3D Printed Shot Hole Borer Trap Systems, **JOAN HORVATH**\(^1\)*, **RICH CAMERON**\(^1\)*, **DANIEL BERRY**\(^2\), **ROGER D. SELBY**\(^3\), **DIEGO PORQUERAS**\(^4\), and **RICHARD STOUTHAMER**\(^1\) (\(^1\)Nonscriptum LLC, 155 N. Lake Ave, Suite 800, Pasadena CA 91101; \(^2\)Huntington Library, Art Collections and Botanical Gardens, 1151 Oxford Rd., San Marino, CA 91108; \(^3\)Department of Entomology, University of California, Riverside, CA 92521; \(^4\)Deezmaker, 290 N Hill Ave., Pasadena, CA 91106; joan@nonscriptum.com, rich@nonscriptum.com).

This exhibit will show traps created with a consumer-level 3D printer to study shot hole borers and other Scolytinae. This system consists of traps that can be used for the introduction of beetles into trees as well as for the determination of the number of offspring emerging from trees and branches, and their production of frass and sawdust. We will also have on hand pictures of the damage caused by the beetle when it invades a tree, and of the traps deployed in the field.

**The DIY Student Wind Tunnel**, **SIMON HUSS**\(^1\)*, **MATTHEW PARSON**\(^1\)*, **TRI NGUYEN**\(^1\), **REGINA RUBIO**\(^1\), **JOAN HORVATH**\(^2\), and **RICH CAMERON**\(^2\) (\(^1\)Windward School, 11350 Palms Blvd, Los Angeles CA 90066; \(^2\)Nonscriptum LLC, 155 N. Lake Ave, Pasadena CA 91101; joan@nonscriptum.com).

We will show the test section and some of the instrumentation of a student-built wind tunnel (about the size of a home aquarium.) We will also show the 3D printed wings tested in the tunnel.

**ISS-Above: Bringing the International Space Station in to the Classroom**, **LIAM KENNEDY** (ISS-Above, Monrovia, CA; liam@issabove.com).

The ISS-Above is used in classrooms throughout the USA. This exhibit will provide examples of how this little gadget (a Raspberry Pi based device) has supported learning across multiple disciplines like physics, geography, biology, space sciences and human spaceflight.

**Project-based Learning for K-12 Next Generation Science Standards STEM Education**, **BETTY WONG** (California Institute of Technology, 1200 E. California Blvd, Pasadena, CA 91125; bwong@caltech.edu).

Developed by a team of Caltech scientists and engineers, AstroGro is a NASA award-winning 3D-printed smart pod to grow fresh food in space. It is now being expanded into a project-based learning platform to revolutionize K-12 STEM education. AstroGro is a platform for students to learn interdisciplinary skills (e.g. 3D printing, electrical engineering, computer programming, and plant biology) and to be enriched in core subjects (e.g. math, statistics, physics, biology) while meeting the Next Generation Science Standards. We will be showcasing the AstroGro learning module.

**Vinduino Soil Moisture Measurement Demonstration**, **REINER VAN DER LEE** (Rancho Santa Margarita, CA; reinivanderlee@gmail.com).

The Vinduino project has been developing a new generation of the open source soil moisture monitor with the following features: 4 inputs for (gypsum) soil moisture sensors, built in (solar) battery charger, support for 6 mile long range radio module or WiFi, clock module for precise irrigation timing, on board temperature and relative humidity sensor, optional irrigation valve control and extra sensor, and power management circuits, resulting in lower power consumption.

**3D Printed Structures for Magnetic-based Immunotherapy of Brain Tumors**, **ALEX PAI**\(^1\)*, **TORKOM PAILEVANIAN**\(^1\), **PENGPENG CAO**\(^2\), **ETHAN WHITE**\(^2\), **KAUSHIK DASGUPTA**\(^1\), **JEFF SHERMAN**\(^1\), **DARYA ALIZADEH**\(^1\), **JACOB BERLIN**\(^2\), **BEHNAM BADIE**\(^2\), and **ALI HAJIMIRI**\(^1\) (\(^1\)California Institute of Technology, 1200 E. California Blvd, Pasadena, CA 91125; \(^2\)Beckman Research Institute, City of Hope Medical Center, 1500 Duarte Rd, Duarte, CA; \(^1\)City of Hope Medical Center, 1500 Duarte Rd, Duarte, CA; apai@caltech.edu).

Immunotherapy utilizing functionalized nanoparticles has been shown to be a promising treatment for intracranial gliomas, the most common type of malignant brain tumor. However, the retention and delivery
of immune cells and nanoparticles to the tumor site remains a hurdle of immunotherapy. We introduce 3D printed structures for brain tumor immunotherapy research. We use this system to implement a cell incubation, imaging, and manipulation chamber that can be used for basic science research. We also demonstrate 3D printed structures for magnetically guided drug delivery in the human body.

**Enhancing Measurement Quality with Robotics**, TOMAS ROBINSON*, COLLIN CUPIDO, DAVE FORTIN, and MARK FREEMAN (University of Alberta, 116 St. and 85 Ave., Edmonton, AB, Canada T6G 2R3; terobins@ualberta.ca).

By utilizing a repurposed 3D printing delta bot, an Arduino, and a milligram scale, this device can collect data on multiple aspects of magnetism. Custom designed 3D printed parts allow one to measure quantitatively the superconductivity of a YBCO pellet by precisely moving the samples together and apart. Magnetic field of a sample can be measured using a magnetometer attached to an Arduino, and experimental flux pumping methods are being looked into, making use of the programmable movement of the arms.

**Science Sticks- Accessible Ocean Measurement**, TONY WHITE (Ocean Lab LLC, 505 E Wilson Ave., Glendale, CA 91206; tony@oceanlab.com).

The small low cost water-drone we have been developing at Ocean Lab will be displayed (in quantity of 2-6 units) alongside a TV showing video of the units in the wild, describing (via text) the sort of applications we are targeting.

**Mitral Valve Backflow Pressure as Function of Leaflet Geometry**, DAVID MITTELSTEIN (California Institute of Technology, 1200 E. California Blvd, Pasadena, CA 91125; dmittels@caltech.edu).

The mitral valve is an asymmetric bicuspid valve that prevents backflow from the left ventricle to the left atrium. Computational fluid dynamics of cardiac blood flow suggest that the unique asymmetric shape of this valve plays a key role in its ability to maintain valvular competence despite the high pressure differential. To confirm these findings, this in vitro experiment uses various geometries of valves and examining the maximum applied pressure which would not cause backflow. This exhibit includes the 3D printed molds used to create symmetrical and asymmetrical silicone valves and a 3D printed water column testing apparatus.

**3D printing in Astronomy**, PAVAMAN BILGI (California Institute of Technology, 1200 E. California Blvd, Pasadena, CA 91125; pbilgi@caltech.edu).

On show will be miscellaneous fixturing parts printed for a new multimillion dollar astronomical camera (Zwicky Transient Factory) for the 200inch Hale telescope at Mt. Palomar. The camera consists of extremely sensitive CCD sensors in a vacuum cryostat system. On exhibit will be the CCD mounts, getter container and camera window retainer. The primary reasons for the use of 3D printing were the cost effectiveness and material properties (pliability) of FDM printing material.

**Interlock Meter-Mix Device for Metering and Lysing Clinical Samples**, ERIK JUE (California Institute of Technology, 1200 E. California Blvd, Pasadena, CA 91125; )

The multi-material 3D printed meter-mix device simplifies nucleic acid amplification testing (NAAT). In a typical NAAT workflow, a trained user operates an expensive pipettor to meter urine, meter lysis buffer, mix urine with lysis buffer (optionally vortex), and transfer the solution to a nucleic acid capture column. The meter-mix device can be used instead to replace these operations. The entire device workflow is performed in under 10 seconds with just 3 sequence-controlled steps. Furthermore, in developing the meter-mix device we showcase multi-material 3D printing capabilities: complex 3D designs, fluidic seals, rapid prototyping, modularity, optical clarity, and compatibility with nucleic acids.

**Using General Packet Radio Service (GPRS) for Realtime Subsea Wireless Data Transmission**, GARRETT BLAKE JOHNSON (Hawaii Institute of Marine Biology, 46-007 Lilipuna Road, Kaneohe, Hawaii 96744; gbj@hawaii.edu).

As an exploration of the possibility of the current 'maker movement' and the internet of things, I am working to develop a low cost DIY method for realtime data analytics of subsea sensor data utilizing existing cell phone data infrastructure to facilitate realtime data readings from around the world.