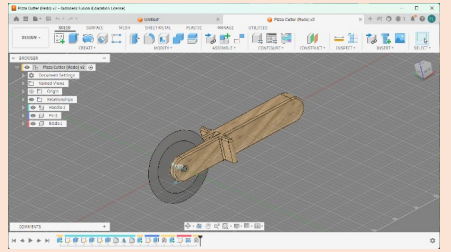
- 3D Design text by CADClass.org
  Fusion Fundamentals Workbook
- Translates graphic skills to 3D
- Focuses on creativity and capturing the design *intent*
- Autodesk Fusion® software
  - 2D sketches to 3D objects
  - Create, modify, build assemblies of objects
  - Generation of models/files for printing: *.STL, *.OBJ

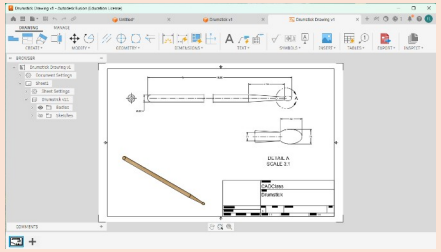












Module 3: 3D Printing

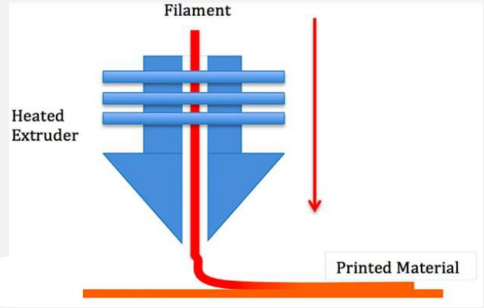
- Utilizes NC3* certification in 3D printing, *Dremel 3D Printing* course.
  - Intro to 3D Printing
  - Slicers and Printing from the Cloud
  - Troubleshooting & Maintenance
  - TinkerCAD and Project Work
- Weeks 11-14 in the course

*NC3 is the *National Coalition of Certification Centers*, an organization that provides portable, stackable credentials for areas of knowledge and expertise.
https://www.nc3.net/

Week 11, Intro to 3D Printing

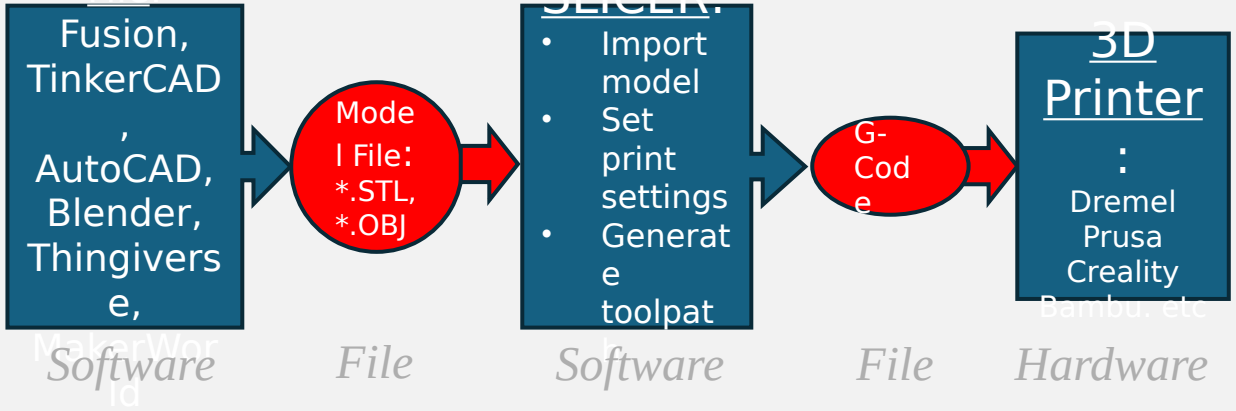
- **History and development** of 3D printing and types of print processes
- Printer **setup** and **safety**
- **First print**: filament installation, prepping/leveling the build plate, loading model file, printing, removing a print
- **Slicer software**: Downloading, opening and preparing files (from repositories)
  - Thingiverse
  - Maker World

3D printing is a, “additive manufacturing” process where *successive layers* of self-adherent material are placed to build a complete structure.



Fused Deposition Modeling (FDM), AKA Fused Filament Fabrication (FFF)

3D Print Production Process



3D printing timeline

- 1983: SLA concept developed by Hull
- 1984: SLS tech developed by Deckard & Beard
- 1986: 1st commercially available, Hull Systems
- 1989: FDM invented, S. Crump
- 1990s-2000s: Refinement development, other methods

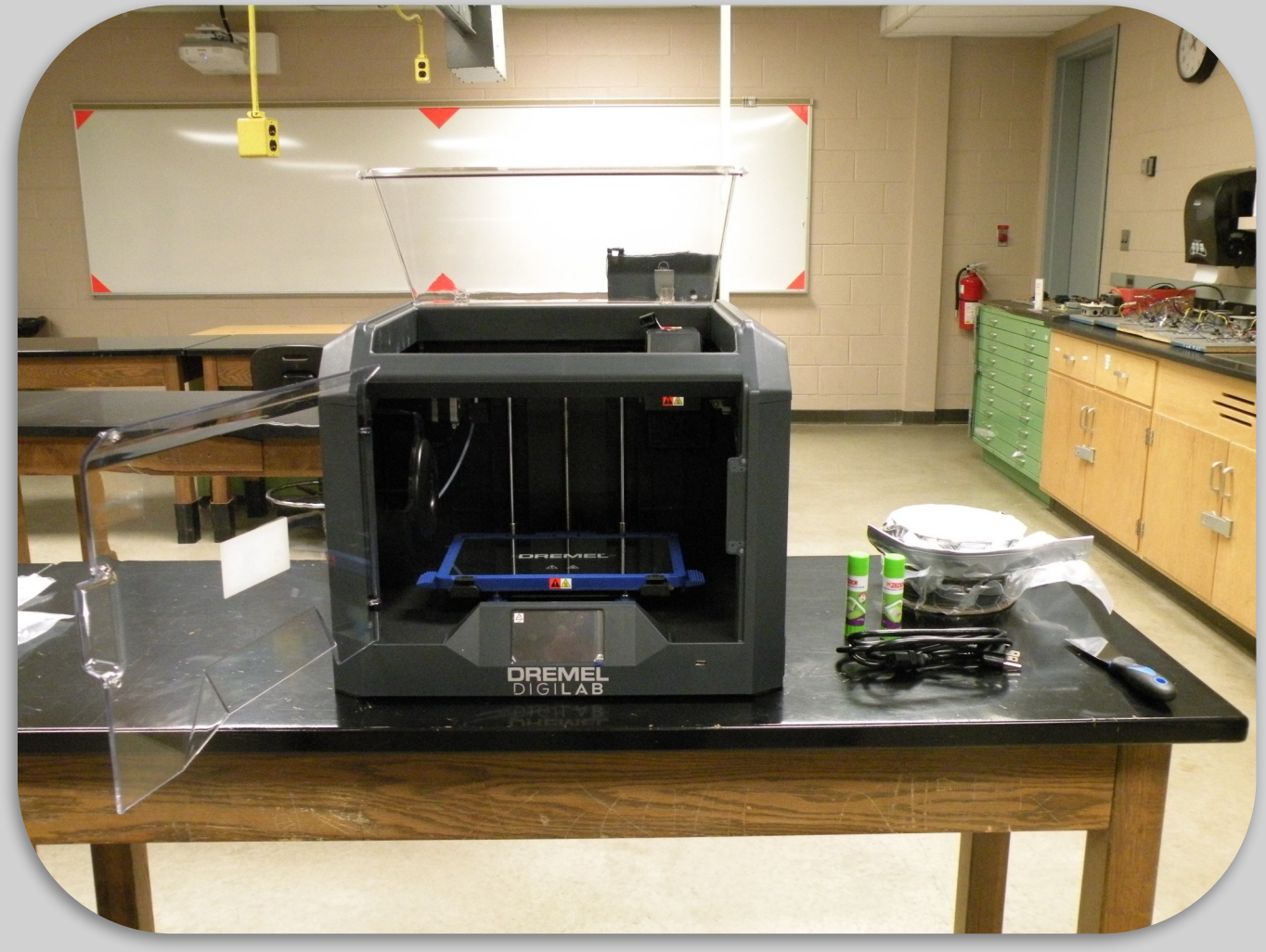
Other Common 3D Print Methods

- Stereolithography (SLA)-liquid resin cured by laser
- Selective Laser Sintering (SLS)-powders fused by laser
- Jetting technologies- liquid sprayed onto powder
- Electron Beam-e.b. melts a substrate

Our ATI Printer

- Dremel, Model 3D45
- Specifications:

Build Volume	**255mm x 155mm x 170mm (10” x 6” x 6.7”)**
Layer Thickness	**50-340 microns (0.002-0.014 in)**
Build Plate Construction	**Tempered Glass, heated**
Number of Extruders	**1**
USB Interface	√
WiFi	√
Interface	**Touch Screen**
Filament Capability	**PLA, ECO-ABS, Nylon, PETG(polyester)**
Material Management	**RFID filament tracking**



Week12, Slicers and Printing in the Cloud

A **slicer** is a program that:

- Prepares the model and printer for printing.
  - Orient, size, duplicate model on build plate
  - Sets parameters for print job
- Generates the command code (G-code) used by the printer.

Slicers enable:

Simple modifications to the model such as:

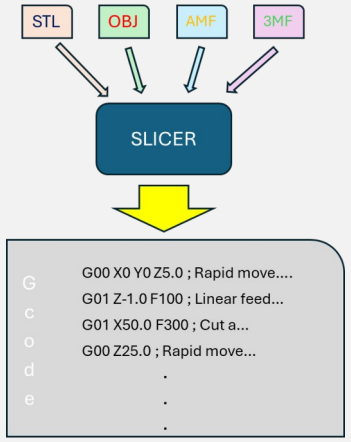
- Orientation: Rotation, flipping
- Scale
- Duplicates

Print job setup:

- Filament—Temperatures
- Quality
  - Layer thickness
  - % Infill
- Support/Anchoring

Information about prin

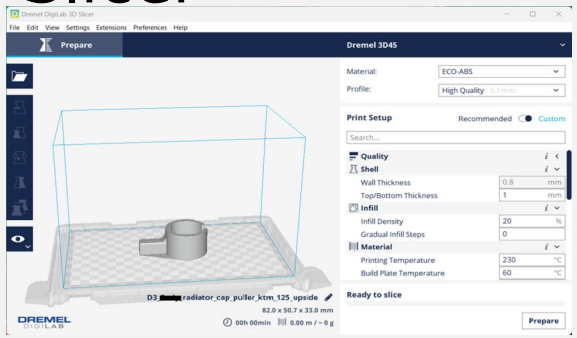
- Time required
- Amount of filament require
- Tool path plan



- Popular Slicers:
  - *Ultimaker Cura*-free, open source
  - *Dremel DigiLab 3D Slicer* (based on Cura) –optimized for Dremel
  - *PrusaSlicer*—free, open-source, many printers supported
  - *Simplify 3D*—paid software, higher end

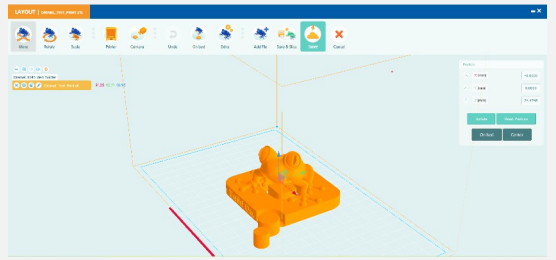
Dremel DigiLab 3D Slicer

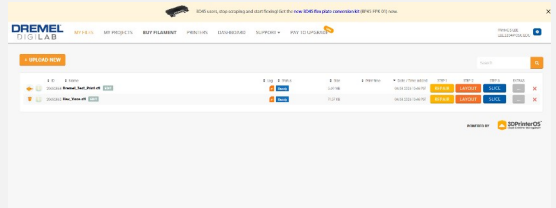
- Installed locally.
- Utilizes conventional file handling to save and maintain models.
- G-code is exported.



Dremel PrintCloud

- Web-based, available on any computing (OS) platform.
- Provides slicer functionality and acts as print server.
- Can be used to send prints to the printer and monitor the print job real-time using printer's *on-board camera*.



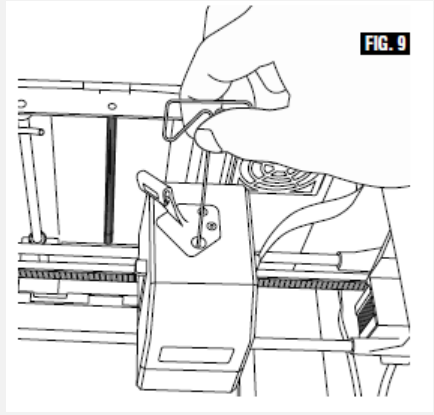


Week 13, Troubleshooting & Maintenance

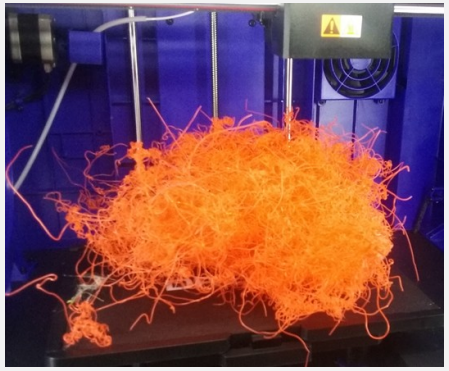
- Troubleshooting
  - Troubleshooting Guide
  - Presentation of common extrusion problems
    - “Spaghetti”
    - Extruder blob
  - Unclogging the extruder
- Maintenance
  - Debris removal
  - Cleaning the build plate
  - Old filament-can lead to “stringing”

PROBLEM	CAUSE	CORRECTIVE ACTION
Filament is not extruding or sticking to the build plate properly.	This can be caused by the build platform not being leveled with the extruder head.	Leveling the build platform will align the extruder head and ensure a better object quality. Cancel your object, clear build platform, level the build platform, and restart the object.
Dremel 3D45 froze before my object started.	Dremel 3D45 may have received conflicting commands.	Turn power switch off, wait 30 seconds, and turn power switch on.
Support material does not break away during cleaning and results in decreased quality of	Orientation of the part is not optimized.	Reorient the position of the 3D file in Print Studio to minimize the support material or place the support material

Source: *V7 Dremel 3D45 Manual*, pg.34



Source: *V7 Dremel 3D45 Manual*, pg.32

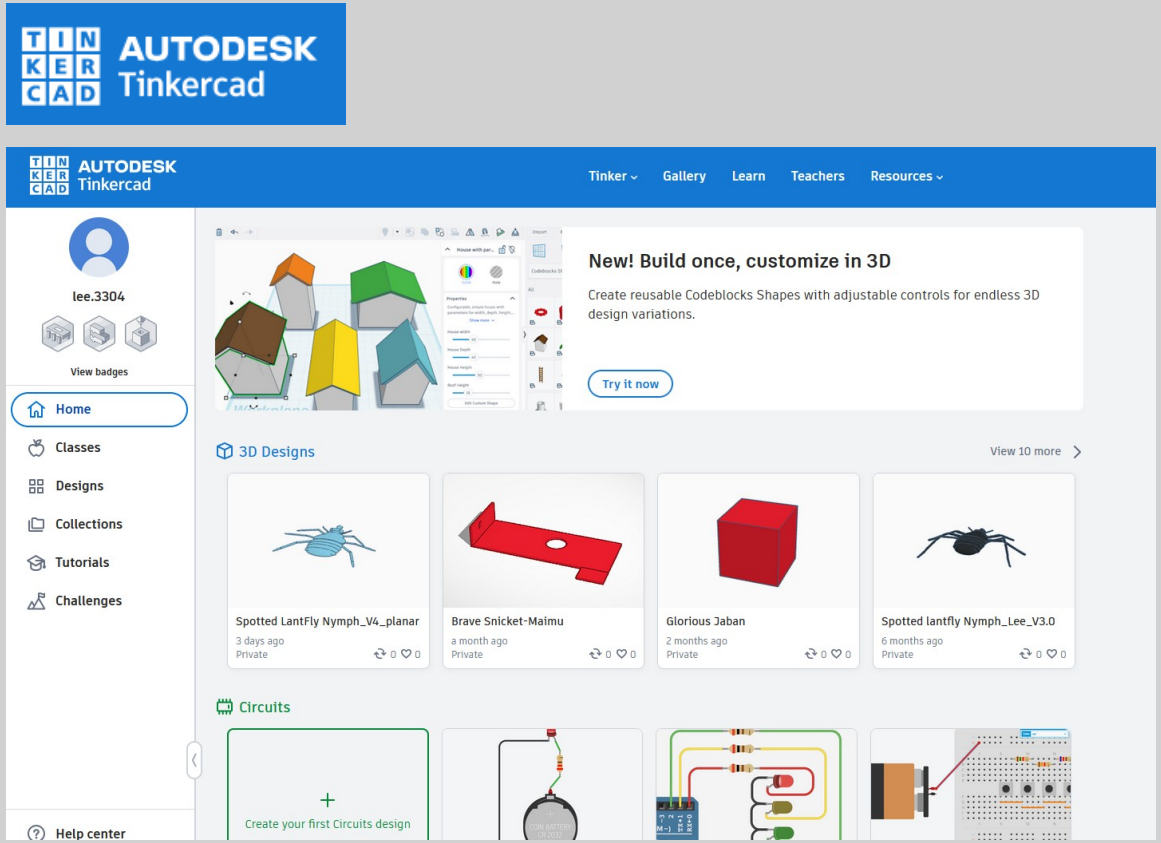


Spaghetti
- Filament not adhering to itself
- Substrate missing
- Incorrect settings

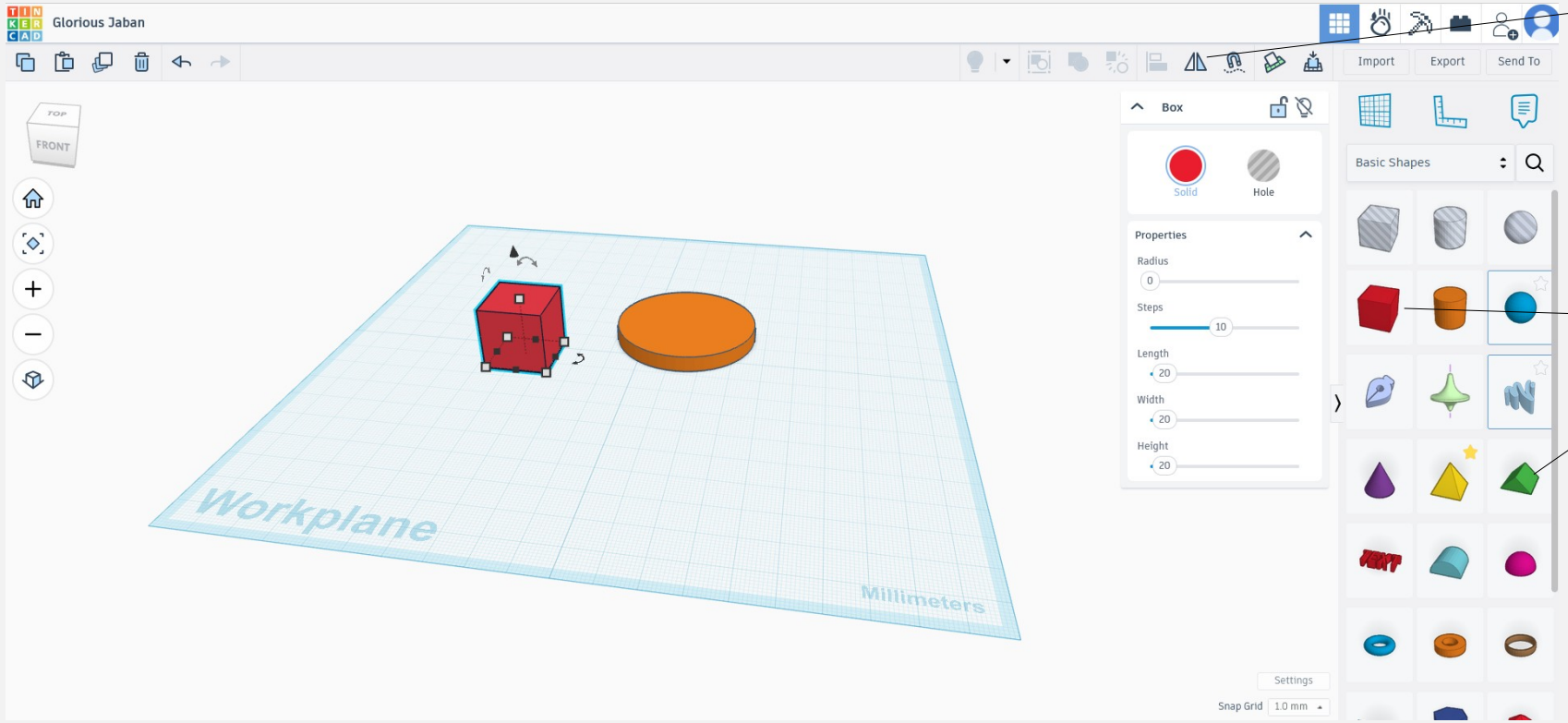
Extruder blob
- Hot filament sticks to extruder and amasses
- Extruder too close to substrate
- Dirty extruder/plate

Weeks 13 & 14, TinkerCAD®

- TinkerCAD is another AutoDesk product
- Web-based software for 3D modeling
- Designed for youth and beginners
- Amazingly capable and useful
- Free with email-based account



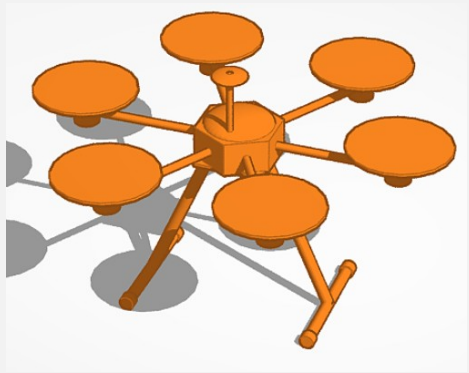
Tinkering with TinkerCAD

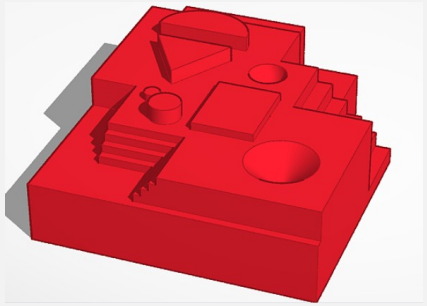


Using these functions at the top, bodies can be joined, duplicated, mirrored, and manipulated in several ways

Variety of pre-formed shapes can be placed and sized

- TinkerCAD is very intuitive for the “computer-comfortable”
- Students find this portion of the course enjoyable

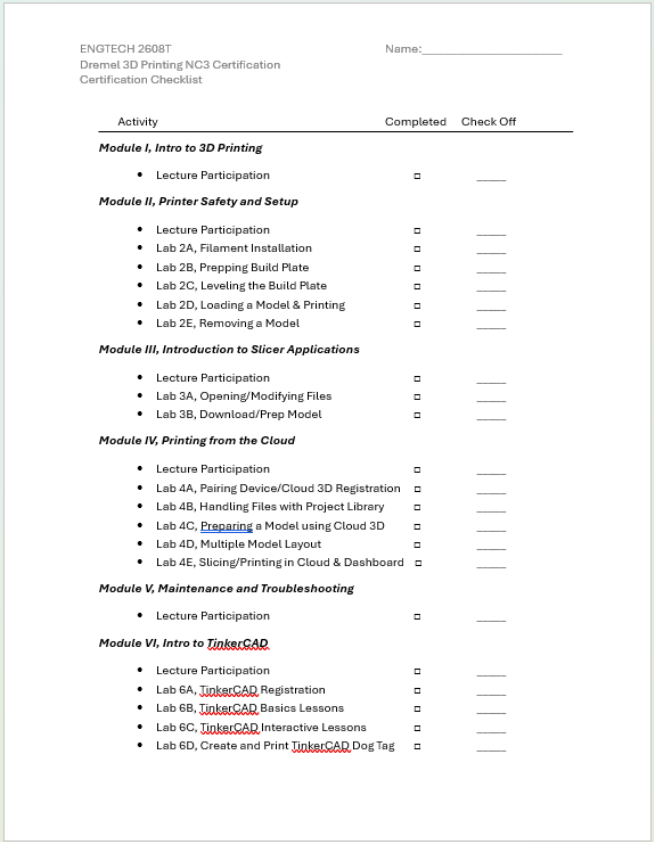




Finishing Up the Class

In Week 14, the students:

- Complete projects to show their mastery of 3D design and 3D printing skills
- Take the *NC3 Dremel 3D Idea Builder* Certification
  - 35 question comprehensive exam
  - 70% correct required for certification
  - Industry-recognized credential



ENGTECH 2608T
Dremel 3D Printing NC3 Certification
Certification Checklist

Name:_____

Activity	Completed	Check Off
Module I, Intro to 3D Printing		
• Lecture Participation	☐	____
Module II, Printer Safety and Setup		
• Lecture Participation	☐	____
• Lab 2A, Filament Installation	☐	____
• Lab 2B, Prepping Build Plate	☐	____
• Lab 2C, Leveling the Build Plate	☐	____
• Lab 2D, Loading a Model & Printing	☐	____
• Lab 2E, Removing a Model	☐	____
Module III, Introduction to Slicer Applications		
• Lecture Participation	☐	____
• Lab 3A, Opening/Modifying Files	☐	____
• Lab 3B, Download/Prep Model	☐	____
Module IV, Printing from the Cloud		
• Lecture Participation	☐	____
• Lab 4A, Pairing Device/Cloud 3D Registration	☐	____
• Lab 4B, Handling Files with Project Library	☐	____
• Lab 4C, Preparing a Model using Cloud 3D	☐	____
• Lab 4D, Multiple Model Layout	☐	____
• Lab 4E, Slicing/Printing in Cloud & Dashboard	☐	____
Module V, Maintenance and Troubleshooting		
• Lecture Participation	☐	____
Module VI, Intro to TinkerCAD		
• Lecture Participation	☐	____
• Lab 6A, TinkerCAD Registration	☐	____
• Lab 6B, TinkerCAD Basics Lessons	☐	____
• Lab 6C, TinkerCAD Interactive Lessons	☐	____
• Lab 6D, Create and Print TinkerCAD Dog Tag	☐	____

Competencies

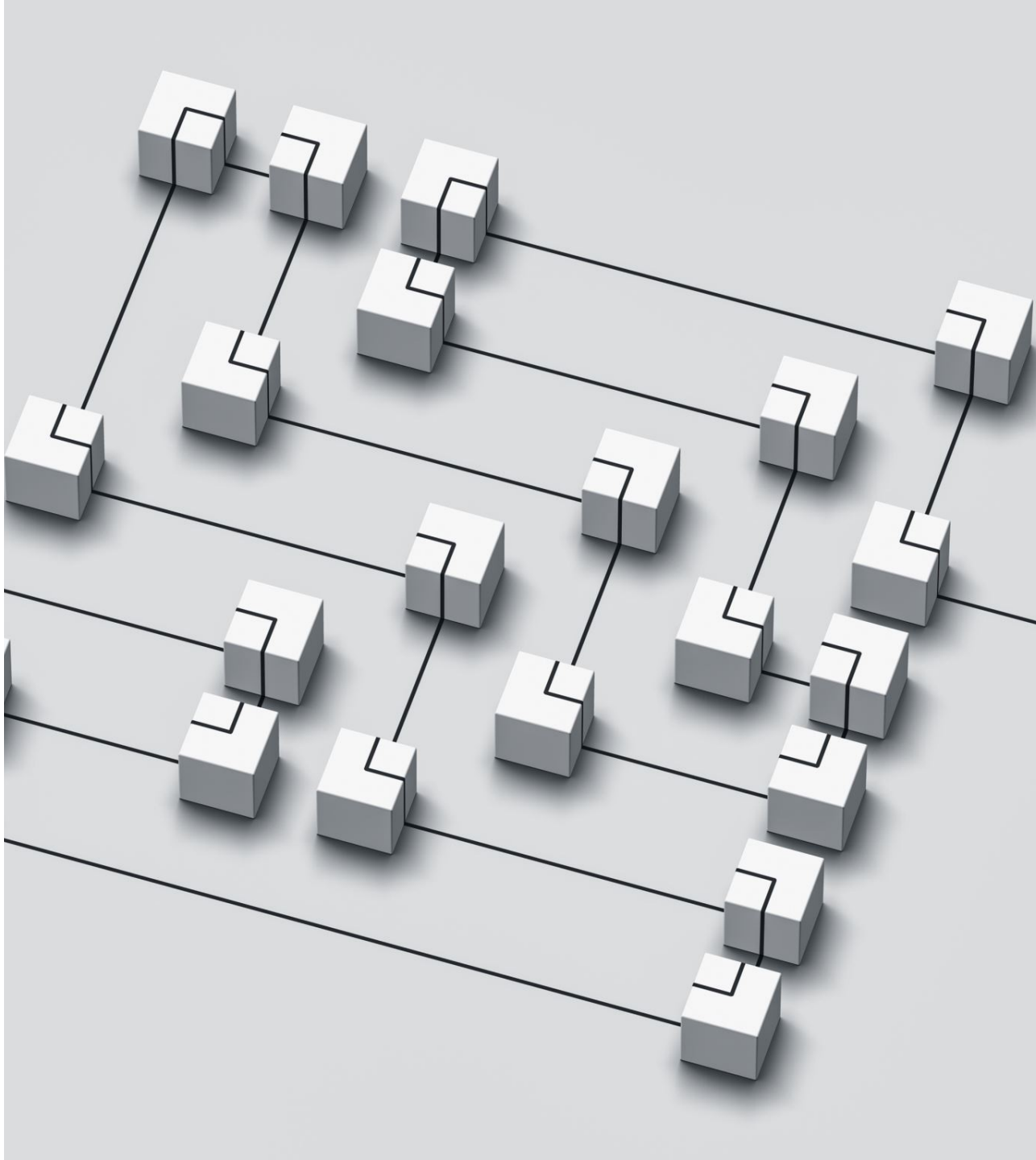
- What is 3D Printing?
- Printer Setup
- Dremel DigiLab 3D Slicer
- Print Cloud Printing
- Maintenance/Troubleshooting
- Introduction to Tinkercad

Skills

Design | Computational Modeling | Analysis | CAD Design | Support Removal | Sanding | Cutting | Filling | Painting | Coating | Polishing | Critical Thinking | Problem Solving | Communication | Collaboration | Troubleshooting | Maintenance

Summary and Conclusion

- Historically, graphic communication has been used to support and facilitate technical development—needs to survive.
- In modern times, graphics are becoming the *means* by which products are developed so ATI adjusted approach.
- Designed ENGTECH 2608T, students proceed from 2D design to 3D design to 3D additive manufacturing production.
- The course builds skills needed in variety of technology careers.



About Ohio State Agricultural Technical Institute

- Ohio State ATI https://ati.osu.edu/
- 2-yr degree-granting component of The Ohio State University
- *Associate of Science* (A.S.)—essentially the first two years of a 4-year degree
- *Associate of Applied Science* (A.A.S.)—stand-alone 2-year degree
- Technically, an Institute
  - Differs from other regional OSU campuses-internal specializations
  - Like a giant "Department" with specialized Divisions
    - Arts, Sciences, and Business
    - Plant Science and Engineering Technologies
    - Animal Science Technologies
- ATI is an NC3 *Certification Center* offering certifications in several subject areas.
- Examples:
  - Kubota Tech Certifications
  - Safety/Health/PPE
  - Precision Measurements

For more information about ATI degree programs:

- https://cfaes.osu.edu/explore-academic-majors#associate
- https://ati.osu.edu/academics

For more information about NC3 certifications at ATI, contact Robert Frutchey, Campus NC3 Coordinator at: frutchey.3@osu.edu

Community Resources

- **Maker Movement**
- **Makerspaces**
  - Digital tools - 3D Printers, Laser engravers, CNC routers, Sheet material cutters
  - Materials
  - Open to the public
  - Meetings
  - Classes
  - Email lists
  - Promote entrepreneurship
  - Private, University-based, Public libraries
- **Identify and Connect**

Online Resources

- **Search**
- **All3DP**
- **Each other?**

(email bromich@aol.com to become part of a group, also for slides)