MARYLAND
ROBOTICS CENTER

Student Preparation to Advance Robotics in College (SPARC) Certificate Program

Track: 3D Nanoprinting & Additive Manufacturing for Soft Medical Robotics

Program Syllabus

Summer 2026

Program Information

The "3D Nanoprinting and Additive Manufacturing" Track of the *Student Preparation to Advance Robotics in College (SPARC) Certificate Program* introduces high school students to the rapidly evolving field of additive manufacturing—often referred to as "3D printing"—with a focus on emerging micro/nanoscale 3D printing technologies used in robotics applications. Students will gain exposure to the foundational principles underlying diverse additive manufacturing approaches, including the design, fabrication, and evaluation of complex structures that cannot be produced using conventional manufacturing methods. Through a combination of lectures, demonstrations, lab tours, and hands-on activities, participants will learn how digital designs are transformed into physical objects using cutting-edge additive manufacturing systems. In particular, students will gain experience with the 3D nanoprinting technology, "Two-Photon Direct Laser Writing (DLW)", using the ***$650,000 UpNano NanoOne 1000 3D Microfabrication System*** at the University of Maryland, College Park. The only system of its kind at an academic institution within ~400 miles of College Park, this state-of-the-art 3D nanoprinter is capable of rapid print speeds (>1 m/s) despite feature resolutions down to the ~100 nanometer range (*i.e.*, 1,000× smaller than the thickness of a human hair). Students will learn and leverage design-for-additive-manufacturing (DfAM) principles in combination with SolidWorks computer-aided design (CAD) software to 3D nanoprint new classes of microrobotic technologies, with a focus on soft, biomedical, and surgical robots toward a final demonstration of a 3D-nanoprinted soft robotic biopsy tool.


Maryland Robotics Center (MRC) Interim Director, Prof. Ryan Sochol, alongside MRC students with the recently installed UpNano NanoOne 1000 3D Nanoprinter.

Program Format

The program will run for three weeks, with instructional hours scheduled Monday through Friday from 9:00 AM to 3:30 PM. Participants must be signed in and signed out of the program each day by an authorized adult; however, students with signed waivers from their legal guardians may be permitted to sign themselves in and out. For the final day of the program, participants may invite guests to attend the final project presentations and demonstrations, which will be followed by the SPARC Certificate Conferment Ceremony.

Daily Schedule

9:00 – 9:15 AM	Student Drop-Off
9:15 AM – 12 PM	Morning Activities
12:00 – 1:00 PM	Lunch
1:00 – 3:15 PM	Afternoon Activities
3:15 – 3:30 PM	Student Pick-Up

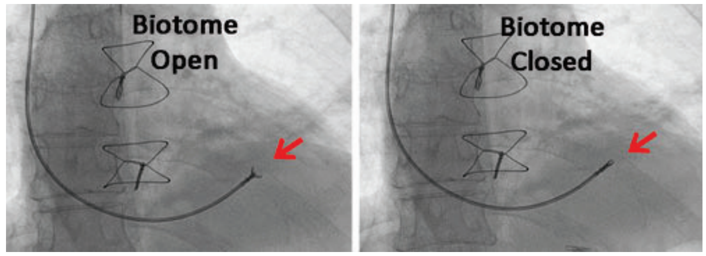
Program Instructor

Prof. Ryan D. Sochol, Interim Director, Maryland Robotics Center

COURSE SCHEDULE

		Morning Topics & Activities	Afternoon Topics & Activities
Week 1	**M**	• Program Overview & Team Formation • Introduction to 3D Printing/Nanoprinting	• Facilities/Lab Tours: Terrapin Works 3D Printing Hub, BAM Lab, MRC Labs
	T	• Vat Photopolymerization (VPP) 3D Printing, *e.g.*, Stereolithography (SLA)	• Introduction to SolidWorks Computer-Aided Design (CAD) Software
	W	• Two-Photon Direct Laser Writing (DLW) 3D Micro/Nanoprinting	• Team CAD Exercises & Challenges using SolidWorks
	Th	• Introduction to Team Design Challenge: 3D-Nanoprinted Soft Microrobotic Biopsy	• Team Concept Development & Preliminary CAD Modeling
	F	• Team CAD Modeling for Macroscale VPP 3D-Printed Prototype	• Finalize/Submit Prototype STL Files • Start VPP 3D Printing Process
Week 2	**M**	• Material Extrusion 3D Printing, including Fused Deposition Modeling (FDM)	• Receive VPP 3D-Printed Prototype • Prototype Testing and Analysis
	T	• Team Redesign & CAD Modeling for DLW 3D-Nanoprinted Prototype	• Finite Element Analysis (FEA) of Mechanical and Fluidic Phenomena
	W	• Team FEA Simulations for Microscale DLW 3D-Nanoprinted Prototype	• Finalize/Submit Prototype STL Files • Start DLW 3D Nanoprinting Process
	Th	• Material Jetting-Based 3D Printing	• Technical Presentation Skills • Preparing Team Project Presentations
	F	• Receive DLW 3D-Nanoprinted Prototype • Prototype Testing and Analysis	• Team CAD Modeling for Microscale DLW 3D-Nanoprinted Final Device
Week 3	**M**	• Team FEA Simulations for Microscale DLW 3D-Nanoprinted Final Device	• Finalize/Submit Final Device STL Files • Start DLW 3D Nanoprinting Process
	T	• Powder Bed Fusion (PBF) 3D Printing	• 3D Printing for Social Change
	W	• 4D Printing • Preparing Final Project Presentations	• Receive Final 3D-Nanoprinted Device • Testing of Final Device
	Th	• Testing & Analysis of Final 3D-Nanoprinted Device Performance	• Finalizing Final Project Presentations
	F	• Final Project Presentations & Demonstrations • SPARC Certificate Conferment Ceremony	

DLW Team Design Challenge:
3D-Nanoprinted Soft Robotic Biopsy Tool



Example of a biotome used for tissue biopsy.

Through this SPARC Certificate Program project, teams will design, fabricate, and test a soft robotic biopsy tool inspired by emerging technologies in minimally invasive surgery and bioinspired robotics. Soft robotic devices are made from flexible materials and are often controlled using fluids (*e.g.*, air, water, saline) that allow controlled bending and interaction with delicate environments. The **objective** is to design a device that can remove as much agarose gel—a "Jell-O"-like material that resembles biological tissue—as possible, while ensuring the device can fit through a constrained incision opening of 1 millimeter in diameter. This design constraint reflects real-world challenges in minimally invasive surgery, where instruments must maximize effectiveness while minimizing invasiveness.

Students will follow a multi-stage engineering workflow and produce three devices across different length scales:

1. **Macroscale Prototype (VPP LCD 3D Printing)**
   - Teams will design and fabricate a macroscale (millimeter-to-centimeter scale) prototype using the vat photopolymerization (VPP) technique, liquid crystal display (LCD) 3D printing to evaluate overall geometry and motion.

1. **Microscale Prototype (DLW 3D Nanoprinting)**
   - Teams will fabricate an initial microscale device using DLW to explore how designs translate to very small dimensions.

2. **Final Microscale Device (DLW 3D Nanoprinting)**
   - Teams will refine their design and produce an improved final device based on testing and iteration.

Using SolidWorks CAD and FEA modeling capabilities, students will design structures that enable controlled deformation and device functionality while learning key concepts in soft robotics, bioinspired design, additive manufacturing, and iterative engineering development. For each design, teams will perform three experimental trials and measure the mass of agarose gel retrieved by their device. The team achieving the strongest final performance, based on agarose gel retrieval capability, will be recognized during the SPARC Certificate Conferment Ceremony on the final day of the program.