MAKER EDUCATION

Hands-on learning at Lynchburg's makerspace

VECTOR SPACE

Fostering innovation, creativity, and the pursuit of science based knowledge.

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A Message from the Director of Education

Education inside a community makerspace overcomes many of the struggles of traditional education, including the propensity for overspecialization and isolation of content. It happens in schools that separate subject areas by hallways and in universities that use entire buildings to keep the humanities distanced from sciences. And with even more severity, entire institutions are used to keep the academic separate from the vocational. It's an approach that has no doubt been successful in creating division between these worlds, generating pride in our overspecialization and resentment toward the others as we fail to communicate across boundaries. What we're left with are specialists; programmed to perform specialized tasks when given specialized inputs. It has become commonplace for a practicing engineer to have never held a thermocouple or repaired a motor. People who are expected to design things are no longer expected to have built things and the result is a troubling lack of understanding. Rarely can the mechanical engineer work on their own failing automobile transmission, and rarely can the electrician program a simple microcontroller. Great thinkers and innovators need relevant hands-on experience to solidify their academic learning, and at Vector Space, we make it our goal to merge these worlds.

"Great thinkers and innovators need relevant hands-on experience to solidify their academic learning."
- Adam Spontarelli

Our Educational Philosophy

Engaging

Projects at Vector Space are never boring. Students are given autonomy throughout the project to try new tools and skills based on their interests, and have the opportunity to lead and collaborate with their peers to accomplish shared goals. Many of our alumni have chosen majors and careers based on their experiences at Vector Space, or made the equally important decision NOT to pursue specific careers. Bonds are formed between old friends and new, often expanding a student's social circle outside of their own school and sports experiences.

Interdisciplinary

To create fundamental objects and complex machines, students must engage creatively in both tangible and digital ways. Each project offers an opportunity to bring the arts and sciences together, encouraging innovation and creative thinking. Lead by makers with a variety of backgrounds and experience who are joined by guest speakers and volunteers from even more disciplines, students are exposed to a variety of career and cultural ideas throughout their weeks at Vector Space.

Equitable

Whether students are college-bound or heading into the trades, the hands-on experience combined with science and engineering theory will set them up for success. Students with strong academic backgrounds and those with more tangible learning styles both perform well and learn to find their own strengths during our collaborative projects. If there is genuine interest, then there is a route to success for each student at Vector Space. Thanks to the generosity of our partners and supporters, no student is turned away due to financial constraints.


Public Art
Camp (2019)

Our Approach to Education

Research-Based 

From the ancient texts of Socrates and the formulas of Archimedes, to the modern leadership of Dale Dougherty and Lady Ada, our leadership team devours research and teachings from great thinkers around the globe. Makiguchi's approach to formal education and Papert and Piaget's findings on hierarchy of learning all influence our teaching methods. Our instructors model lifelong learning with their continued investigation of the world, from Maker Ed conferences and Exploritorium classes to the great orators of YouTube. We are constantly reading, learning, trying, and exploring the world alongside our students. Our hands-on approach with carefully positioned lessons supports students' academic knowledge and allows them to see theories come to life in their hands. Moreover, the physics and mechanics of each tangible skill is explored to provide knowledge on both how and why various tools and materials function.

Student-Led 

Each project starts with an idea, originating in the instructor's own mind or influenced by students' requests, but the details unfold over time. We know that giving students a soft goal or focus will allow them to move toward it with enough autonomy to take ownership of the project, but without being paralyzed by overwhelm. Project instructors are skilled in diverse tool and materials abilities, with a deep appreciation for and understanding of making and tinkering. Our projects are designed to put instructors' knowledge to the test, allowing them to learn just one step ahead of, or sometimes alongside of, the students in their program. For students to experience mistakes and revelations and see them normalized in an adult role model builds a growth mindset and encourages perseverance through related and unrelated tasks. This approach allows students to focus on specific fields or skills of interest, and often leads to college or career decisions.

Project Focus: Fashion + Tech

In January 2019 ten teen girls interested in fashion design and unfamiliar with computer programming were introduced to the world of possibilities afforded by the ability to code during our Fashion + Tech project sponsored by Best Buy. Students learned technical skills in the areas of electronics, using microcontrollers and Python to allow their garments to interact with the real world. With sensors as inputs and lights as outputs, each student saw that computer programming can bring to life ideas that before seemed only fantasy.
In addition to the tangible skills gained, students saw how two traditionally separate industries, fashion and technology, can come together to revolutionize not only those two fields, but can impact additional areas such as healthcare, public awareness, athletics, and more. They learned that when people with diverse backgrounds - be that education, experience, race, class, or otherwise - come together, new and important accomplishments can be achieved.

Furthermore, this project not only bridged the gender gap for these ten females in computer programming, but put them far ahead of the majority of their male counterparts of the same age. This unique experience has given ten girls an advantage in a male-dominated field at a time in their lives when they can easily pursue a path and will no doubt have successful experiences in computer science should they choose to do so.

The final product of this project was not just the ten garments and ten accessories created by the students, but a public runway show where the students modeled their outfits. While nervous to present their work in front of such a large crowd, the students were proud of what they had created- from design to implementation of their own ideas. This was not a cohesive runway collection, but ten unique looks that reflected each individual student. Some of the ideas that students brought to life in their garments included a set of green lights with one blue light every 1,000 units, to represent the the genetic anomaly she was born with. Another included a microphone and set her lights to change with the music played during the runway show. A third used a real time clock to synchronize the lighting of two neopixel rings with the visibility of the actual sun and moon. There are seven more unique examples, each of which students had complete creative freedom and ownership over. The impact of that alone - making a project of your own creation - is profound.

Student Alumni Timelines

2015

Multicopter Video Project

Caleb was the team member responsible for the airframe design during this project, where he was introduced to 3D CAD design and 3D printing for the first time. The body design of the copter needed to mount the motors and house all electronics. He also designed the landing gear to avoid crushing the on-board camera.

2016

Space Balloon Project

Caleb wrote about his role in this project, "I decided in the beginning that I wanted to do programming for the learning experience and to generate interest in this field of science. I have not done any previous studies in programming." This project introduced Caleb to the field of study that he would go on to study in college.

2020

Virginia Tech

Caleb is a Senior pursuing a degree in Computational Modeling and Data Analytics at Virginia Tech. After graduation, he plans to pursue a career in Computer Science.

2017

Giant Flip Book Project

Sydney was first interested in Vector Space because of her love and talent for traditional artistic mediums. While the arts attracted her to this project, she learned skills such as welding, math, and engineering to bring this art project to life.

Summer Internship

In addition to contributing to the makerspace, summer interns each work with a mentor on a personal project. Sydney created a 3D multi-media piece using the CNC router to engrave her drawings on wood, accented with paint and metal.

2018

Autonomous Boat Project

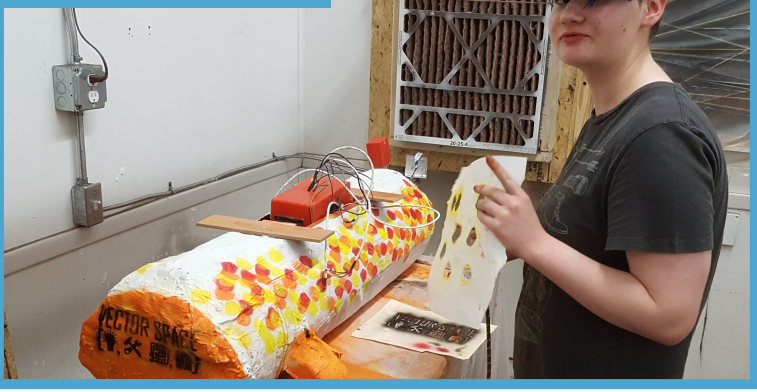
Building on her previous experience, Sydney led the visual design and structural design aspects of the autonomous boat. She created a mold and fiberglassed the boat body, and then laser cut a stencil to spray paint a design mimicking fish scales on the exterior of the vessel.

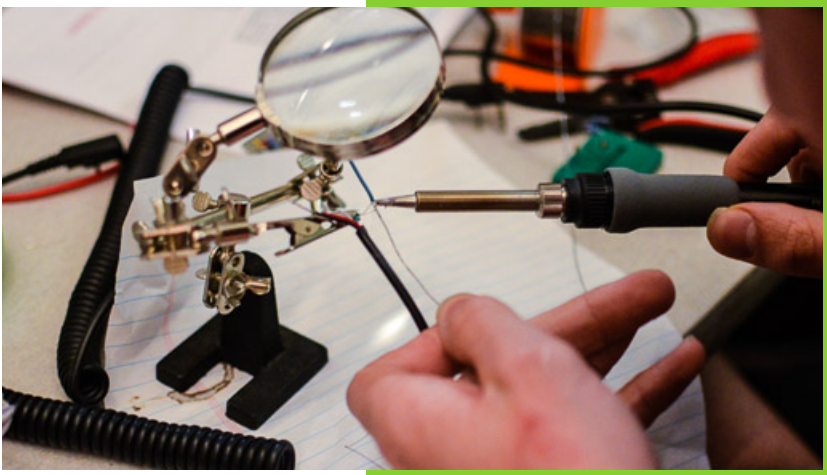
2020

Hastings College

As a Sophomore, Sydney is pursuing a Bachelor of Arts.

Sydney Palmer





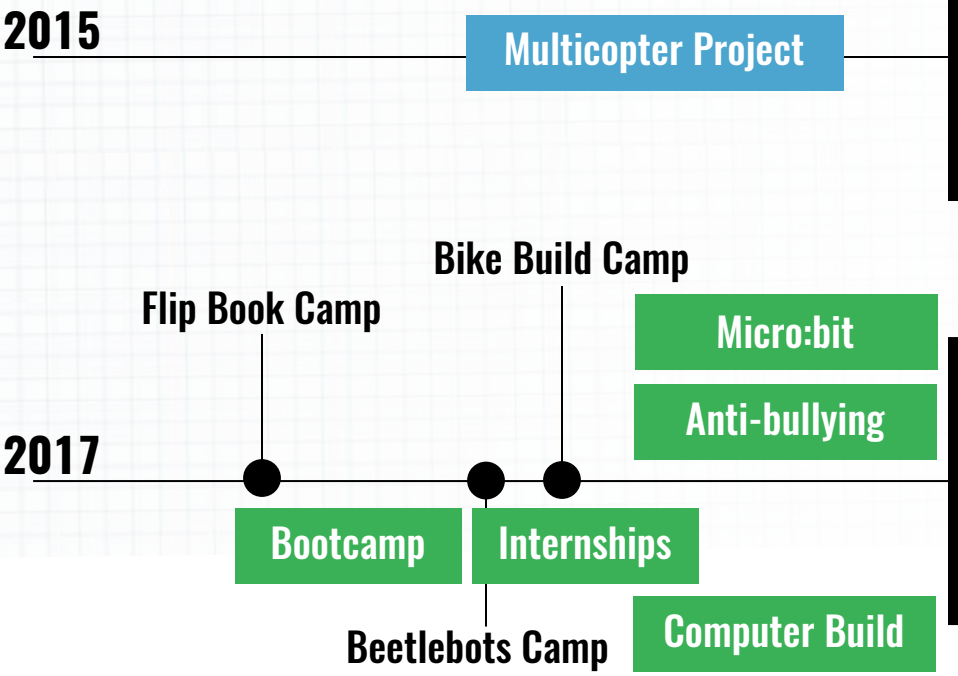
Project Spotlight: Space Balloon

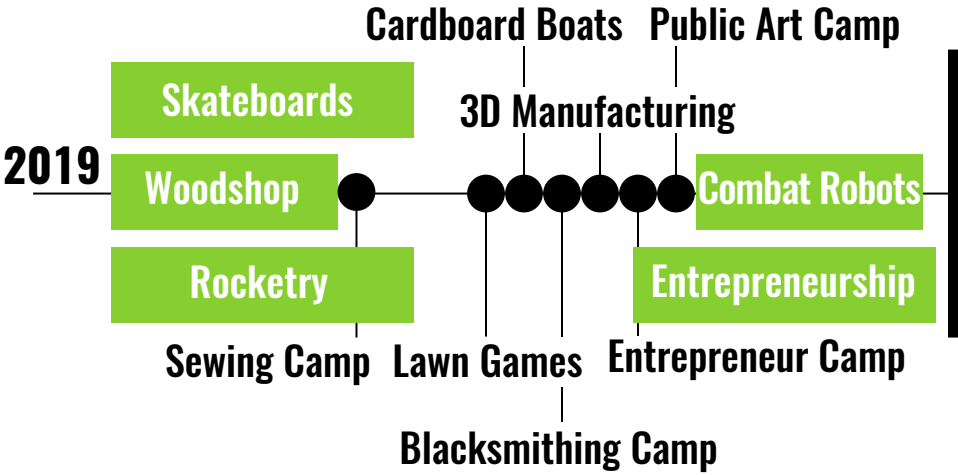
Our goal was to take a picture of the Earth. With three engineers at the lead, we recruited two teams of high school students for our very own mini space race. Each team had seven students from a variety of backgrounds and local schools, and each was led by one of our engineers. The only guideline was that we'd use weather balloons to carry the cameras. Aside from this, the approach was open for the students to decide, and it shows, as both teams adopted wildly different strategies. And while both have incredible stories to share after a combined total of 20 weeks of work, this story is but a snippet of team No Strings Attached.

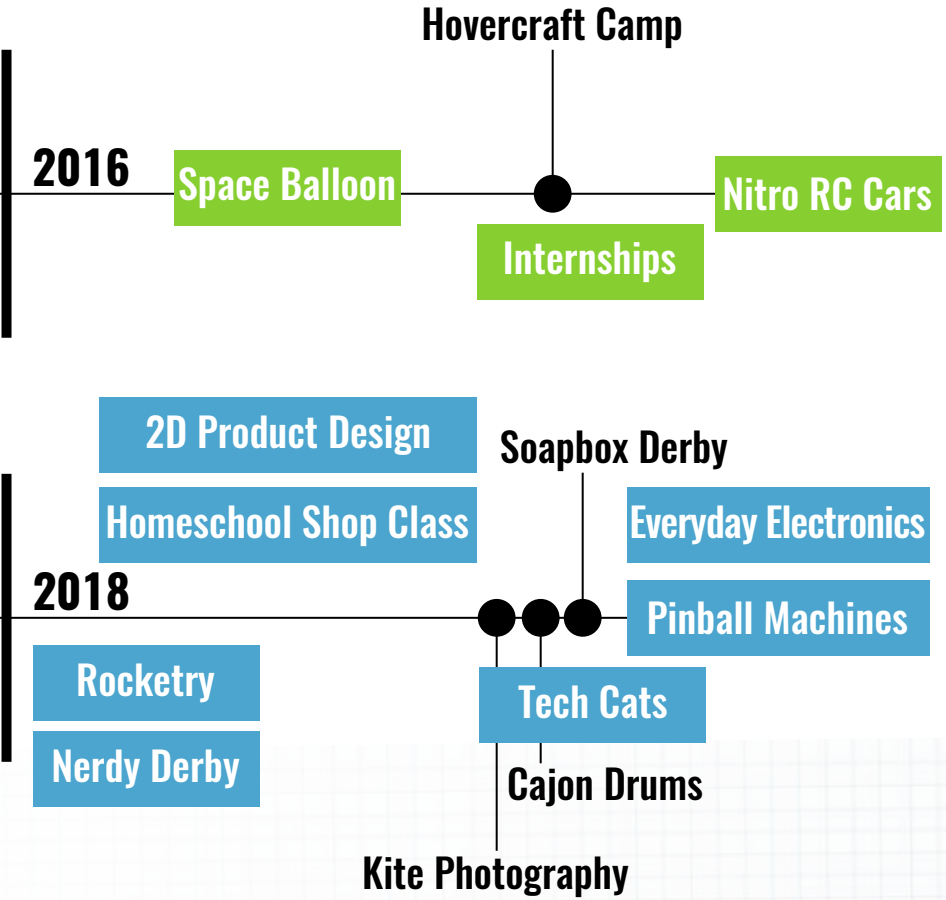
The team agreed they wanted good pictures, which meant they would need to reach high altitudes. They started out strong, building and using a vacuum chamber to demonstrate the physics (and test their hardware). They tested their altimeter's accuracy in the chamber and added dry ice to simulate the negative 50 degree temperatures that would potentially freeze their electronics. They used it to burst balloons, confirming their predictions. But testing was only a small part of their efforts. Much of their time was spend building circuits, writing code, designing and building their capsule and its various components.

During all of this learning, team No Strings Attached missed the launch window to be considered in the official Global Space Balloon competition. Regardless, two weeks behind schedule, they were ready to launch. Arriving on location, the first test of the flight controller made clear that not everything was actually ready. After uploading the wrong version of their code, discovering a dead camera battery and missing SD card, a GPS tracker transmitter not working, and experiencing a premature explosion meant to expel the ballistic parachute during flight, stress was high and it was time to let the capsule on its journey, regardless of the problems faced so far. The countdown began and when it reached 4, the tether broke, and off went the balloon with all of its helium, but without the payload. The team stood there, dejected, capsule still in hand. They met back at Vector Space to share their thoughts. It was no surprise that everyone was disappointed, but what was unexpected was the way the students handled it. Instead of sulking and parting ways, they made a plan. They would meet again to fix what went wrong. They regrouped, put in extra hours, and their capsule ended up reaching 116,000 feet before returning back to Earth and landing in Lexington. Though they succeeded in the end, No Strings Attached experienced a phrase often heard at Vector Space: failure IS an option.

Projects Over Time






Hovercraft Camp
2016
Space Balloon
Nitro RC Cars
Internships
2D Product Design
Soapbox Derby
Homeschool Shop Class
Everyday Electronics
2018
Pinball Machines
Rocketry
Tech Cats
Nerdy Derby
Cajon Drums
Kite Photography
Biomimicry
2020
Entrepreneurs
Soccer
Rocketry
One Week Camps
Multi Week Projects

Project Focus: Empowerment Entrepreneurs

Each semester, students from the Lynchburg City Schools Empowerment Academy spend three hours each Wednesday afternoon at Vector Space launching their own businesses. In the Fall of 2019 Trianna, Jayla, Michael, and Jamar each came up with a business idea, acquired materials using their allotted budget, and produced a line of products. Using skills and inspiration gained at the makerspace, they spent time identifying a customer, researching the market, and then got to work designing and building their line of products. Some students used digital tools to design and produce their items, while others sketched plans and got to work with hand and power tools. Hear more for each student below, and see photos on the right of their goods in production and for sale at the Lynchburg Community Market.

From Trianna: In my semester at Vector Space I started a business called Glowbies. I went online to find my ideas but I created my own twist. I used acrylic for my design on the laser cutter. I feel like everything was easy except the measurement part and how much time we had, but I had fun. Now that I have done this I want to continue my business and create things for the world to see.

From Jamar: This semester we went to different restaurants for menu design ideas. We came up with three types for Grey's. Which are wood, plastic, and acrylic. I think they look amazing and restaurants will like it. I learned how to use a laser cutter, and I re-created the menu using Inkscape.

From Jayla: In my semester at Vector Space we started J.L.C., Jays Luxurious Creations, and my idea was chairs for children. Now that the holiday is coming families will need extra seating and play seats for the kids. My creation is made of wood with comfy seat cushions and the decoration is fun and kid-like. Since I started this program I have gotten better with my wood working skills, using all types of tools, and I plan to go on in the future doing more.


HITACHI


I CREATE FOR
YOU
GLOWBIES


UNEEK
JLC

Project Budget: Combat Robots

Income

Sponsorship	$2,000.00
Class Registration	$2,305.00
Total Income	*$4,305.00*

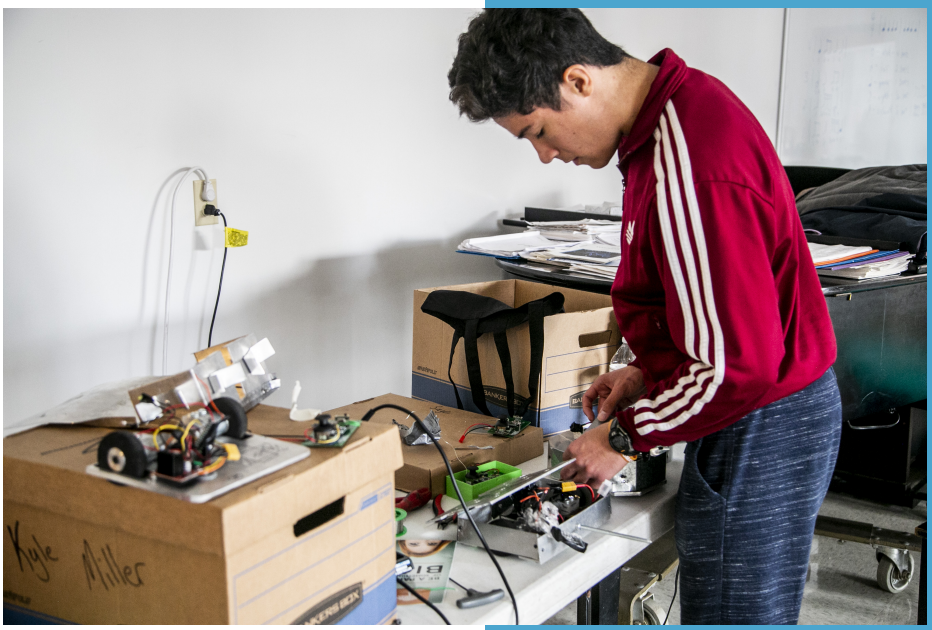
Expenses

Supplies	$872.41
Instructors	$2,200.00
Consumables	$12.90
Tools	$230.60
Site Fee	$1,000.00
Bank Charges & Fees	$61.27
Total Expenses	*$4,377.18*
NET INCOME	*-$72.18*

Project Summary

Students	10
Instructors	2
Hours	40+

The greatest investment in our students is the time spent with them by our instructors. While not paid nearly their value, these individuals are compensated for sharing their knowledge, experience, and passions with our students. Despite careful planning, there are often unexpected costs and additional time needed for natural mistakes during the learning process.



Financial Breakdown

Earned Income | Each project is reasonably priced at $6-8 per instruction hour. This helps ensure buy-in from families and commitment from students, without being unattainable. Families in need of financial support are provided scholarships.

Contributed Support | Our educational partners are companies, individuals, and grant organizations committed to high quality maker-centered learning experiences. This support is crucial to the success of our programs, allowing instructors to focus on student needs, materials to be acquired, and advanced tools and techniques to be made available to participants.

In-Kind Donations | For some of our local suppliers and manufactures, in-kind material donations allow them to encourage the next generation of learners with experience in their fields. This also helps us keep our costs down for participants.

Scholarships | We work with partners to ensure that financial need is never the barrier to entry for students. The LCS Education Foundation and Future Focus Foundation are committed to provided scholarships for teens to attend Vector Space programming.

Tools and Materials | Specialized tools and materials are often required to accomplish the unique and ambitious project ideas that stretch students and keep them engaged. From electronics to sheet metal, students are provided with everything needed to complete their goals.

Instructor Pay | While we can't compete with industry rates, we are intentional in paying our instructors for their advanced knowledge and experience. Their time with students is one of, if not the most valuable aspect of any Vector Space project.

Makerspace Site Fee | Consumables, wear and tear on tools and equipment, administrative and marketing costs, project storage, and occupancy of the makerspace are all a part of the site fee allocated to Vector Space for each student project.

BUILT AT VECTOR SPACE

Structure

Vector Space is a non-profit community makerspace. Our founders and staff are passionate about making, and teaching others to make. We believe the most rewarding things in life are hands-on experiences shared with others.

Mission

Vector Space is a makerspace and community workshop with the mission to build an open and collaborative community that fosters innovation, creativity, and the pursuit of science based knowledge.