Engaging Students in Real-World Engineering: Building an SLA Printer using a Scaffolded, Team-based Approach (Resouce Exchange)

Ms. Stephanie Elaine Ott-Monsivais, University of Illinois at Urbana - Champaign

Stephanie Ott-Monsivais serves as the Director of Undergraduate Programs for the Department of Mechanical Science and Engineering in the Grainger College of Engineering at the University of Illinois at Urbana-Champaign. She is a dedicated instructor and mentor, committed to fostering a welcoming and supportive academic community where all students are empowered to succeed. Through her efforts in community building and student-centered initiatives, she works to ensure that everyone has the opportunity to thrive.

Passionate about curriculum development, outreach, and advancing engineering education, she continually strives to enrich the student learning experience and promote engagement across the department. Her excellence in teaching and advising has been widely recognized. She has appeared on the List of Instructors Ranked as Excellent a dozen times and on the Engineering Council's Outstanding Advisors List five times. She was honored with MechSE Staff Awards for Exemplary Service in 2021 and 2024, named a Kay Kappes Golden Shamrock in 2022, received the Excellence in Undergraduate Advising Campus Award in 2023, and was selected as a participant in the Emerging Women Leaders Forum for the 2024–2025 academic year.

Joe Muskin, University of Illinois Urbana-Champaign

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Grade level: High school students, 9-12th graders.
Time: About 20 hours total, can be done in a week-long camp or in daily classroom modules.
Standards: The unit aligns with Next Generation Science Standards related to engineering (HS-ETS1-2, HS-ETS1-3) and concepts related to chemical reactions and energy transfer (HS-PS1-2, HS-PS4-3, HS-PS4-4).

This curriculum unit introduces students to engineering, solving a real-world problem and creating a seemingly complex device that all students succeed in finishing. The unit is roughly a 20-hour scaffolded module in which high school students design a stereolithographic 3D printer for additive manufacturing. Our approach ensures all students can succeed by focusing on designing to meet specific requirements, not to win a competition. The project is team-based and allows for built-in redesign opportunities, which reflects both the collaborative and the iterative process of real-world engineering.

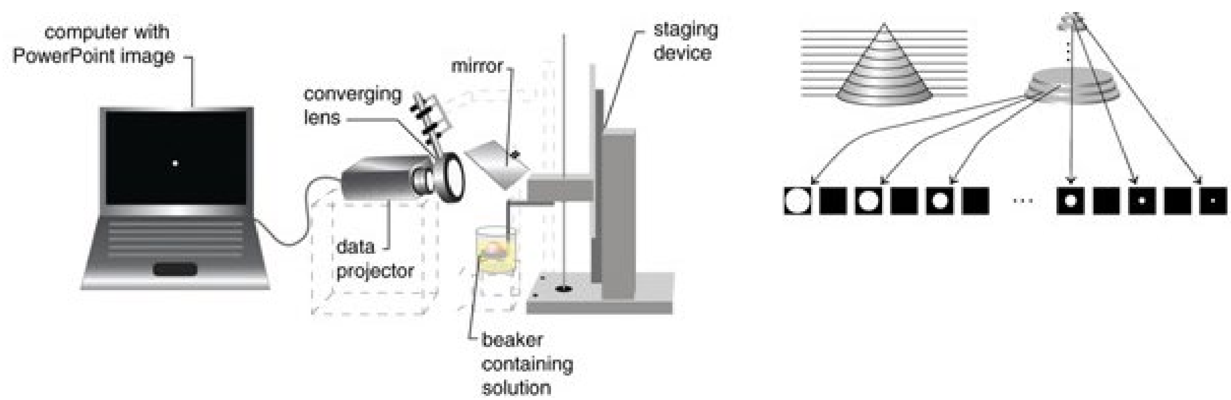


Figure 1. SLA printer setup (left). The PowerPoint slides are projected onto the surface of the resin solution to build a part layer by layer (right).

The types of 3D printers most students are familiar with are filament printers. These use motors to control movement along three axes and to extrude the filament at a precise rate as it melts. However, other methods of 3D printing exist, including stereolithography (SLA). If a data projector is used to project light in the X and Y dimensions, then the only movement required by a motor is in the Z dimension, leading to a much easier 3D printer for students to design and construct. This setup makes the challenge more accessible while still teaching students essential skills like Arduino programming, motor control, rotary-to-linear motion, and system design, as well as how to consider the trade-offs inherent in their many design decisions.

Evaluations of this curriculum unit have been extremely favorable, with over 80% of 200+ participants reporting a significant increase in engineering interest and 95% reporting at least some increase.

Curriculum Unit Overview

Introduction: How does an SLA 3D Printer work? (3 hours)

Students familiarize themselves with the SLA 3D printing process and work with a partner to print a part using the provided SLA printer.

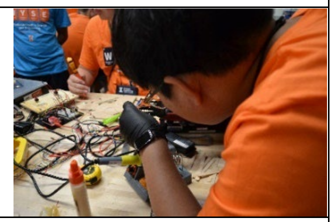
Activity: 3D Print with the SLA 1.0 Printer.

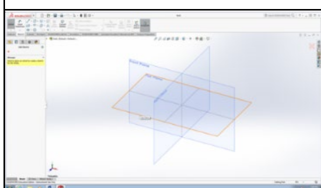
Scan to access the full curriculum

Arduino Programming and Circuit Design (4 hours)

Students familiarize themselves with creating circuits with copper tape, soldering, Arduino programming, and incorporating buttons and switches.

Activity: Create an LED Art Piece.

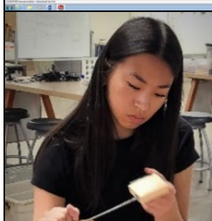




Computer-Aided Design (2 hours)

Students familiarize themselves with creating parts in SolidWorks CAD software.

Activity: Create a Custom Keychain.



Rotary to Linear Motion (3 hours)

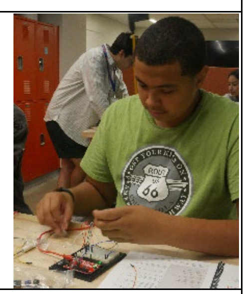
Students engage in small groups to start the construction of their 3D printers, using wood to make a base and adding VEX parts and other components to produce smooth rotary to linear motion.

Activity: Start the Construction of your SLA 2.0 Printer.

Arduino and Motor Control (3 hours)

Students are introduced to Arduino programming with motor control and engage in inquiry-based activities involving both DC and stepper motors to determine which type is best suited for use in their printer.

Activity: Control a DC or Stepper Motor with Buttons. Integrate a Motor into your SLA 2.0 Printer.



Options: Customization (2 hours)

Student teams explore adding custom artwork, buttons, switches, LCD screens, and auto advance options to automate the SLA printing process.

Activity: Choose a Customization Option for your SLA 2.0 Printer.

Final Design Testing (3 hours)

Students create prints using their printer build and perform fine-tuning and troubleshooting to finalize their printer build.

Activity: Finalize and 3D Print with your SLA 2.0 Printer.

Contact: Stephanie Ott-Monsivais (ottmonsi@illinois.edu) or Joe Muskin (jmuskin@illinois.edu)
Link to full curriculum and sample materials lists: https://publish.illinois.edu/exploringmechse