



CALIFORNIA COMMUNITY COLLEGE

Makerspace Impact

Implementation Strategies &
Stories of Transformation



cccmaker.com

ACKNOWLEDGEMENTS

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—Carol Pepper-Kittredge, Statewide Project Director, CCC Maker

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California Community Colleges

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WHAT DOES IT
MEAN TO BE
WELL-EDUCATED
IN THE 21ST
CENTURY?

WELCOME

From July 2016 to May 2019, the California Community College Chancellor's Office (CCCCO), Workforce and Economic Division, funded the \$17 million CCC Maker Initiative, to grow a statewide network of makerspaces linked to community colleges, in an effort to develop a much-needed workforce for what is being termed the digital or innovation economy, thereby helping to close the skills gap.

The problem our economy is currently facing is a lack of eligible employees for middle-skills jobs, ones that require advanced training but not necessarily a bachelor's degree. According to the National Skills Coalition, in the next five years, middle-skill jobs will dominate nearly half of the employment market. And according to the Georgetown Center on Education and the Workforce, by 2020, 65 percent of all U.S. jobs will require either a credential or post-secondary degree, but at the current rate that colleges and universities are awarding them, we're falling roughly 5 million workers short.

In addition, entrepreneurship in the U.S. has been on the decline in recent years, with startup-creation at historic lows. Though the needs of the workforce and marketplace have changed rapidly over the years, our educational system has not kept pace. Today's 21st century jobs require 21st century skills—not only digital literacy but “soft skills” such as collaboration, problem-solving, and flexibility.

How do we help prepare students for the 21st century economy and job market? The answer lies in integrating hands-on making and familiarity with digital design and fabrication into our current pedagogies and curricula. And at the core of this integration are academic makerspaces.

CCC MAKER INITIATIVE OVERVIEW

Problem: California's education pipeline is not keeping pace with the skills and education required by employers, entrepreneurship among young adults has declined, and instructional delivery methods of the past are being replaced by more accessible, inexpensive, and plentiful sources.

Opportunity: With over 2 million students, California Community Colleges (CCC) represent the largest and most diverse education system in the United States. With a goal of closing California's middle-skills gap, a successful model could positively impact many students, preparing them with 21st century skills, growing STEM/STEAM fields, fueling job creation, and strengthening regional economies.



Vision: CCC makerspaces will drive innovation in education, and California Community College students will be prepared for success in STEM/STEAM careers that demand 21st century skills.

Mission: The CCC Maker Initiative will build a network of college makerspaces that welcome non-traditional students, support faculty in embedding making into instruction and offering adaptive curriculum, and partner with businesses to produce innovation-ready graduates inspired to contribute to the creative economy.

UNIQUE POSITION OF COMMUNITY COLLEGES

The California Community College network is the largest higher education system in the country, with 72 districts and 115 colleges serving 2.1 million students every year. These colleges are uniquely qualified to affect systemic change because they're ubiquitous, accessible to a wide demographic, adaptable to local needs, and more flexible than four-year universities.

California Community Colleges are also the largest providers of workforce training in the state and nation, offering postsecondary technical education in 175 fields, and educating more than 100,000 individuals each year in industry-specific workforce skills. Yet, California's education pipeline is not keeping pace with the higher levels of skills and training required by employers. By 2025, a roughly 1.9 million jobs in California will require some form of postsecondary education short of a four-year degree.

Creating a college innovation and entrepreneurial culture through makerspaces will enable the most diverse student body in the nation to explore, create, and connect in new creative ways, developing 21st century skill sets, increasing digital proficiency, empowering students through authentic learning experiences, and more effectively preparing students for meaningful careers in our current economy. By virtue of having the largest community college system in the U.S., CCCs have the potential to serve as a powerful example of what's possible for the rest of the nation.

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At the onset of the CCC Maker Initiative, the CCCCCO commissioned the California Council on Science and Technology (CCST), a nonprofit whose mission is to improve science and technology policy and applications in California, to compile a report providing background on the Maker Movement and to inform the creation of the CCC makerspace network. In their report, CCST distill key hallmarks of making as: communal, empowering, interdisciplinary, diverse, process-focused, STEM/STEAM/entrepreneur-focused, open-ended, inquiry-based, creative, and playful. In the light of these findings, CCCCCO holds that creating a makerspace network can effectively help bridge the gap between skills and jobs, becoming a crucial catalyst in strengthening California's economy.

Notably, at the epicenter of the Maker Movement and makerspaces is the maker, the individual, inquiring, experimenting, and learning through hands-on making. In the realm of education, this is a notable pedagogical shift from teacher-driven to learner-driven.



CCC MAKERSPACE STARTUP PROCESS

The CCC Maker Initiative began in fall 2016 with selection of the leadership team, assembly of the advisory committee, and the first advisory committee meeting. From January to June 2017, 34 colleges participated in the Makerspace Startup Process. This process is not unlike the one that a budding startup business would go through to ensure a successful launch. While the goal of most businesses is monetary profit, the return on investment of a lucrative makerspaces is intellectual and social capital, with its primary benefactors being individuals, communities, the economy, and society as a whole.

At the epicenter of the CCC Maker startup model is the student, the main “client.” The core question was: How best can the makerspace serve the learning and career needs of the students? For community college students in California, makerspaces provide skills, experiences, and connections to prepare them for entrepreneurship and innovative careers.

Even though the process CCC Maker developed focuses on community colleges, it can easily apply to and benefit any community considering developing a makerspace, be it another educational institution, library, museum, or a group of passionate citizens. To that end, and in the spirit of open information sharing that is prevalent throughout maker communities across the globe, the Makerspace Startup Process has been documented in detail and is freely available on the CCC Maker website as the [California Community College Makerspace Startup Guide](#).

Following a design thinking process, with emphasis on the student, the key components of the Makerspace Startup Process are:

Institutional Self-Study: Research, explore, and identify the needs of the community.

Ecosystem Mapping: Identify resources and allies by mapping out the extended support ecosystems.



Logic Modeling: Locate, map, refine, and analyze the findings.

Community Outreach: Invite and engage students, faculty, and staff.

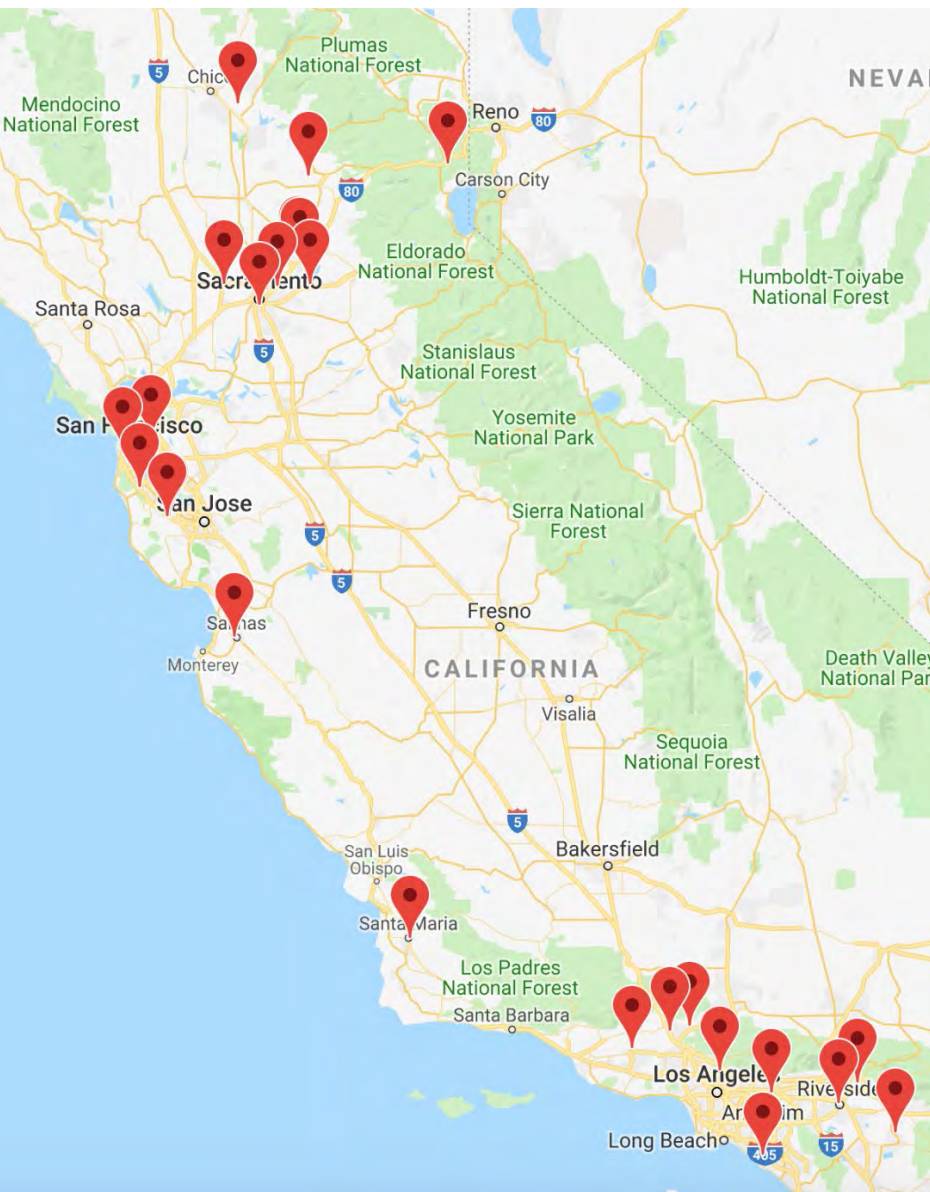
Internships: Build the bridge between local industry/businesses while providing tangible work experience for students through internships.

Makerspace Design: Develop robust plans with which to go forth and realize the actual physical makerspaces.

Of the 34 colleges that embarked on the Makerspace Startup Process, 28 colleges competed for grants, and in July 2017, 24 colleges were awarded implementation grants ranging from \$100,000 to \$350,000 that were renewable for a second year. During year two, the CCC Maker program guided colleges to transition from the planning phase to implementation and empowered college teams to actively support and build community among the CCC Maker colleges.

These 24 colleges were encouraged to function as a network and to collaborate, teach one another, share resources, inform each other of their failures and resolutions, work together with employers to arrange internships, conduct webinars, develop student leaders, offer tours, tell student stories, make curriculum available, and contribute to the overall success of the state-wide college maker community.





The 24 funded CCC Maker colleges are:

Allan Hancock College (Santa Maria)
 American River College (Sacramento)
 Butte College (Oroville)
 Cabrillo College (Aptos)
 Chaffey College (Rancho Cucamonga)
 City College of San Francisco (San Francisco)
 College of Alameda (Alameda)
 College of San Mateo (San Mateo)
 College of the Canyons (Santa Clarita)
 Folsom Lake College (Folsom)
 Foothill College (Los Altos Hills)
 Glendale Community College (Glendale)
 Golden West College (Costa Mesa)
 Hartnell College (Salinas)
 Laney College (Oakland)
 Moorpark College (Moorpark)
 Moreno Valley College (Moreno Valley)
 Mt. San Antonio College (Walnut)
 Mt. San Jacinto College (San Jacinto)
 Orange Coast College (Costa Mesa)
 Sacramento City College (Sacramento)
 San Bernardino Valley College (San Bernardino)
 Sierra College (Rocklin)
 Woodland Community College (Woodland)

MAKERMATIC TEAM INTERNSHIP MODEL

One of the key goals of the CCC Maker Initiative was to place 800 students in internships between July 2017 and May 2019. CCC Maker colleges committed to arranging 50 internships. Wages for up to 20 hours were funded through the CCCC Workforce and Economic Development CCC Maker grant. The hope was that employers would provide an additional 20-hour match.

The issue that the colleges faced during the program, however, was that traditional one-to-one internships are time-consuming to set up and execute, and colleges find it difficult to structure sustainable, scalable business internships to help prepare students for the job market. The time and effort it takes for colleges to build business community relationships, define internship roles and expectations, meet intra-college expectations, and then execute the convoluted rules of hiring, liability, and documentation are understandably daunting. The Makermatic team internship model was born out of a desire to completely reimagine the way that college-based internships are structured.

The Makermatic model pairs one or more business leaders with a team of interns to tackle an actual problem the business is trying to solve. Makermatic is a structured, seven-session, paid 20-hour team internship, hosted in any college makerspace, that connects students to real-world business problems. Rather than the traditional one-to-one internship model, interns in Makermatic (up to 25 per internship run) work in teams of 4–5 students, modeling how work is most often conducted in the business world. This system is not only more efficient and sustainable, but it offers a richer and more fulfilling experience for all involved.



Makermatic was executed as a pilot program at one CCC Maker college makerspace in fall of 2018 and then across five makerspaces in spring of 2019. The results were very promising and beneficial to students as well as the business leaders. The comprehensive program step-by-step is detailed in the *Makermatic Workbook for Coaches*, which served as the framework for the Makermatic pilot programs and is freely available on the CCC Maker website, along with the overview publication, *Makermatic: A Scalable Approach to Team Internships*, which includes details about the pilot programs, as well as an evaluation summary.

PROGRAM METRICS AND OUTCOMES

Throughout the CCC Maker program, metrics were recorded and shared through the freely available stats dashboard on the CCC Maker website.



LANDSCAPES OF POSSIBILITY

While the numbers in the stats dashboard may be impressive, nothing captures the human impact of the CCC Maker initiative quite as powerfully as the stories that arose from the colleges. This publication offers case study vignettes from 10 of the participating colleges, as well as personal essays (and one poem) directly from students who use these makerspaces.

The stories shared here collectively illustrate landscapes of possibility. They demonstrate a wide variety of solutions to the challenge of creating a community college makerspace. The spaces are unique, the communities are diverse, and the ecosystems reflect the varied geographical, cultural, and economic resources of the region and the state. Yet there are common qualities among the successful makerspaces and students profiled in these stories that speak to the potential of the community college makerspace to catalyze educational and economic opportunity for the broadest range of stakeholders, from community members of all ages to entrepreneurs and business owners, educators, students, and institutional and state leaders.

While it's impossible to catalog the many small variations that emerged to give each makerspace its distinctive flavor, a few foundational principles instilled during the startup process, and reiterated during the implementation phase, strongly contributed to the success of the makerspaces profiled here. These principles are:

- The solution must empower all stakeholders. We are all in this together.
- Start with community. A makerspace is not a room full of tools.
- Embrace and learn from the process. It's all a prototype.

These principles were established through the deliberations of the CCC Maker Leadership Team, a diverse group experienced in educational innovation, workforce development, communications, and entrepreneurship. The team challenged assumptions about current educational systems, programs, pedagogies, learning outcomes, and the innovation process itself. These principles crystallized into a fundamental question: What does it mean to be well-educated in the 21st century?

This query sparked responses that evolved and expanded over the course of the initiative. The leadership team gained deeper insight into their role and responsibility as both educators and learners. A metacognitive approach drove the leadership team

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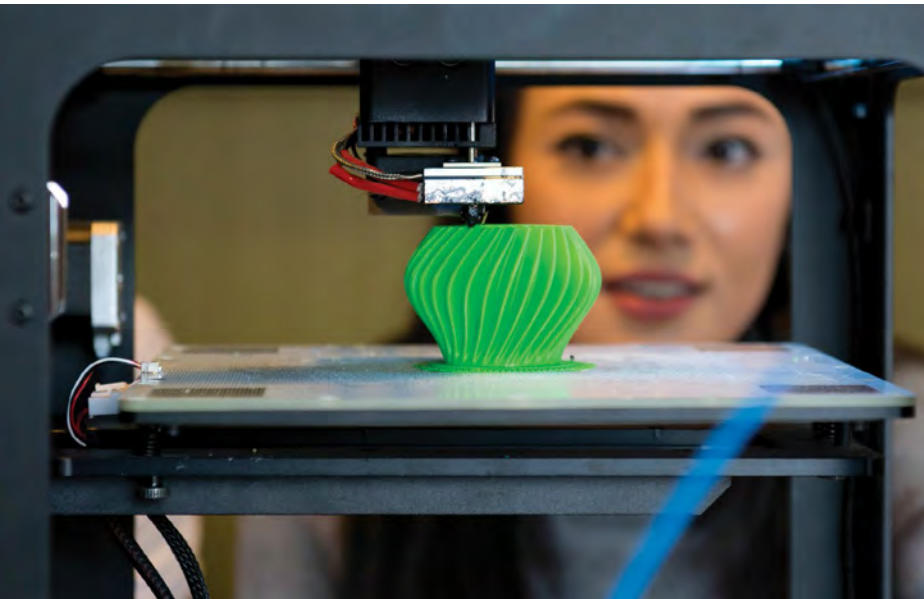
to define a safe space for colleges to explore and respond to their individual needs, challenges, and opportunities. It facilitated a tolerance for risk and experimentation, embracing flaws and failure as an opportunity for learning and improvement. And, with a heightened level of reflection combined with ambitious goals for project outcomes, the leadership team witnessed the emergence of dynamic, positive results far beyond what had been thought possible at the beginning of the project.

As described in these college and student profiles, faculty leads challenged traditional curricular boundaries and pedagogical practices. Project leads engaged local employers to collaborate with student teams in real-world problem solving. Students brought those experiences back into the makerspace for the benefit of their colleagues. Students initiated projects across disciplines, started entrepreneurial ventures, and became the lifeblood of these dynamic learning environments. Together, faculty and students forged a collaboration based on shared goals, mutual respect, and community spirit.

It's important to note that these case studies are all snapshots of a moment in time from an ongoing journey. None of the colleges profiled have solved all their problems and challenges; in fact, some might say that they've barely started to scratch the surface of the potential of their collaborations, technologies, and institutional resources. However, they've all embraced an innovation mindset that spurs them on to greater success. This motivates college teams to look simultaneously outward to their ecosystem and inward to their human and social capital to grow and evolve with time.

QUALITIES OF SUCCESSFUL COLLEGES

What are the common qualities that emerged from the network? Here are a few observations about the success achieved by colleges that embraced their communities, empowered their stakeholders, and were willing to take the risk to innovate.



Successful colleges looked outward to the network for resources, ideas, and collegial support. As Zack Dowell of Folsom Lake College stated, “I am nourished by the network.” Some colleges, including Butte College and Cabrillo College, participated in every CCC Maker event and activity, sharing and learning from others through webinars, online meet-ups, regional and statewide convenings, and directly through one-to-one relationship building. These colleges shared curricula strategies to generate apportionment funding, information on equipment to engage new makerspace users, ideas from college administrators to address risk management, and contractual solutions to unique community collaborations.

Project teams that continuously developed student and faculty engagement reaped exponential rewards as they leveraged talent, expertise, and energy from within.

At Moorpark and other colleges, maker allies were found in unexpected places. Counselors, administrators, librarians, and lab techs all committed to the mission, supporting the growth of the college as a maker community. These allies also helped spread the makerspace’s message of inclusivity and made possible successful Maker Faires that included hundreds (in some cases thousands) of attendees.

Successful colleges were generous with their community partners and didn’t try to go it alone. Taking their initial steps with a community partner or two, they shared the responsibility and balanced each others’ strengths. For example, Allan Hancock College teamed up with the Santa Maria Valley Discovery Museum and the Santa Maria Public Library to form the Central Coast Makerspace Collaborative, which supported makers of all ages, across all educational levels and socio-economic groups. College of the Canyons scaled up existing relationships with nearby K–12 institutions and local industry to stage large-scale annual Maker Faires.

VOICES AND IMPACT

The student stories shared in this publication demonstrate the enormous potential of makerspaces to change lives. Student empowerment, the goal at the heart of this initiative, has afforded these student makers clarity in their educational plans, determination to stay on their path to career success, and the opportunity to start their own entrepreneurial ventures. In each instance, these students describe the importance of their community in helping them reach their goals. Their stories are representative of the experience that thousands of students have enjoyed by engaging their intellect, curiosity, and maker skills to realize their creative vision.

In telling their own stories, these students are also telling the creation story of their respective makerspaces. As early adopters, students were fully engaged with—and instrumental in—the planning and implementation of their spaces. Their goals drove everything from equipment requests and space planning to outreach activities and

workshops. Project leads often commented that the makerspaces simply couldn't work without the commitment of the students.

Now students organize, manage, maintain, and program the spaces as mentors, student workers, and in some cases, as adjunct instructors. Most importantly, the students create an inclusive and welcoming culture that evolves along with the makerspace community. These skills are at the heart of a sound education. Self-directed learning, in a productive, self-managing community, creative collaboration to solve real-world problems, career education in the context of social justice and civic engagement, and a facility with new and emerging technologies—together, these factors form the economic, intellectual, and technical foundation upon which successful lives are built.

The voices in these profiles also represent college management and classified staff, whose continued commitment to their makerspaces gave the project teams room to maneuver, experiment, take risks, change focus, and adapt to conditions on the ground. Many managers were staunch advocates for their spaces, winning over reluctant colleagues and finding effective ways to support their nascent spaces. Their efforts have ensured continued funding for their makerspaces after the completion of the CCC Maker initiative. So, the question of how to become “well-educated,” in the context of the CCC Maker experience, applies not just to students, but also to faculty, management, and institutional leadership.

We are all together on a professional path of development. Some are students aiming for their first job in a new career, others are mid-career professional educators determined to engage teaching and learning as a more organic, social process, and others are employers, entrepreneurs, and community leaders who want to connect with our institutions to help students and build strong communities. Together these case studies show the potential for CCC makerspaces to substantially improve lives, communities, the future workforce, and the economy of California. Enjoy!

ICON KEY

We've employed a set of icons to highlight which of the key focal points central to the CCC Maker Initiative each college story highlights.



For more information about the program and the colleges: cccmaker.com.

CASE STUDY



CENTRAL COAST MAKERSPACE COLLABORATIVE OFFERS POWERFUL CROSS-GENERATIONAL PROGRAMMING

“We’re proud of the partnership, the ability of these three entities to come together with diverse experiences and backgrounds to work on something that can leave a really big footprint in our community that benefits a wide array of individuals and families.”

—NANCY GASTELUM, EXECUTIVE DIRECTOR,
SANTA MARIA VALLEY DISCOVERY MUSEUM

What happens when a community college, a public library, and a children’s museum combine forces to create their own makerspace network? They can effectively serve all of the members of a community, regardless of age or socioeconomic factors, and

positively impact educational pathway planning. The Central Coast Makerspace Collaborative in Santa Maria is doing just that, serving as a powerful example of how to affect change across generations through making.

With roots dating back to 1920, Allan Hancock College (AHC) is situated in north Santa Barbara County, a largely agricultural area with a high poverty rate, roughly 65 miles northwest of the city of Santa Barbara and about 30 miles south of San Luis Obispo. Area students are traditionally underrepresented in STEM fields, and one of AHC’s initiatives is to increase those numbers, which drove



the desire to create a makerspace on campus. Faced with limited available space on campus for a standalone interdisciplinary makerspace and looking to have an impact on the broader community, AHC sought to leverage local resources in the form of a partnership with the Santa Maria Public Library (SMPL) and the Santa Maria Valley Discovery Museum (SMVDM).

FORMING THE COLLABORATIVE

AHC had previously written a makerspace grant proposal to the US Department of Education, which was not funded. Grant writer Suzanne Valery notes, “We had already done quite a bit of research for the proposal, and we were really focused on the fact that it would be a better project for the community than singly for the college, precisely because of the kind of environment we’re in. There are not a whole lot of resources for young people, especially, to experience the kind of opportunity they could have with a makerspace.”

When the CCC Maker grant was announced, the AHC team recognized how perfect it was for the Collaborative. They invited SMPL and SMVDM, both obvious partners with a focus on lifelong learning, to meet and explore interest in establishing a collaborative organization. In a stroke of serendipity, it turned out that everyone was on the same page at the same time.

SMPL city librarian Mary Housel notes, “We had decided to start a makerspace long before we had any money or resources to do it.” When the library had upgraded the machines in their computer room, they moved them out onto the main floor of the library, freeing up the room with the intent to transform it into a makerspace. Nancy Gastelum, executive director of SMVDM, says their team was originally introduced to the idea and potential of museum makerspaces at an Association of Children’s Museums conference. They had been interested in implementing a makerspace, but they didn’t have readily available resources.

“We had decided to start a makerspace long before we had any money or resources to do it.”

The Collaborative’s proposal for CCC Maker was one that involved three different organizations and not just a community college. The funding made it possible for all three to fast-track creation of their own makerspaces, which they spent the first six months doing, before coming together to collaborate on cross-organizational programming.

THREE PERSPECTIVES CONVERGING

Though the community college, museum, and public library serve different demographics, for all three organizations, much of their impetus to create hands-on opportunities revolves around offering a welcoming space for those who may not have access otherwise.

Robert Mabry, Machine Technology instructor and makerspace lead at AHC, notes that the college is ironically only 30 miles from Cal Poly, a highly rated hands-on college in a well-to-do area whose slogan is “Learn by Doing,” yet AHC’s offerings are so far behind. Mabry explains, “I work in the Industrial Technology department, where we do a lot of hands-on stuff, but there are many students at our school who leave without ever having made anything. I look at this population and think we could do



something about that, not just because it's cool to make stuff. We lose a lot of first-generation college students whose parents work in the fields. They come here, take English and math, fail, and start to think they're not college material. The makerspace actually opens a pathway for a lot of these students."

At SMPL, the desire to create a makerspace was more of a community-building venture, to inspire families and multiple generations of people who may have never used the library to come in. Housel notes, "Our mission statement is to inspire lifelong learning, so to reach children at a young age and inspire them to become learners throughout their adulthood is important to us, and we feel that making plays well into that. We always try to attract new users, and we know that some people don't care to read, so this is a way to offer another

avenue for learning that's more hands-on." She goes on to say that many people in the demographic they serve can't afford family entertainment, so the library being able to offer a place for families to come and engage in an activity together is essential. Once they're in the library, these patrons may then even become interested in checking out books or movies or exploring the library's other offerings.

From SMVDM perspective, Gastelum shares, "We address informal learning for the whole child and there are lots of developmental things that happen with children when they're given an opportunity to make and tinker, when they're invited to fail in order to achieve success. With the withdrawal of really critical educational resource programs like home economics, woodshop, and auto shop, children in schools aren't receiving opportunities to use their brains and capacities in that way, but the makerspace allows them to do so." Further, she adds, "We want the family to be involved and engaged because it's not just about building the brain capacity to think critically and be a problem solver. It's also about building relationships within the family, and the makerspace really lends itself to that."

COMMUNITY-WIDE INVITATIONS TO MAKE

If the Collaborative's impetus is inviting folks who may not otherwise feel invited, how do these three organizations actually get new folks into the space, and once there, how do they make them feel comfortable and welcomed?

From the beginning, all members of the Collaborative have wholeheartedly agreed on the importance of including arts and crafts in the hands-on opportunities they offer. As explained in the Collaborative's white paper presented at the 2018 International Symposium on Academic Makerspaces (ISAM), "Since its inception, the model has included art among its STEM-related activities. Not only do the tools and methods of

design offer new models for creative problem-solving, but art integration also has been shown to increase student engagement and achievement, especially among students underrepresented in STEM fields of study.”

On the AHC campus, one of the ways is by creating pop-up makerspaces in different disciplines. Pop-up makerspaces on campus have been hosted, for example, in the Culinary Arts kitchen, where people can make omelets and such, as well as the ceramics lab, where attendees can spin pottery on the potter’s wheel, and in the library, which has hosted a number of different hands-on activities. These campus-wide, accessible invitations to make present an opportunity to tell folks about the makerspace and its broader offerings, as well as to celebrate the many different forms of making.

Joanne Britton, one of the librarians at SMPL notes, “In academics, people often feel like they can’t make mistakes, and we’re actually inviting them to do just that.” The library hosts three free projects a week and then offers one day of skill building to practice new skills. For example, patrons can take what they learn on Wednesday and apply it on Saturday. They learn how to use tools safely with the library’s focus on risk management and then are encouraged to practice and experiment. AHC interns who work in the SMPL makerspace contribute greatly to creating a welcoming environment for all. The library now has many folks who not only return but are also helping to spread the word to others.

At SMVDM, the makerspace is set up primarily to appeal to children, but also to offer opportunities for families to make together. All of the tools and equipment are at the level of a child, so they don’t have to reach up high. Special attention was given to the colors in the space, and everything is modular, so the space can be reconfigured to accommodate whatever activity is being hosted. There are facilitated activities as well

SMPL hosts a button-making workshop.





The museum's puppet-making activity presents opportunities for cross-generational making.

as consumables available for unfacilitated tinkering. The museum makerspace also has a “problem of the week” that children can come in and try to solve.

Gastelum shares, “Our goal at the museum is that we just want children to come to us for the makerspace, but we also really want the child and the parent to work together to create something. We’ve found that this is another way to engage and strengthen the parent-child bond, by creating opportunities to work together and make.” One example is during a free community day, the space hosted a puppet-making activity that invited collaborative creativity and was wildly successful.

SHARING OF RESOURCES

One of the most notable features of the Collaborative is the generosity of spirit, knowledge, and resources freely shared among the three partners. With open communication and regular meetings, the college, library, and museum work to avoid duplicating offerings, in an effort to eliminate any kind of competition and instead lift one another up. For instance, they regularly cross-promote one another to raise awareness of each of the partner’s unique contributions to the community.

Outside of their respective spaces, the partners participate in broader community events, such as Open Streets in March of 2019, a large event hosted over several blocks of a predominantly Spanish-speaking neighborhood in Santa Maria, which draws upward of 2,000 attendees. AHC has a mobile makerspace lab that they brought out, creating a physical window into what makerspaces in general offer. The museum and library presented alongside the mobile lab, showcasing the broad range of hands-on possibilities available to the community.

Another example is when the museum hosts their annual Free Family Kite Festival, inviting the AHC mobile makerspace to be present to promote the college’s space to the 2,500+ attendees. Yet another example is the popular Friday Night Science event hosted at AHC, where the Science department invites the community to see a wide array of neat scientific displays. The AHC makerspace hosted a mini makerspace in

the middle of the festival and cross-promoted events going on at the museum and makerspace during the rest of the weekend.



THE VALUE OF INTERNS AND FUNDING

Of special note is the fact that AHC hosts an internship program where college students work in the library and museum makerspaces. Housel notes that the AHC interns were perhaps their most valuable resources at the library, “Without the Hancock interns, we would not have been able to pull it off because they’re very quick at learning. The interns are really on the ground and ready to do whatever they need to do, and they’re the main communicators with our patrons.” Gastelum agreed that the same was true at the museum, noting, “The interns have been instrumental in making sure we can operate and have the open hours that we do.”

Gastelum also adds, though, that “Without the grant, we would not have had the funds available to make the beautiful space we have, to create an inventory of consumables we have, and to purchase the tools and equipment, so as wonderful as the interns are, none of that could have been possible without the grant funding we received as a sub-recipient. The museum just did not have that capacity and we had been so focused on our other exhibits and programming that the makerspace and activity would have taken a backseat.”

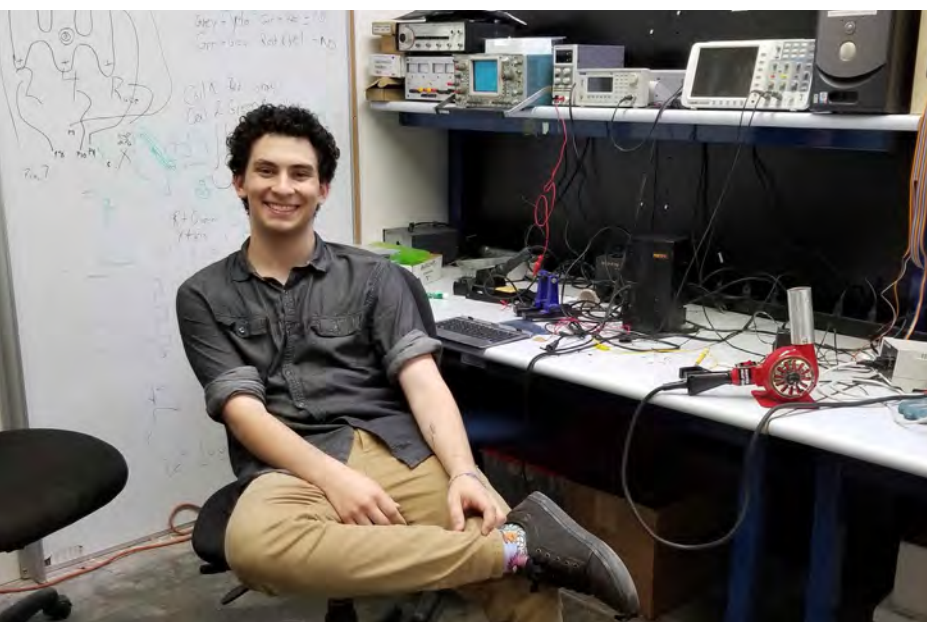
FINAL THOUGHTS FROM THE FIELD

The Central Coast Makerspace Collective is more effective because of the unity, collaboration, and cross-promotion across the three organizations. As Mabry succinctly states, “We’re all part of the same thing.” Gastelum adds, “It’s really word of mouth that generates the most visits to each of our organizations. We can market with collateral as much as want, but it’s expensive and time-consuming. Word of mouth is really the key and being involved in events like this help spread the work and invite people in.” Cross-promotion between partners has proven to help reach and empower a broader community demographic.

STUDENT VOICE

HOW MY JOURNEY TO BECOMING A MAKER EVOLVED

BY CONNOR CHALLIS, SIERRA COLLEGE



My journey to becoming a maker began in middle school. Just as I was entering 8th grade at Olympus Junior High, they were rolling out their very first PLTW (Project Lead The Way) class, and my teacher Tim Conway was absolutely ecstatic about teaching it. After joining that class, the only thing I wanted to be was an engineer.

I was infected with that itch that all makers get—the desire to build something. But I had never even heard of a makerspace, didn't have any skills, and didn't have any funding for projects. So, what did I do? I started teaching myself. I learned CAD. I learned to use more tools and then power tools and then onto some heavier stuff.

TRANSITIONING INTERESTS

I got into high school and started taking every STEM course my school offered. But I was torn. My whole life, from childhood until that point, I had lived in the water, but at that point I felt that I was investing way too much time and energy into my swim team and water polo team. I quit them both and joined my high school robotics club instead. I walked away from years of practice and dedication to these sports because I saw the potential in using my creative juices elsewhere. And man, am I happy I made that decision. It was like opening a Christmas present that had infinite possibilities.

By my senior year, I was a teacher's intern for a STEM class under Steve Dolan. He taught most of my engineering and wood shop classes, and he did a wonderful job assisting me with furthering my learning. I was interning at an engineering firm, leading part of my robotics club, and constantly working on something. It was wonderful—a whole new lifestyle had opened up to me. I had mentors and access to facilities, which were limited but fine for what I was working on.

Next, I began to learn some basic electronics and fell in love. I would stay in my high school shop until they kicked me out just about every night. I went from going home at the first possible chance after practice to taking every moment I could get at the shop. That's the power of finding your passion. I'm not forced to work anymore. I work because I want to know more. I work because it's challenging. I work because I want to work now.

SHIFTING VIEWS ON GROUP PROJECTS

This was the turning point when I started learning what it means to be a maker: I had the freedom to do whatever I wanted to do, as long as I put in the effort. I was building a solid foundation to lean on and had a world of projects in front of me. But something always troubled me. You see, there are two words that you can say to any student to make them groan. Just say "group project" to a group of high schoolers and wait for the collective roll of their eyes. I loathe group projects in English classes. I despise group history projects despite loving history. Forced collaboration for a class that's not conducive to facilitating a group project doesn't teach teamwork. It makes people not want to work with others. It makes students shy away from project-based learning.

"I needed peers to collaborate with, bounce ideas off of, and shape realistic expectations from. I needed a community to build with and rely on outside of my school. Looking back, I needed a makerspace."

I decided that the first step toward solving this issue was to address it. If you just follow the basic path in school, you won't be prepared for higher-level projects or the working world. I had found that I enjoyed working on projects immensely, but students are trained to hate projects. So, to counter this, I started doing outreaches with my robotics club and coming up with projects that I could implement in the classes where I was an intern. I needed to make more projects to share with others.

Step one: Start making more projects to teach myself topics I thought were important. If I want to make any fraction of a percentage of difference in this world, I need more knowledge. But my biggest foe has always been my ambition. I didn't know how to harness it then, and it's something I still struggle with today. Most of my mind is logical and procedural, but a sizeable chunk of my brain just wants to do everything and run wild and free. It's like a cowboy trying to ride and tame a wild horse.

I needed peers to collaborate with, bounce ideas off of, and shape realistic expectations from. I needed a way to harness my ambition. I needed a community to build with and rely on outside of my school. Looking back, I needed a makerspace.

ENTER HACKER LAB

After I got out of high school, I enrolled at my local community college, Sierra College, where I've learned the most about electronics and engineering. Through my college robotics club, I was introduced to my local makerspace, the Hacker Lab powered by Sierra College. I'm finally working with a collaborative community to generate the interest for making in others. I even recently collaborated with fellow mechatronics major Mason Sage to develop a robotic hand that is programmed in American Sign Language.

I get to participate in conferences, lectures, and competitions because of my makerspace network. I get to build and collaborate and explore new ideas in a safe and positive environment at my makerspace. It augments and enhances my education because I feel at home here. I'm confident in my decisions that have led me to this point because I fit in at my makerspace. I'm able to achieve great things, but I'm not special. Nothing about my education is particularly outstanding. I didn't get into Stanford. I didn't get into Cal Poly. It was the environment that I'm in now that cultivated my interest for creating. Makerspaces are conducive to learning and experimenting, and that's a fact that I will stand by and defend.

Middle school developed my interest in making. High school developed my understanding of the underlying principles. College develops the skills needed to create anything I want. And makerspaces offer the freedom and facilities that let you apply all the knowledge you've amassed.

I became a maker because of the influence others have had on me and the environment I progressed in. Without the influence of my peers, my family, or my mentors, I wouldn't have ever chosen this path. Talk about your projects. Tell stories. Convince others to try making things. Be the positive influence you needed when you were getting started. It's a cycle and we need to help out the next generations and make a better future for those who come after us.



CASE STUDY



BUTTE COLLEGE MAKERSPACE FOCUSES ON GIVING STUDENTS THE TOOLS TO BECOME ENTREPRENEURS

“We built a makerspace where someone can come in and ask if they can make something, and pretty much 98% of the time, we now have the equipment for them to be able to do it.”

—DANIEL DONNELLY, BUTTE COLLEGE CREATE SPACE MAKER LAB FACULTY LEAD

Uniquely situated on a wildlife refuge in the Northern California city of Oroville, Butte College is enveloped by natural beauty and has been recognized as a community college leader in sustainability. In 2018, the surrounding nature succumbed to the most destructive wildfire in California history, the Camp Fire, which came dangerously close to destroying the school. The surrounding community suffered great loss and was deeply affected. On campus, 207 students and 57 faculty members lost their homes and were displaced.



The college was closed for three weeks, but after the damage on campus was remedied, when the doors opened, an amazing and unexpected thing happened: The Create Space Maker Lab emerged as a safe haven for the campus community, a place where students and faculty could come together and lean on the camaraderie that came from making together. There were even fundraising efforts kickstarted during that difficult time, through the sale of T-shirts made in the space, offering healing and help through creating.

The assumption may be that a place which garners this level of community support and trust must have had ample

time to become rooted, but Create Space was no more than an idea a mere two years ago. When the CCC Maker grant was announced, administrators messaged faculty members asking if there was any interest in pursuing this opportunity. Most cited not having the bandwidth to take on the project, but Daniel Donnelly, who chairs the Digital Art & Design Department, knew he had to make the bandwidth. He'd been introduced to makerspaces through the independently owned Idea Fab Labs in nearby Chico, and he'd been picking up the DIY publication *Make*: for a while, which provided a tangible window into the burgeoning Maker Movement.

STUDENT-FOCUSED FROM THE START

Butte College didn't have anything resembling a makerspace, and the space they had to work with was completely gutted and not even wired electrically. The team was tasked with building the space from the ground up, but that allowed them the ability to research and design a space that Butte students genuinely wanted to use, based on student feedback. Donnelly notes, "It doesn't matter who you are—if you come into the makerspace, there's going to be something that you're interested in. It

can be 3D printing, or sewing, or the T-shirt machines, or the CNC machines, or the virtual reality equipment." The newest tool they added as of this writing, per student request, was a 16-color embroidery machine.

"In classes, you can learn how to run a business or learn a skill that will get you a job, but our focus at the Maker Lab is: What can we do to help you start your own company and make money?"

For the most part, their modus operandi is that when they get student requests for a tool they don't have, they try to add it or research a workaround. For example, a student came in describing a company they saw online that can print custom designs on shoes, and they asked if this capability was available through the tools at the makerspace. Donnelly originally thought the answer was no, but he spent time researching and realized that there was an available fixture for shoes that would work with their high-end Epson T-shirt printer. The fixture was ordered and now students have the capability to print custom designs on shoes.

DIALED FOR ENTREPRENEURSHIP

Donnelly observes, "There's no other place on campus set up for starting your own business. In classes, you can learn how to run a business or learn a skill that will get you a job, but our focus at the Maker Lab is: What can we do to help you start your own company and make money?" Several students have used the makerspace to create merchandise—such as custom T-shirts, shoes, and 3D-printed phone cases—that they then market and sell on online platforms like Etsy, as well as in local stores and the campus bookstore. With the widespread growth of the gig economy, this foray offers students a powerful first step in entrepreneurship.

Donnelly estimates that seven out of every 10 students who enter the space want to make something they can sell. Part of that drive is a result of the local economy: There aren't a lot of high-paying jobs in the area, unlike metropolitan areas like Los Angeles and San Francisco. Donnelly adds, "We're trying to get students out into the workforce as quickly as possible, but we also want them to understand that they don't have to

go work for someone else if they don't want to. We're showing them that they can start their own businesses and make really good money by being freelance designers or making products and selling them." The makerspace even offers forms and printed resources that outline the on-demand companies, online marketplaces, and crowdfunding platforms that students can use to launch their products and businesses.

INTERDISCIPLINARY BY NATURE

The Butte College Create Space Maker Lab is located in room 148 of the Arts building on the main college campus, and while Donnelly points out that the whole building is essentially a makerspace with various kinds of making happening throughout, the lab is decidedly interdisciplinary. The makerspace team has intentionally made efforts to invite all of the departments to learn about the offerings and make themselves at home, with outreach focused on faculty, which then ripples out to the student population.



Offering the ability to design and make your own T-shirt has been a great draw for a wide range of students.

Every Monday and Wednesday, there's a special event hosted for staff (faculty and non-faculty alike), giving everyone an opportunity to roll up their sleeves, make something, and feel welcomed in the space. Donnelly believes that once they've toured the space, they then realize it doesn't just belong to the Arts Department, and ideas are generated for how to incorporate the space into curriculum. In one semester alone, they may host a number of different class tours and countless staff members coming through.

More and more faculty members, from physics to engineering to art appreciation, are requiring that their students incorporate use of the space into their class projects. In fact, seeing the potential of the tools in the space is also helping to feed different courses on campus. For instance, new students are signing up for design classes to learn the

fundamentals and be better equipped to design for the tools in the space. As well, new students are signing up for engineering classes out of a genuine desire to learn about mechanisms and principles.

They even recently hosted a group of six help desk employees, who field incoming calls to the college. The help desk was receiving so many calls with questions about the space that, on their own volition, the staff requested a tour to learn more. They actually ended up touring twice because they were so excited about the space after having seen it firsthand.



The Create Space, pictured minus the most important ingredient: the vibrant community.

A SUSTAINABLE MODEL

Not only is the makerspace well-loved and frequented by students and staff alike, but the team is showing that it can actually be financially viable for the school through tracking student hours spent in the space. One art appreciation teacher, for instance, was teaching five classes where she required her students to research artists and select a piece of artwork to then press onto mugs in the makerspace. She had a total of 255 students, and the hours they spent in the space amounted to \$600 for the college. While that may not be a lot of money, it's enough to show the potential there.

The makerspace also offers a MSP 300 class, which is a non-credit tutoring course (that receives state funding) to get training on the machines. There's a weekly schedule of trainings on every single piece of equipment. Once students are trained, they can begin to use the machines on their own. Because MSP 300 is a course, students get logged in and out of the space. Student-use hours are tracked, and for every full-time equivalent that a student spends in the space, the school makes money. The first semester that the course was offered, 522 students were registered, and with the 950 hours they spent in the space, the school made \$3,600.

FINAL THOUGHTS FROM THE FIELD

When asked what he learned that was unexpected through the whole makerspace startup process, Donnelly replied, "I was expecting it to be really, really hard. I didn't expect to get the support from the campus community or our administration that we did. Our greatest resource has been our administration because they've been so behind this. There wasn't a single time I can remember them saying, 'No, we can't do that.' Instead they would say, 'Let's figure out how we can make this happen.' They came in and toured and saw what was possible. Our VP of Students has said multiple times that our makerspace is the most advanced place on campus."



Be sure to check out the Butte College profile video: bit.ly/CCCMbuttecollege

STUDENT VOICE

HOW SCC MAKERSPACE HELPED ME REALIZE MY CAREER DREAMS WEREN'T OUT OF REACH

BY CHRISTIAN ESPINOZA, SACRAMENTO CITY COLLEGE



Thinking back to when I was a child, I remember having crazy dreams about becoming an independent artist or designer when I grew up. At the time, it was all I ever wanted—to create things that were unbelievable and out of this world. But as I grew up, those dreams felt more and more unachievable. I thought I could only work a standard job with a fixed pay and maybe benefits, which didn't sound half bad. I assumed that my days of starting my own business and chasing my dreams were far behind me. That is, until I discovered the Sacramento City College (SCC) Makerspace, which—little did I know—would touch my deepest childhood memories and actually make my dreams become a reality. I believe that makerspaces can do the same for all individuals who have dreams of making their unbelievable creations come to life.

WINDOW INTO TALENTS

My knowledge of the makerspace began even before it was established at SCC, at a design tutoring center on campus. I still remember that day like it was yesterday. As an assignment for one of my architecture classes, we were asked to create a functional part in a software called Creo 3.0. I decided to create a super charger for an engine block. I struggled for days on making that part, so as an attempt to get help, I called one of the tutors to give me a hand with the process. They told me that this particular part was almost impossible to make and asked if I was able to go through with it. I impulsively said “yes” and stuck to making the supercharger. In the end, I managed to pull it off after days of intensive headaches. I shocked one of the tutors to the point of offering me a job in design tutoring, but I turned it down due to a restaurant job I was committed to at the time—working fast food at El Pollo Loco.

Months later, that very same design tutor told me about a massive project on campus focused around the fundamentals of design, a makerspace. I asked, “What’s a makerspace?” It sounded too good to be true, featuring 3D printers, CNC machines, laser cutters, and so much more. I knew I wanted to be involved. The first thing I did that day was check out where it was going to be. That’s where I met the project director Tom Cappelletti, one of the nicest and most inspiring people on the planet.

The makerspace consisted of two rooms that, at the time, were completely empty in preparation for a huge remodeling. I started to visualize the space for what it could be. But the end result was way better than I had ever imagined. As the days rolled on, we brought in boxes and more boxes. It was a series of seemingly endless unpacking and set up to get the place going. I had never seen such machines in my life, and I couldn’t even imagine myself behind the wheel of one of them. It was like being in Willy Wonka’s Chocolate Factory for artists, designers, and engineers. Once the wheels were turning, that’s when I had impulsively said “yes” to a leap of faith that had touched my childhood dreams of being an independent designer.

ENTREPRENEURIAL BY NATURE

One day while working in the space, I decided to test my skills in CNC machining and create a simple three-piece table that was about three feet high, made from some cheap plywood. This was the first time I had ever done anything like this, and on that day I met my first client. She was the owner of a hair and nail salon that needed a complete new set of furniture. She saw what I was doing as I assembled the table and asked me if I did furniture design on a professional level. Again I impulsively answered

“I had never seen such machines in my life, and I couldn’t even imagine myself behind the wheel of one of them. It was like being in Willy Wonka’s Chocolate Factory for artists, designers, and engineers.”

“yes,” not knowing the massive order she was about to put on my table. As I worked on the order day after day, I had a sudden moment of realization that “Oh my god, this is it,” as I looked back on all those crazy childhood dreams of becoming a designer and having the skills and knowledge of owning my own business. However, working multiple jobs making furniture and attending classes was really taking a toll on me. So I had to make a decision quickly before this workload consumed me.

Working at El Pollo Loco had its perks: Some days were easy, the people were really nice, and the pay was honestly not that bad. It just was not what I was looking for as I was sharpening my skills in furniture design. I remember one Saturday asking the general manager if I could speak to him and handing him my two-weeks notice saying, “This business that I have going on has really helped me grow into the field of design, and I’ve had a great time here with all of you but I think it’s about time that

I pursue something that I’m passionate about. Peace out.” That very decision to quit for the better of my business made me learn an important lesson about growth, but not just as a business but as an individual willing to try and make some of their most unbelievable ideas come to life. That very same manager even requested a piece of furniture for himself, as he believed in me and my crazy ideas.

Had it not been for the makerspace, the CNC machine that I use in my designs, or my ability to say “yes” even when the odds seem difficult, I wouldn’t be where I am today, creating my own original designs and having the world take a look at them. The energy

that makerspaces give an individual like myself—to make their wildest dreams or theoretical ideas come to life—is what gives those ideas purpose and a chance to make them something the world can use everyday. This makerspace movement is honestly something that I will hold on to forever.



CASE STUDY



ROOTED IN THE ARTS, CABRILLO COLLEGE MAKERSPACE FOSTERS INCLUSIVITY AND INDUSTRY ENGAGEMENT

“That’s our community of practice: We all value each other’s areas of expertise and what skills you can learn from other disciplines.”

—PAYSON MCNETT, MAKERSPACE DIRECTOR

Santa Cruz County is known for its natural beauty, vibrant arts community, burgeoning tech startup scene, and inclusive vibe, all of which are reflected in Cabrillo College’s Makerspace. Founded in 1959, Cabrillo College aptly bears the motto “*concentus*,” Latin for “harmony.” Prior to the CCC Maker grant, Cabrillo already had a Fab Lab with standard digital fabrication tools including 3D printers, laser cutters, vinyl cutters, and CNC mills in the Visual, Applied, and Performing Arts (VAPA) department, but the grant enabled them to open a second space, greatly expanding their offerings to serve a broader student population.



The catalyst for the Fab Lab was former student and current Art Studio instructor Payson McNett (pictured at left), who returned to his undergraduate alma mater with a passion for the potential of digital fabrication, gleaned through his MFA studies. He collaborated across disciplines to create a digital fabrication course series based in VAPA. McNett then identified the equipment their Fab Lab would need to teach the courses. The dean of VAPA, Dr. John Gaulty, immediately saw the potential impact on the curriculum and was fully onboard.

McNett observes, “We get a lot of students coming from engineering because they associate this equipment and this learning with engineering, but they come to the art department to get access. Students feel comfortable coming to the art department, no matter what department they’re from. Our art students, though, wouldn’t have felt comfortable making the venture to the engineering department.”

The seed had already been planted on campus with the Fab Lab, and the CCC Maker grant provided the fuel to create a second makerspace to support a broader spectrum of making beyond just digital fabrication. While it may have been easier to expand upon the existing Fab Lab, it was a conscious decision to put the new makerspace in a separate location, an underutilized space that the Office of Instruction identified in the 3D Design and Sculpture building. The Cabrillo Makerspace is an offering for the entire campus that happens to flow through the arts department. And the idea was so supported from the get-go that the gutting of the new space was done entirely by an all-volunteer crew who understood the power of makerspaces and really wanted to see Cabrillo’s become a reality.

COMMUNITY-FIRST APPROACH

Just as McNett had surveyed across disciplines to formulate the first digital fabrication courses based on campus-wide need, the team used the same approach with the broader ecosystem of potential industry partners. When they were just beginning the process of developing the makerspace, Dr. Gaulty met with the economic development manager for the City of Santa Cruz to ask who in the community could use makerspace students with their respective skill sets. He was able to leave that meeting with a long list of potential partners as well as a shared database.

All 200+ potential industry partners were invited to an all-day Plan-a-Thon, and roughly 50 showed up. The Cabrillo team asked questions like, “How would a makerspace benefit you? What kind of curriculum would you want to see in a makerspace? What skill sets does a student coming out of a makerspace need?” They then used the responses to help shape their space and curriculum.

Before opening the space, the team hosted a series of “sneak peeks” every Friday to help spread the word and drum up support from the campus community. Through both industry and campus community outreach, the response was overwhelmingly positive. Folks from across the board wanted to be involved and lend time, skill, and expertise.

CULTIVATING A CULTURE OF INCLUSIVITY

The Makerspace is a safe place on campus for students to experiment, play, fail, learn, collaborate, and grow. McNett shares that in the Makerspace, “Failure is always an option. Failure is growth. That mindset builds our community of practice to the point where students feel that they can go there and do whatever because there’s no pressure. And then they realize that they’re growing at an accelerated rate because they’ve taken the pressure off of themselves. Then they just want to be part of it because it’s fun.”

“Students feel comfortable coming to the art department, no matter what department they’re from.”



Student composer Galen Getz and engineering student Robert Mulholland install Getz's assistive keyboard cover, made in the Makerspace.

Cultivating and encouraging students to morph into mentors within the space is another key ingredient. Anyone can come in without any knowledge of tools, and with time and dedication, they may find themselves eventually becoming experts and mentoring others. Often, these students won't even realize they're mentoring, but instead they naturally just step up to share their knowledge when someone needs help. McNett notes, "The passing of knowledge is truly the moment when I know my students understand the material fully. There are students who can test well and still don't really fully understand what's happening. If they can teach somebody else, they know what they're doing." But in the makerspace environment, doing is deep learning. Staff members mentor the students, then the students mentor one another and send McNett feedback that he then incorporates into his curriculum, creating a full circle of knowledge.

What's their secret sauce? One main ingredient is a staff that celebrates diversity and agency. Mary Govaars, the Makerspace program coordinator shares, "All of us on the team are from different generations. I've had kids, I had a career, I came back to school. Having all these different age ranges and experiences in the Makerspace is really helpful." When users of the Makerspace are able to see themselves in the diverse staff and other users of the space, there's an inherent sense of belonging and ease.

INTERDISCIPLINARY DEEP LEARNING

Flipped or blended classroom, nonlinear research, and project-based learning are all just natural components of a makerspace learning experience. Organic processes and "creative collisions," as McNett calls them, grow out of having students from different interests and backgrounds working in the same space. For example, the Holding the Future Club, a group of STEM student who banded together to create 3D-printed prosthetic limbs for kids in need, intersected with the Music Technology and Recording Arts Club in the makerspace. There they met Galen Getz, a student composer with cerebral palsy. Because of his limited motor control, Getz was having difficulty with the keyboard until the club laser-cut him a plexiglass keyboard guard that ensures he would only hit one key at a time.

McNett observes, "None of the creative process that emerged was part of something taught in a class. It was purely students seeing a problem and organically identifying methodologies to creatively solve it. How do you teach that? You just provide the real estate that enables it."

While traditional educational models focus on measurable outcomes, what is learned in the makerspace defies those stringent metrics. McNett notes, "The makerspace gives students all these things that we know they're learning. Students thrive as a result of it, and they get back into their academic classes with new information and a mindset that enables them to succeed in their classes as well. The makerspace is all about giving the entire campus community the opportunity to grow at its own rate."

POWERFUL INDUSTRY INTERNSHIPS

Laying the foundation for a healthy makerspace ecosystem of industry and campus partners from inception has enabled Cabrillo College to have a truly standout internship program. Industry partners to date have included such diverse entities as the Monterey Bay Aquarium, Calfee Design bikes, Cruz Foam (makers of eco-friendly foam), the Santa Cruz Museum of Art and History, and RCR Fabrication, to name just a few.

Realizing the need for expertise in workforce development, the team contracted with Courtney Cogan of Goodwill Industries, to serve as a dedicated internship developer and coordinator. Cogan not only helps to build relationships with potential industry partners, but she's also the main point of contact for students preparing to enter internships, helping them to navigate new terrain that includes resumes, building out their LinkedIn profiles, and practicing interview skills. Cogan notes, "This should all really be part of the educational process. It's basically how you present yourself and get your foot in the door. If you know how to look at a job description and use appropriate interviewing skills, you're going to go into the experience confidently and it'll be much more successful and rewarding." Presented in the context of a class, this might not be as meaningful or engaging, but as part of an opportunity to go into a local business and be involved, students become very interested.

"This should all really be part of the educational process. It's basically how you present yourself and get your foot in the door."

Cogan also focuses on matching the right students with the right opportunities, setting them up for success. Interns have proven their worth to employers and are becoming partners in their ventures. For example, interns initially hired by the Monterey Bay Aquarium to scan artifacts for an online 3D printing library will serve as near-peer mentors and coaches to local high school students in the aquarium's new education center. In the program, students will identify ecological problems in their home or community and come up with solutions.

FINAL THOUGHTS FROM THE FIELD

Clearly, the work that the Cabrillo College Makerspace did to lay the foundation and build the ecosystem in advance of creating their space had a profound effect on their outcomes. McNett emphasizes, "It's really important that we don't take the 'if you build it, they will come' mentality. It's really important that we take the mentality that we're going to plant a seed and watch it grow. Because if you build it and they don't come, it falls apart. If you plant a seed and allow your community to determine what they want to see grow, it'll be them watering that seed, and they'll be invested in its success."



Be sure to check out the Cabrillo College profile video: bit.ly/CCCM_Cabrillo

STUDENT VOICE

HOW OUR MAKERSPACE PROVIDED THE TOOLS AND ENVIRONMENT FOR US TO REACH NEW HEIGHTS

BY PATRICK GAGNON, COLLEGE OF THE CANYONS



I couldn't have succeeded without it. We wouldn't have reached the heights we did without its support. The payload would have struggled to come to fruition without its resources. Because of its help, we were able to go where only few have gone before. Of course, I'm talking about our MakerSpace. As an aerospace engineering student at College of the Canyons, my team and I have sent experiments to space on payloads which were designed and created out of our MakerSpace.

We're participants in the Louisiana State University's NASA HASP (High Altitude Student Payload) program. We began designing payloads in 2016, and this marks our fourth consecutive year in the

program, a rare feat for a community college. I've had the pleasure of serving on all four of our student teams, and it's been my privilege to act as the project manager for the past two years. We're collecting further data on the efficacy of actively neutralizing harmful acids in the stratosphere, and our goal is to develop a means of mitigating some of the effects of climate change by removing these acids before they're able to cause more harm to the ozone layer.

Our experiment SOLARIS (Stratospheric On-board Laminar-flow Acidic Reduction and Inspection System) is a miniature laboratory with a suite of sensors and instruments used to analyze samples of the atmosphere. We've produced a basic aqueous solution that interacts with the acids in the samples and produces reactions that break down those acids into simpler forms. The experiment is contained in order to preserve the

samples and collect data with minimal threat of contamination to both the outside environment and our experiment.

The MakerSpace on campus has been imperative in the design and prototyping of our payloads since its conception in 2016. Our first payload failed to see much use out of the space, which at the time was a couple of hand tools and some woodworking equipment. We've since greatly grown the MakerSpace to contain two huge laser cutters, half a dozen 3D printers of various sizes, a resin printer, soldering stations, drawing tablets, and a full woodshop.

PRIME FOR COLLABORATION

Because of the open availability to such equipment, the space is always alive with the buzzing of creative minds. Our architecture department uses the available resources for prototyping structures the students have designed, the art department uses it for a slew of creative projects ranging from abstract art to theater costumes, and those of us with a STEM background have used it as a place to assemble our meetings and conduct work. The 3D printers are used for rapid prototyping and, in some instances, are utilized to make flight components. We flew a 3D-printed intake manifold on last year's payload to the stratosphere, where it endured and survived the harsh environment of near space for eight hours.

The MakerSpace also serves as a hub for the team's organization and workspace, and because of its open-door policy, we've been able to collaborate with other students from various departments. Our team has grown over the years, and the exposure of being in the MakerSpace attracts all sorts of creative energy, which has been instrumental in the design and testing of these payloads. The space is an incredible resource to all the students on campus; to have the ability to bring ideas to fruition in a physical medium provides limitless opportunity for what can be achieved.

“Our team has grown over the years, and the exposure of being in the MakerSpace attracts all sorts of creative energy, which has been instrumental in the design and testing of these payloads.”

Where else can one go to bring their ideas to life without having the burden of cost? The budget of a typical community college student is not high, and basic necessities are sometimes too much for a student to bear, so the MakerSpace becomes a proverbial sanctuary for students to be adventurous and creative without having to foot the bill. Over the years of working with and in the space, the talent of our students and their respective confidence has increased, leading up to our busiest and most challenging year yet.

FUTURE OPPORTUNITIES

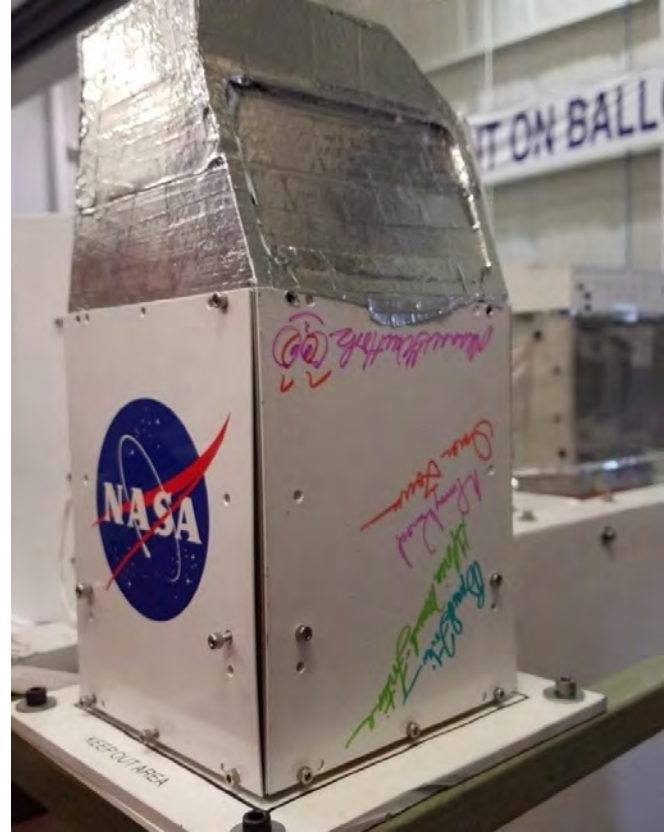
This year we're attempting to fly two payloads: SOLARIS and MAPLE. MAPLE (Mesospheric Autorotational Payload Lander Experiment) is being flown on RockSat-X, a student platform that allows experiments to run tests in the outer atmosphere, at 93 to 110 miles high. MAPLE will attempt to demonstrate the validity of using autorotation to slow a reentry craft to a safe landing velocity without the use of any contingent systems such as a parachute or boosters. We're dealing with factors such as reentry temperatures, RF (radio frequency) communication, multi-axis positioning, and

rotational inertia. Both of these payloads are complex in their own ways and slated to launch just a couple months apart. The data collected will support future missions of College of the Canyons' payload team, and it's all happening in the MakerSpace.

To be able to access these resources has been beneficial to all of our students, but some have definitely taken the opportunity to new heights. Many of our teammates have acquired internships at prestigious companies and organizations due to the work they contributed to the payloads and the skills gained from the experience of working in the MakerSpace.

I personally had never used a 3D printer before, and I certainly didn't have the means to buy one. The skills I gained using the printers in the space helped me secure an internship at NASA this past spring, where I used a 3D printer weekly to complete tasks. The MakerSpace has been an important part of my development as a student, an engineer, and a leader. Being able to help other students bring their visions to reality while learning how to do things in different ways has contributed to the success of the payloads and the students who built them.

Sometimes, all you need are the proper resources and a communal, friendly environment to bring your dreams to reality. That's what our MakerSpace is providing for so many students. Whether they're just starting their journey as makers or are experienced visionaries, the MakerSpace provides the scaffolding that supports the ambitions of our team while lending us the tools required to make it happen.



CASE STUDY



CCSF FOSTERS INCLUSIVITY THROUGH CROSS-CURRICULAR PROGRAMMING AND CONSCIOUS NAMING CONVENTIONS

“Our approach in the beginning was to try and redefine what it means to be a maker, but we don’t have to do that. We just have to make the space welcoming.”

— MAURA DEVLIN-CLANCY, MAKERSPHERE COORDINATOR

As the sole community college in the city of San Francisco, CCSF (City College of San Francisco) serves as many as one in nine residents. With this important role comes the responsibility to provide access and equity, to reflect the community they serve, and to help best prepare students to succeed in today’s job market.

When the CCSF team embarked on the two-year CCC Maker makerspace startup process, they set out to meet three main goals: curriculum that directly ties to the makerspace, a campus-wide network of three makerspaces, and a makerspace

demographic that is a direct reflection of the student population. With hard work, focus, and dedication, they’ve proudly accomplished all three.

BACKSTORY

In 2015, CCSF, in an effort to prioritize student success, particularly for underrepresented students, held a flex day where faculty could spend time looking at student data for their respective departments. Maura Devlin-Clancy, at the time the department chair of the Computer Networking and Information Technology (CNIT), became



increasingly concerned with the student data around gender, ethnicity, socioeconomic status, and success rates. Clearly, the systems already in place were somehow failing to engage students and prepare them for the Bay Area job market. Something needed to change. Career and technical education (CTE) data was showing that even a few CTE units could significantly increase a student's earning potential and chances of being hired.

"We see a need to build internal connections, to support and encourage faculty to create interdisciplinary courses and scale evidence-based practices focused on increased student inclusion and 21st century skills."

Serendipitously, at the same time, Devlin-Clancy was invited by CCSF partner Cisco to visit an Internet of Things (IoT) Boot Camp pilot they were running at a makerspace inside The Exploratorium. She recalls, "I knew about makerspaces, but I had never been in one, and I didn't really see a connection. They seemed like a niche sort of thing." The experience was eye-opening, and she began to see the potential.

So in January of 2016, when the CCC Maker project, initiated by the California Community Colleges Chancellor's Office, launched the call for proposals, the CCSF team knew a solution was in sight. Notably, leadership at CCSF also recognized the potential student benefits of a campus makerspace and were on board: Chancellor Mike Rocha and Associate Vice Chancellor of Workforce and Economic Development Theresa Rowland were both quite supportive, which made the process much smoother.

PROBLEM STATEMENT AND SOLUTION

Their problem statement read:

"Across our large urban college, a network of a main campus and nine centers, we see gaps in connectivity in many areas. Students who are ethnically and gender-diverse or socio-economically disadvantaged connect to STEAM pathways in lower numbers. Our faculty lack space and a platform to connect across programs and to industry resources that support the development of New World of Work skills in the classroom. We see a need to build internal connections, to support and encourage faculty to create interdisciplinary courses and scale evidence-based practices focused on increased student inclusion and 21st century skills."

Fast-forward three years, and not only are CCSF's three makerspaces (collectively called the MakerSphere) integrated into curriculum across campus, but they're embraced by the full spectrum of departments and student population, a testament to the power of intentional inclusivity.

SPACES AND CURRICULUM

The CCSF MakerSphere is a network of three makerspaces on two different CCSF campuses:

1. The Collaboratory (Ocean Campus Library) hosts “clean” equipment (e.g., designing and rapid prototyping) as well as large community events and an entrepreneurship program.
2. The SmartHub (Ocean Campus) hosts an ambient intelligent networked environment, laser and fabrication materials, and midweight equipment for individual and class use.
3. The Industrial Hub (Evans Center, co-located with the Welding, Automotive, Construction, and Fashion/Upholstery departments) is the most recent addition and hosts heavy industrial equipment.

CCSF’s cross-disciplinary curriculum currently includes a general education course called Maker 100, a Maker Studies Certificate of Accomplishment (“a program designed for working professionals, business owners, and students working towards a degree who wish to understand and apply maker concepts and techniques to their existing or future educational pathways”), a capstone Maker 400 course, and a one-unit course for teachers, all hosted in campus makerspaces.

The Maker 100 course, interestingly, is team-taught by three teachers from three different departments: Eugene Young from Visual Media Design, who teaches papercraft and engineering; Suzanne Pugh from Art/Sculpture, who teaches sculpture and jewelry making; and Lea Smith from Computer Networking and Information Technology, who teaches computational tinkering and creative coding. The inclusionary strategy in the design of the class structure is to begin with neutral materials that are familiar to everyone (in this case, papercraft) and add skills and materials from there.

Devlin-Clancy notes, “It’s interesting the impact the makerspaces have had. They’ve created a platform for more innovation and more faculty coming together

from different disciplines in a very complementary kind of way versus a competitive sort of way. Just having these spaces on campus has infused a lot of excitement and a lot of rethinking about what our classrooms should look like.”

NAMING CONVENTIONS AND EQUITY

The three spaces intentionally bear names that exclude the word “makerspace” in an effort to appeal to a wider audience. What’s in a name? Quite a bit, actually. Devlin-Clancy shares, “Who identifies as a maker and what it means to be a maker are some things

Even the marketing material for the MakerSphere is intentionally designed to be inclusive.



that we're learning about." For example, as a way to reach underrepresented minority students, the SmarHUB hosted a program called Art and Activism in conjunction with the African American Studies and Philippine Studies programs. In reality, it included the same use of tools and projects as the previously named Freedom School, but the difference was that the makerspace deputized the partner programs (who have strong student voices) to name it. The program has been quite well-received and successful at inviting and welcoming an underrepresented demographic into the space.



A bodycare workshop celebrates the range of forms of making.

The MakerSphere has also made some great gains in regard to gender equity. Going into this work, the CCSF team knew that makerspaces traditionally attracted more men than women, so they laid the foundation by working with the National Institute for Women in Trades, Technology and Science (IWITTS) on recruiting and retaining women in makerspaces. The Maker 100 classes have been at least 50% female students every semester it's been offered. The goal, though, is 55% to mirror the gender breakdown of the school's overall population.

Devlin-Clancy notes, "We want the spaces to welcome all students: those who are beginning makers to experienced makers who actually have projects that they're already thinking about. So it was very intentional how we created our spaces to welcome every student from across the campus: male, female, young, old, and across all ethnic groups." CCSF's data-driven, student-focused, cross-disciplinary approach is not only inspiring, but quite effective.

FINAL THOUGHTS FROM THE FIELD

From the perspective of an educator who has seen the potential makerspaces have on students and the college, Devlin-Clancy wraps up by sharing, "The last thing I'll add is that having a space dedicated to innovation gives you a platform for engaging with partners in a way that you might not if you don't have this spirit of innovation and a space to experiment. Just by having a neutral space where we're trying new things, we've established connections with industry. I would encourage colleges to find a place that can be an innovation space where everyone can try things. Having a space for innovation brings a lot of things to your partnerships, your students, your faculty, and to how you think about teaching and learning. It can be hard to do, but once you do it, the payoff is really great."



Be sure to check out the CCSF profile video: bit.ly/CCCM_CCSF

STUDENT VOICE

ODE TO MAKERSPACE

BY DUNIA HIJAZ, MOORPARK COLLEGE

Editor's Note: Dunia Hijaz, a Child Development major, discovered the MakerSpace at Moorpark College while working on a project idea for her Observation class. Upon bringing a sketch of her idea to the MakerSpace, she was welcomed and guided. Not a self-identified maker, Hijaz was introduced to a side of her creativity she didn't know existed before. She plans to incorporate the makerspace and hands-on learning into her future teaching career. When asked to share the effect the space has had on her, she wrote the following poem.



My mind is like a car moving forward, resembling all my ups and
downs on this journey I travel

I am the driver, steering on a path of direction

The farther I go, the farther I succeed

I might fail along the way, but I'm learning from my mistakes

The engine ignites when that thought comes to mind, all I need
to do is push to start

3, 2, 1, Go!

Sometimes my gas tank is full, but other times it's empty

It's my responsibility to fix anything I break

The radio playing in the background is my thoughts and my ideas

The label on my car is my name — Dunia Hijaz

The year the car was made is the year I began — 2018

The clock represents the countless hours it took to complete

The exterior is my creativity and the interior is my heart and soul

When I press on the brake I need to stop and think, but when the
thinking occurs, I press on the gas pedal and I continue on my way

My mind is like a car moving forward, resembling all my ups and
downs on this journey I travel

With the support of my seatbelt

I can move slow or I can move fast, but it's up to me to choose a path.

CASE STUDY



COLLEGE OF THE CANYONS MAKERSPACE PROVIDES THE PERFECT COMPLEMENT TO TRADITIONAL CLASSROOM LEARNING

“Unless you come in and experience it, it may be hard to understand this way of learning; it just stays with you. Students learn 21st century soft skills, and they don’t even realize that they’re learning them: team building, problem solving, all of these things are equitable skills in the job market.”

—CHRISTOPHER WALKER, MAKERSPACE OPERATIONS COORDINATOR

Beyond the expansive doors of the Student Center, past the cafeteria, lies perhaps the most student-centered place on the College of the Canyons (CoC) campus: the MakerSpace. Digital fabrication tools commingle with traditional hand tools while the

steady, hypnotic buzz of collaboration and innovation provides the soundtrack. From NASA space balloon payloads to multimedia art, the CoC MakerSpace supports a broad range of disciplines and interests.

The seed was planted when the college’s chancellor, Dr. Dianne Van Hook, tasked Ronald McFarland, at the time the dean of the School of Applied Technologies, with creating a makerspace on campus. Dr. McFarland knew just who to deputize: Christopher Walker, at the time a lab technician in the Architecture department. A lifelong maker, Walker was immediately on board. He recalls, “I had always wanted



a place where I could use the tools that were inaccessible to me and most other people. This is what many people want. I couldn't pass up the chance to make it happen."

Initially, the MakerSpace was nothing more than a couple of 3D printers in a small room. Hours of operation were limited, and there wasn't much student participation. As Dr. McFarland puts it, "Our makerspace started as mostly a space, very little maker." Then, as the word spread, they began receiving monetary and tool donations, which helped them grow and expand the space and its offerings. That first semester, Walker was the only employee of the space and ran it single-handedly. Eventually, with the help of the CCC Maker grant, they were able to expand to their current 10 employees.

COMMUNITY AT THE CORE

To drum up interest and support, the team hosted an open house and were pleasantly surprised at how many people showed up. Clearly, the concept resonated with the community. At the open house, attendees were handed feedback cards asking them

"We didn't really do anything but facilitate the culture for our makerspace—the students did that themselves, and that's one of the greatest things about it: Not only do they come in and make stuff, but they came in and made a culture."

what they'd like to do and see in the space. These responses were then used to determine which additional tools to purchase for the space. Interestingly, of all the options listed, the majority of students said that they were most interested in woodworking, and the space now houses a robust woodshop. As Hsiawen Hull, director of Technology Service, notes, "It helped us focus on what was next for the space. If you don't ask, what are the needs, what are you planning on doing, what do you want to do, you don't get an understanding of what your community is good at."

In addition to surveying the community, the team put together an advisory board comprised of representatives from organizations and corporations in the broader area, as well as K-12 partnerships. By taking this community-first approach from the beginning, the CoC MakerSpace team was able to foster a space that caters to the interests of many, where everyone feels welcomed and where there are no titles. Students can work alongside administrators and faculty with little to no sense of hierarchy because the ethos of the space is that all perspectives and levels of knowledge are inherently valued.

Instead of taking a prescriptive approach, they simply listened and provided what the community asked for. Walker holds, "The culture of MakerSpace created itself. We didn't really do anything but *facilitate* the culture for our makerspace—the students did that themselves, and that's one of the greatest things about it: Not only do they come in and make stuff, but they came in and made a culture."

CELEBRATING INTERDISCIPLINARY DIVERSITY

This resulting diversity of tools and participants is one of the MakerSpace's greatest assets. Jason Oliver, department chair of Interior Design and Architecture, remarks, "One of the things that really helps to not only enhance a makerspace but give it some room to grow is the diversity of the students, the faculty, and all of the community members because its greatest strength is in having a variety of viewpoints, a variety of skills, a variety of resources coming together organically, so that you never quite know



Workshops offer an open invitation for participation.

what you're going to need, but when a need comes up, you know where to go for it. Also, having all that in one space is ideal so that these things feed off of each other."

As the MakerSpace grew, it also gained an important advocate: Andy McCutcheon, the dean of the School of Humanities. He notes, "I was really excited by the interdisciplinary nature of it all. We're often put on the spot to justify what we do in the humanities. People sometimes don't see a clear connection to a job in the real world, and it seems rather esoteric. I've always been interested in anything that connects learning in the humanities to real-world experiences that are useful."

McCutcheon, a musician and poet, also comes from a do-it-yourself mentality and background, but he admits that his initial impression of makerspaces, like many, was that it's defined by the equipment it houses. But upon his first visit to an established makerspace in Portland years ago, he was instantly struck by the students, many of whom were very engaged in collaborating on interdisciplinary capstone projects. That was when he first saw the powerful potential of makerspace as places to seamlessly bring together the disciplines. For the CoC MakerSpace, he has worked to weave the arts and humanities into the space and has advocated for more curriculum to legitimize and sustain it.

COMPLEMENTARY TO THE CLASSROOM

In the standard classroom environment, there is typically a set syllabus with a set goal. Walker explains, "The end game is to pass the class. Students are more unwilling to take risks or deviate from this path for fear of failing, whereas in the MakerSpace, we encourage risk taking and failure because those are the best learning experiences." In contrast to a classroom dynamic, employees of the MakerSpace focus on being mentors, not teachers, suggesting options rather than making prescriptive statements, in effect opening up a world of possibilities for users of the space.

Walker adds, "Here you're encouraged to take different paths, to explore failures, explore successes, and in the end, this gives you a greater sense of competence and a greater sense of accomplishment. It may be harder and take longer, but the end game

is so much bigger than a grade in a classroom. These are experiences that stay with you forever.” As a hub for experiential and applied learning, the MakerSpace serves to make classroom academic learning more concrete and meaningful.



McCutcheon agrees and furthers the argument, “It’s a completely different mindset in the MakerSpace. Students are intrinsically motivated. The question here isn’t why do I have to do this and how, it’s how can I do this differently, how can I make it work, and how can I try again? There’s more ownership of what they’re doing and what the outcomes are. It’s a much more resilient and self-directed way of thinking. This is exactly what they’re going to need to survive the 21st century workplace because it’s no longer about titles or degrees—it’s about skills and your ability to reinvent yourself maybe several times over in the same position as job descriptions continue to change.”

INDUSTRY INTERNSHIPS AND REAL-WORLD EXPERIENCE

To boot, makerspaces also present an opportunity for exploration that students might not be getting elsewhere. In an effort to streamline and fast-track education, many educational pathways have cut out the opportunity for students to delve deeper into their interests and discover their passions. Makerspaces give them a chance to decide their career paths based on real, hands-on experiences and not just job descriptions.

The industry connections that the CoC MakerSpace team developed to build the foundation of the space have also paid off for students in the form of meaningful internships. One powerful example is the work that Jason Oliver is leading with the City of Santa Clara and the Green Streets project, essentially a civil engineering project focused on re-envisioning how we treat underutilized and “neutral” spaces (such as the area between a sidewalk and the street) in our cities, as well as how to implement eco-friendly systems such as a rainwater catchment, employing native plants, and using special absorbent asphalt.

As part of this paid internship, CoC students work in teams to tackle problems in the community and suggest the best solutions. CoC MakerSpace deployed their first 20 students on this project to great effect. Not only did the students come up with bright ideas, more importantly, they gained the invaluable experience of working on teams to solve a problem, mirroring what would happen in the real-world work environment. Plus, this type of experience is fantastic resume material.

Another notable program that CoC MakerSpace students have been involved in is the NASA High-Altitude Student Platform program. In its 12+ years of operation, only five community colleges have sent payloads into space, and CoC was the very first. The CoC NASA team works exclusively out of the MakerSpace, and their participation has even

led to team members landing internships at NASA.

In addition to their industry partnerships, College of the Canyons has hosted an annual SoCal Makerspace Festival since 2018, a collaborative effort that includes K–12 partners as well as the South Central Coast Regional Consortium, which includes other area community colleges such as Allan Hancock, Glendale, and Moorpark. Each year, the festival has brought together over 2,500 makers, industry partners, educators, students, and future innovators.

FINAL THOUGHTS FROM THE FIELD

In a nutshell, what elements have made the CoC MakerSpace such a resounding success? Dr. McFarland summarizes, “What has made our makerspace really successful is multifaceted. Number one: Hiring really good people who really want to learn in the space—that’s a key element—and another essential element is really listening—not speaking to but really listening—to our community partners to see what they really want out of the space.”



Be sure to check out the College of the Canyons 2018 ISAM video: bit.ly/CCCM_CoC

STUDENT VOICE

HOW MY INVOLVEMENT WITH THE MAKERSPACE PAVED MY PATH TO EMPOWERMENT AND ENTREPRENEURSHIP

BY SEBASTIAN ROMANET, SIERRA COLLEGE



A year or so after high school, I started taking mechatronics classes because going to college seemed like the normal thing to do. But after a couple of semesters, I wasn't really feeling like anything was happening, and I didn't see it going anywhere. The basis of what I was learning excited me, but I felt that the path I saw ahead of me was a waste of this education. I was missing the connection between my classes and making money while being happy.

On the other hand, my dad drove big rigs for about 15 years. I liked the travel lifestyle and most importantly, I knew he was making good money, so I went to talk to a truck driving school in Sacramento. I decided to switch over to driving to make

some money. My justification was that I'd drive and carve out time on the road to learn programming and work on software. I was still interested in it, but this way I could learn it on my own, on my free time, not having to depend on it for money.

Then, one day, I was at Hacker Lab working on a simulator for a trainer that we use in a mechatronics class, and that's when Steve Hunter (a retired CTE professor and mechatronics consultant who works at Hacker Lab) saw my project. He got Carol Pepper-Kittredge, the Statewide Program Director for CCC Maker, who also happened to be there. I hadn't met either of them yet, and I just thought they were teachers who were personally interested in what I was doing. Right away, Carol was mentioning that the simulator could be on a resume or presented to a prospective employer to show what I'm capable of. They were so enthusiastic. To see this passion from these individuals and how seriously they took my project changed my perspective. I saw

value in what I was doing at school. I saw that I could do stuff with more my head than my hands, and if I could use my head to actually earn the money, I think that's a lot more fun. There wasn't really much of a plan for the future, but there were now options.

Soon after, my software was made available to Sierra College. They use it in class to train students. When you load up the software on your laptop, you actually see a three-dimensional rendition of the trainer on your screen, and you can interact with it, click on parts, and write your own code to operate it.

THE BEGINNING OF MY VR JOURNEY

As soon as I had signed up for Sierra College, I discovered Hacker Lab. I had no idea it was tied to Sierra College, but it sounded cool, so I started reading about how they offered 24/7 access to tools, and my mind was just blown. Then I saw that students at Sierra College pay \$25 a month instead of \$100, so I skipped a day of work to go to the opening day at the lab.

Eric Ullrich, the Hacker Lab co-founder, signed me up. When I had first walked in as a newbie, I had seen everyone working on projects, so I felt like I had to have something to work on, otherwise I'd look like I was wasting time. There was a social anxiety that kept me out at first. And then I just started going there and working on web development. I was building websites for small businesses for extra money at the time.

One night at the Hacker Lab, I saw a drawing of a girl wearing a VR headset on the calendar of events advertising a VR meetup. I'd been researching VR and watching videos of people trying it but I had never tried it before because I had no way of accessing the tools. I ended up coming to the meetup, and that's where I got

introduced to the equipment. Several students got together and decided this is something that we want to work on and be involved in.

“To see this passion from these individuals and how seriously they took my project changed my perspective.”

I got a brief introduction to the development environment by one of the people there, who actually ended up being my mentor for a while. This guy was so cool. After two weeks of knowing me, he let me borrow his VR prototype kit that you can only get sent directly from Oculus. He let me borrow it for five or six months to develop on it and learn. I eventually started teaching others.

One day Eric asked me about what I was working on, seeing the VR equipment out. I put the headset on his face, and someone snapped a picture for social media. That's when things took off because that image made it across a bunch of different platforms and people started getting excited. This was the first people were hearing of development happening in Sacramento, so to bring the development side of VR rather than just the entertainment side of it actually gained a lot of attention here.

I ended up doing my very first instructional class on how to develop VR just by chance. I was at an event called Code for Hood in downtown Sacramento. There was a class that got cancelled, and enough kids wanted to learn VR that they ended up talking me into creating a class for them, just impromptu, to fill it. The original plan was for me to just do my VR presentation, but they put me in the lunch room with a big projector while the kids were eating. As soon as I got my screen up and started running things, all the



kids just stopped eating and were staring at the screen. I ended up with 30 or 40 kids in line wanting to learn more.

The organizers handed me a microphone, and from that point forward, they had me doing presentations and talking to people. So next thing I knew, I had an impromptu class with 13 to 15 students, introducing them to the development environment of VR. The kids were really engaged, and that sparked the interest in VR classes I kept getting.

I repeatedly got bombarded by messages from people asking if I was teaching VR. Or I'd walk into the lab and the person at the front desk would say five people came in looking for VR classes and saying they thought I was teaching. Sierra College ended up supporting me by investing \$5,000 for me to get all the VR equipment, and we did VR camps that were six meetings for three hours each. I would have people who had never programmed, and by the end of the camp they were able to start any VR project they wanted to from scratch. It was very satisfying.

A CULTURE OF EMPOWERING STUDENTS

For me, all of this was really cool, but there was kind of an anxiety at first. I was 22 years old and people twice my age were looking to me for the answers. As a student, you're usually told how things are and to suck it up if you don't like. Here it's different. When I'm meeting with people at Sierra College, it doesn't matter that you're "just" a student. In fact, it's almost the opposite. When you're a student, it's like you're the most important person here. It took a very long time to get used to the fact that when people are asking your opinion, they actually mean to get a response of your real opinion back, not what they might want to hear. They trusted my opinion to be able to take the program further.

The official name of my current position in the makerspace is student ambassador. What I've been tasked with doing is promoting the space across campus and trying to help figure out the sustainability inside of the makerspace. It's very broad. One thing I do is talk with other makerspaces to see what their issues are. I also present about the makerspace during classes, which is a good way to bring students in. I tell them about everything they have access to, the price, and how to get there. I can bring in about 10 students a day by presenting in classrooms.

All of this shift in my career trajectory happened because I got involved with Hacker Lab and Sierra College directly. I was shown that what I can do with my mind actually has

worth. I followed my interests and ended up teaching VR. I even ended up organizing a couple of large-scale events on campus, and that has all ultimately led me to now: I just recently started my own small prototyping business. I'm very excited about this path and offer services like custom PCBs, microcontroller integration, and 3D printing.

***"When you're a student,
it's like you're the most
important person here."***

CASE STUDY



FOLSOM LAKE COLLEGE'S STUDENT-CENTERED APPROACH YIELDS EXCEPTIONAL RESULTS

“We’re most proud of how students who interact with the space rise to levels beyond what we might have imagined in terms of leadership and devising creative solutions that nobody’s ever thought of. We’re proud of seeing people rise to their potential.”

—ZACK DOWELL, FLC INNOVATION CENTER DIRECTOR

Established less than 20 years ago in 2004, Folsom Lake College (FLC) is a relatively young institution. Just three years after being accredited, the school purchased its first digital fabrication tool: a high-end 3D printer that only a handful of people knew how to operate. One of them was Instructional Design and Development Coordinator Zack Dowell, who has witnessed (and been at the forefront of) the college makerspace’s evolution to what is now the vibrant and decidedly student-centered Folsom Lake College Innovation Center.

Even though FLC already had an established makerspace before the CCC Maker grant, the makerspace startup process helped them to use the network as a resource and sounding board to further hone their focus toward students. Being able to connect with the CCC Maker network of colleges also informed their direction through sharing of information, systems, perspectives, methods, and camaraderie.

Dowell’s original role in 2007 was to help faculty navigate the waters of 21st-



century innovation tools, but now he works alongside his nearly all-student staff at the makerspace. In addition, he continues to guide faculty in ways to incorporate hands-on learning in their curriculum. He shares, “The inspiration is empowering students to look at problems in a different way, to have a different set of possibilities, and to give them access to tools. Empowerment manifests itself in a lot of different ways.”

REFLECTING STUDENT INTERESTS

The Innovation Center has become a multi-faceted reflection of student needs and desires, as well as a central campus location for workshops, events, internships, and collaborations, all prime for students to build both hands-on and soft skills, to explore career options, and to develop an entrepreneurial mindset. This 1720-square-foot space includes both a Dirty and Clean lab (think debris-forming tools like woodworking saws versus tools that require clean environments, like computers and

digital fabrication machines), as well as a full music studio and array of virtual reality and gaming equipment. The programming includes machine-specific trainings, open lab hours, tours, and workshops.

The music studio and VR equipment are prime examples of responding to student interest to welcome and encourage a broader student population in the space and to ensure access and equity. The recording studio, in particular, broadens the forms of making happening in the space and is a big draw to students who may not have otherwise felt inspired to check it out. The Innovation Center even

has its own page on SoundCloud, the open audio distribution site, featuring music that students created in the studio, essentially serving as an online open portfolio.

The workshops that the Innovation Center offers also represent a wide range of student interests. On any given month, the lineup may include everything from traditional makerspace workshops, such as learning to use a CNC mill or 3D printer, to a workshop on crafting paper wreaths and an Alice in Wonderland Tea Party complete with hands-on tea making, laser-cut shadow puppets, and character figure drawing. With offerings as diverse as the student population, every student is welcomed. As Dowell notes, “People love this space and they’re proud of it. It’s amazing to think of a place on campus in an institution that people have that level of emotional connection to.”

AGENCY THROUGH RESPECT AND RESPONSIBILITY

With programming and tools informed by student interest, as well as a predominantly student staff, an inherent respect for the space organically develops. By creating an environment where all are welcomed and by cultivating a strong sense of student agency, FLC found that students naturally step up. Dowell reflects, “Our single greatest resource has been the students and the degree to which we’ve let them rise as leaders



The Asian Pacific Islander Club collaborated with the makerspace for a katazome activity, combining a traditional art form with laser cutting.

and participate on very deep levels. Empowering students is like a giant wellspring of energy, creativity, and uniqueness.” At the time of this writing, students alone had entirely planned and executed the semester grand opening of the makerspace, intended to celebrate the space and welcome new students, with little oversight from Dowell and other faculty, to great effect.

When students feel an emotional connection to a space and a sense of ownership, they become invested in its betterment. Dowell notes, “There have been times where we had to reset expectations, and we do that as necessary, but we have students who’ve stepped up into leadership roles, and the students themselves end up holding each other accountable,” thereby creating a strong culture that is internally moderated. Not only does this instill a sense of responsibility and work ethic that will prove to be useful in future work environments, it frees up faculty staff members to focus on bigger issues. Student leaders in the space are even deputized to find their replacements when it’s time for them to graduate. The key is establishing conditions in which people can thrive and flourish.

AUTONOMY, COMMUNITY, SUSTAINABILITY

The Innovation Center staff participates in a retreat at the beginning of every semester, and a recent one brought to the fore three overarching themes: autonomy, community, and sustainability. The focus of the team discussion was how to elevate students who walk into the space into full users of the space while ensuring the safety

of users and the preservation of tools. Tool trainings were being conducted via appointments and workshops, which were becoming a bottleneck with the number of students who wanted to use the space. The team’s solution, in the spirit of autonomy, was to have staff members choose tools to then create training materials for. Using the students’ body of knowledge, they created trainings through the Canvas online learning management system. Now folks can auto-enroll in trainings, move through the steps, and become certified to use a particular tool.

The community theme manifested in focusing on ways to deputize super-users of the space, who are not paid staff, to take on some of the responsibilities of the space. Dowell notes, “There are people who just want to be there. They feel at home in the space and appreciate having access to these amazing tools and people, and so they want to help.” Recognizing these students and making them shop stewards is essential to building strong community. There are students who have excelled at certain tools, like the laser cutter, and they

can help offset some of the work that needs to be done. Dowell adds, “It’s not that we don’t want to pay them, but we can’t pay everyone in the space. That would be unsustainable.” Thus, building autonomy and a strong, passionate community lends to the sustainability of the space.

“Our single greatest resource has been the students and the degree to which we’ve let them rise as leaders and participate on very deep levels. Empowering students is like a giant wellspring of energy, creativity, and uniqueness.”

A student in the lab experiments with biofabrication techniques.



NEW DEFINITIONS OF WELL-EDUCATED

The demands of today's job market require a different kind of training. Being well-educated no longer means being well-versed in any one particular topic or discipline, but rather having the ability to nimbly evaluate a problem, see connections, devise solutions, test them, and iterate. The makerspace environment, like the 21st century work environment, is interdisciplinary. In traditional classroom education, subjects are, for the most part, kept separate, and yet students are expected to transition to the work environment and somehow know how to think across disciplines.

The makerspace becomes the ideal complement to traditional educational models, as it is, by nature, collaborative and cross-disciplinary.

Dowell notes, "In the makerspace, they're learning that there's a range of possibilities and that you can solve problems in new ways that you had never thought of. Here's a community that can help you get there. And I don't think they learn that in a typical course environment where there are prescribed instructions and a set sequence." The makerspace environment accelerates student capacity to see the interconnectedness of problems and solutions, and it grants them the agency to be nimble and innovative. These benefits not only translate to a brighter work future for students, but they're also essential life skills to cultivate.

FINAL THOUGHTS FROM THE FIELD

As someone who has been focused on creating, cultivating, and growing a makerspace for the past 12 years, Dowell shares, "I've been consistently surprised by the solutions that people come up with—the unique and creative ideas that students, faculty, staff, and all who intersect with the space have. It's really renewing to see how people solve problems and to find ways to let them do that. The most unexpected thing is the magic that just emerges from people given the opportunity or the environment in which to express themselves."

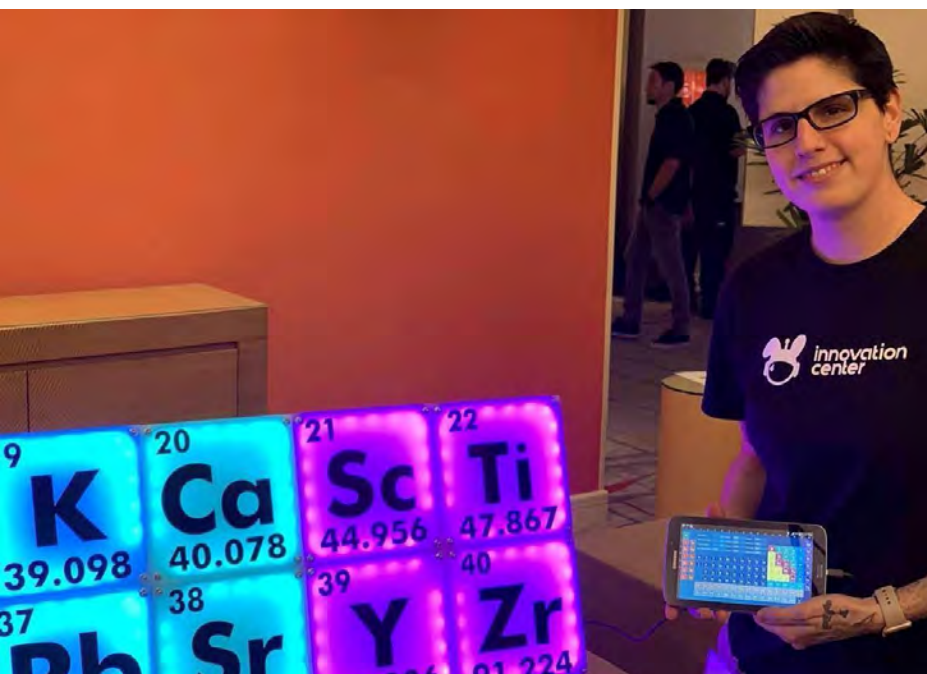


Be sure to check out the FLC profile video: bit.ly/CCCMfolsomlake

STUDENT VOICE

HOW THE INNOVATION CENTER HELPED ME REALIZE MY HIDDEN TALENTS AS A RE-ENTRY STUDENT

BY NICOLE SHUMAN, FOLSOM LAKE COLLEGE



I grew up in Los Angeles, and prior to moving to Folsom, I had a 15-year career in big box retail, holding many roles in the district: leadership roles, working with HR, inventory, loss prevention. My parents had separated, and my twin brother, mom, and I had decided to purchase a house together in Folsom and relocate. On my 30th birthday, coming back from Punk Rock Bowling in Las Vegas, I flew back into Los Angeles, my mom met me down the airport, and we drove up together. I was promised a job with the company that I was working for, and I stayed in L.A. an extra month living with friends to make this happen. But when I came up to Folsom, the company didn't have a position for me.

I went from making \$80,000 a year to now being offered \$12 an hour to do the entry-level position that I started at 10 years

ago when I was originally hired. It's disheartening to know that you can dedicate every fiber of your being to the people, the message, and the value of a company, and then they can't even come through for you. It was heartbreaking, and it destroyed me. That was one of the very lowest lows of my life—to come out after all of that hard work and to be in a completely new location, no real education other than a high school diploma, no friends, no clout, nothing. I was a nobody from nowhere in this small town, and it was awful.

So, I bounced around minimum wage jobs just trying to make ends meet because now I had a mortgage to pay. Then, at some point, my mom said, "You know, just quit your

jobs, go back to school, and get your education.” They say it really takes you hitting rock bottom to make those realizations. I always dreamed about having a four-year degree and being educated like some of my good friends that I look up to from high school, but I thought “No, that’s not for me. I’m not good at anything, and I don’t really know what I want to do.” I knew how to manage big box retail and I knew how to make future leaders, but how was I going to sit in a classroom? I was 32 then.

GETTING INVOLVED WITH THE INNOVATION CENTER

I enrolled in Folsom Lake College in spring of 2016, and that was the start of it. I signed up as a biology major, just because I like birds and science. I then got involved with Hands On Science, which hosts hands-on activities every Friday that introduce students to the various professors, programs, and science-related things on campus. One of the activities in fall of 2016 had us take a trip to the makerspace, the FLC Innovation Center.

At the time, I had no idea what a makerspace was. It wasn’t really open to the public and there were just a couple of students in there. But that day, I happened to bump into Zack Dowell, the head of the Innovation Center, and we started a conversation that changed everything. I commented on a 3D-printed hand there and told him about how I was interested in doing wing, beak, and talon modeling for birds. And then I just started going off about how much I love birds and how I’d like to take all these birds that are grounded due to some genetic misfortune and put them back in the air through the use of materials science, engineering, and bio-fabrication. Zack was totally jazzed about it, and for once in my life, these far-fetched ideas that I had seemed within reach.

I just kept coming back to the makerspace, and then in spring of 2017, Zack asked me to join the team as an official makerspace facilitator. At the end of the day, all of us in the space are essentially doing the same job, which is serving the students that enter the space. I currently hold a team lead role, kind of that middle person between Zack

*“For once in my life,
these far-fetched ideas
that I had seemed
within reach.”*

the staff, the community, and the faculty, just trying to keep things in line and functioning. My previous careers had me creating and implementing training systems and protocols, so I used those skill sets to help build sustainability features for the makerspace.

Since our involvement in the CCC Maker initiative, the FLC Innovation Center has become the main space on campus where students can make stuff. This is the only space that’s interdisciplinary and where everybody can connect around one common goal to make rad stuff and start obtaining the soft skills and tech skills necessary to be successful beyond community college.

PERIODIC TABLE PROJECT

One day, Greg McCormac, our Dean of Math, Science, and Engineering, showed me a photo of a giant periodic table of elements on the side of the chemistry building at the University of Murcia in Spain. He said, “Wouldn’t it be really neat if we could do something like that here?” I proposed we could do something indoors, and it would be



The Innovation Center team presented student projects at Maker Faire Bay Area 2019.

an awesome project for one of our CCC Maker internships. I offered to be the technical advisor and chemistry professor Max Mahoney became our client along with Greg.

We wanted to create something that would be way more interactive, way more unique, and that didn't exist yet, so I recruited a team of interns and we started the design thinking process, slowly bringing on more individuals with special skills sets as the need arose. Teeing off all of their passions, the project grew and became more extensive, as did the team. Our student interns are gaining skill sets, including soft skills, building their portfolios, and learning how to propose a plan and budget.

With my retail career experience, I knew how to do many of these things, and so I got to coach the students along in this process. Being that older, mature, re-entry student, I have a special outlook on the entire way I navigate my projects, education, and career, and I've enjoyed sharing that with younger students through the makerspace. Basically, our student interns are getting applied knowledge of the jobs that they're going to have in the future through working on this project.

FUTURE PLANS

This was my last semester at Folsom Lake College and I'm off to UC Davis to get my degree in Material Science Engineering and Math and then head off to grad school. Then hopefully, fingers crossed, I plan to head back to Folsom Lake College, where I can continue the legacy that I'm building there with the students. I'd love to maintain involvement with the space, partnering with Zack to continue this Maker Movement that has really changed my life for the very, very best. I owe a lot of gratitude to Zack for changing my outlook when I was down and defeated. Zack saw something in me, and hopefully I can continue to give back to the makerspace community in his honor.

CASE STUDY



MOORPARK COLLEGE'S STUDENT-CENTERED MAKERSPACE OFFERS BROAD INVITATIONS TO MAKE

“At this point in history, people really need to be able to adapt to different circumstances pretty quickly, and the makerspace allows people to develop those skills.”

—MICHAEL BRYANT, MAKERSPACE CO-FACILITATOR
AND ENGLISH ADJUNCT FACULTY



The subject of academic makerspaces may conjure images of digital fabrication tools, housed in a tech-related department, with tech faculty at the helm, but the MakerSpace at Moorpark College challenges all of those preconceived notions. Housed in the Campus Center and started by two adjunct faculty members—from Fine Arts and Journalism—the MakerSpace celebrates all forms of making, hosting sticker-making workshops alongside 3D printing.

Prior to the CCC Maker grant, Journalism instructor Michael Hoffman and Fine Art instructor Clare Sadnik had a deep appreciation for hands-on education through their respective fields but hadn't yet explored the potential of makerspaces. Hoffman explains that Journalism, and in particular his area of specialty of news production, involves design, photography, and the

same process of gathering and assembling elements as does creating projects in a makerspace.

He recalls, “The more we learned about how makerspaces work, the more we networked with people, the more we saw the potential and got excited about it.”

Coming from a field that is inherently hands-on, Sadnik inherently knew the value of learning by making and saw how this could help students in other disciplines. She notes, “We were excited that we would be able to give the students more access to equipment and technology.” The grant offered the opportunity to create a central place on campus to bring making to all students, regardless of discipline.

“The more we learned about how makerspaces work, the more we networked with people, the more we saw the potential and got excited about it.”

Upon being awarded the grant, the team spent the first year identifying a space on campus, mapping their broader ecosystem, drumming up support, and purchasing equipment. They then brought on Michael Bryant, another adjunct faculty member, this time from the English department. Bryant explains that though there may not seem to be a direct relationship between his field and making, his background is in video, and having previously managed a facility that offered video equipment to students, he too immediately saw the potential.

INVITATIONS AROUND

The MakerSpace’s location in the heavily trafficked Campus Center has been pivotal for inviting students from the full range of disciplines into the space. Sadnik notes, “There are big double doors that open into the space, and we get a lot of people who pause and look in. I encourage our student workers to be super welcoming and try to draw them in.” One “gateway” tool they use is their analog button maker, a simple hand-operated tool that can create a custom button in just a few minutes. The space has magazines to choose an image from, along with a circle cutter. Sadnik observes, “If they come in and make something really easy, like a button, then their eyes start to open and see all the possibilities.”

In her role as MakerSpace coordinator, Sadnik runs the space, orders equipment and supplies, manages the student workers, does outreach presentations for faculty and students, and helps faculty think of ways to integrate making into



their curriculum. She's often seen on campus wearing her MakerSpace T-shirt (which student workers are required to wear at the space), wheeling a cart with a 3D printer off to a classroom presentation.

She shares, "One thing I emphasize, especially in presentations, is that making spans not just 3D printers, but it can be as low-tech as crochet hooks, knitting needles, and sewing machines, which we have in our makerspace." The space intentionally hosts a wide variety of workshops, including simple ones like sticker making and basic soldering, to help dispel the notion that makerspaces are for tech and engineering students only.

Another tactic is to host an intriguing project-based workshop that teaches an underlying skill. For example, the LED earrings workshop is popular for the end product but is very much focused on teaching basic soldering skills. By focusing on a project and not the skill learned, the workshop ends up having broader appeal.

To help extend the invitation even further, the team takes every opportunity to table at any and all applicable events on and off campus. Aside from the annual Moorpark College Maker Faire, the MakerSpace has had a presence at events like Club Rush and

the Artisan Festival on campus, where student workers showcased jewelry and other items they had made in the makerspace. Off-campus, they've participated in nearby College of the Canyons' Regional Spring Makerfaire as well as other community events.

STRENGTH OF THE COMMUNITY

Looking back, the MakerSpace team is most proud of the strong community that has formed around the space, both among students as well as staff and faculty, especially considering it was scratch-built and merely an idea two years ago. For students, it's become not only a place to freely experiment, learn new skills, and explore options, but it's also just a welcoming space to be.

On the day that a mass shooting took place in November of 2018 in nearby Thousand Oaks, at a bar frequented by students from the college, the MakerSpace became a refuge for the community, a safe place to gather, comfort one another, and await the developing details of the tragedy. Sadnik shares, "This place has become

Makerspace coordinator Clare Sadnik assembled a mobile 3D printer cart she can bring to classrooms for presentations.





Student workers promote the MakerSpace at a campus event by showcasing items they've made.

a community, and that's what I'm most proud of."

The community includes strong support from college administrators and faculty across all disciplines. Hoffman notes that the team hosted a series of faculty meetings during the makerspace implementation period, "We brought people from very diverse disciplines together, and they're now part of the community." In a community college setting, in particular, where students are typically on campus for only a couple of years, having this level of support from faculty, who are there for much longer, is integral to the sustainability of the space and community.

Sadnik remarks that the faculty outreach has paid off and now faculty members are reaching out more often wanting to do projects in the space. Notably, while the leadership team is comprised of

adjunct faculty members, which is not traditionally a position of power in academia, Bryant observes, "Moorpark has a very unusually collaborative environment, so maybe at another campus it might have been more difficult, but here it's always been pretty egalitarian." One of his goals now is to grow faculty involvement even further.

Putting tools in a space is the easy part; building a passionate community takes far more effort. In fact, prior to the MakerSpace, there already existed a small digital fabrication lab in the Communications building (which covers graphic design, multimedia, film, television, and media arts), housing tools purchased from a previous grant. The lab was underutilized, though, lacking the essential community support. The MakerSpace team was also able to help shape the lab to be more user-friendly by adding furniture, additional equipment, and computers to run the machines, leveraging the lab to increase the college's hands-on opportunities for students.

ALLIES IN FACILITIES PERSONNEL AND OTHER MAKERSPACES

The MakerSpace team sings the praises of the folks who work in facilities and maintenance at the college, noting that they're makers too. Sadnik posits, "The facilities guys are a huge asset and have been extremely supportive and helpful. Get to know every single person who works in the warehouse. Find out who the electrician is, who the plumber is, who the grounds person is. Understand how those systems work."

Naturally, setting up a makerspace is more than just placing tools. There are a lot of auxiliary tasks that need to happen. Chances are that the facilities crew may actually be interested in the work that needs to be done for the makerspace because it's often outside of their normal tasks, and they may also want to use the space once it's set up.

“Find out who the electrician is, who the plumber is, who the grounds person is. Understand how those systems work.”

As Hoffman observes, “They really get what we’re trying to do, and so building relationships with them is important.”

Another significant asset to the Moorpark team, especially considering that their makerspace was being created from scratch, was the network of CCC Maker colleges, some of which already had pre-existing spaces and were further along in their development. Hoffman notes, “Without those connections, we wouldn’t have made the progress that we made.” Being able to connect with other makerspace teams, ask questions, find out what worked for them, and visit their spaces was immensely

helpful to the team. For colleges who may not have a built-in network as the CCC Maker colleges did, Hoffman advises, “Find the model and the people who are doing the thing you want to do and interview them because these people will help you.”

WELL-EDUCATED IN THE 21ST CENTURY

As the job market changes and evolves, so too do the sets of skills needed to be successful. What is it, exactly, that the makerspace offers students that they may not have access to in their classes already? Sadnik, who teaches 3D design, cites that the makerspace offers an understanding of how things work in the physical world. She’s seen students develop superior skills in problem-solving, troubleshooting, teamwork, spatial awareness, mentoring, and peer-to-peer learning. Time and time again, when students in the space are taught something in particular, they will organically step up and offer their knowledge to the next person grappling with the same issue. These skills are all also hallmarks of career success across disciplines.

Bryant adds the skill of adaptability. In today’s work environment, being able to assess and adapt are crucial. He notes, “That’s one of the things that the makerspace allows people to do because you have a lot of different equipment and a lot of different personalities. Students are able to figure it out, move through, and grow.”

Hoffman remarks, “Being well-educated is being able to gather information and sort through the analysis, being able to distill that information and present it. Education is not just knowing the facts but being able to determine which are true facts and which are falsehoods and being able to discern the difference there.”

A student proudly displays her iPhone stand, made at a 3D printing workshop.



FINAL THOUGHTS FROM THE FIELD

A commonality seen across all successful CCC Maker makerspace teams is gumption and persistence. The Moorpark team is no exception. Sadnik shares, “One thing that we decided early on is to never say no to anything. If someone asks me to do a presentation, I always do it. If there’s a possibility that we can have a booth at an event, we always will. So just any opportunity that’s presented, we always say yes and then figure out how we can do it.”

STUDENT VOICE

HOW A CLASS REQUIREMENT TO USE THE MAKERSPACE HELPED ME THINK BIG AND SET NEW GOALS

BY ASHLEY TAMORI, BUTTE COLLEGE



While finishing up my last semester at Butte College, I enrolled in a 3D foundation class that's a requirement for my Interior Architecture degree. Our first assigned project was to create a three-dimensional piece revolving around "clan identity," and a class requirement throughout the semester was to use the college makerspace, the Create Space Maker Lab. I had originally heard about the makerspace in a previous class, but I never had the opportunity to use the facility because we didn't need it for class.

I wasn't quite sure what the makerspace was at first or what it had to offer, but I remember occasionally walking by and peeking inside to see what people were making. It was always so cool to see students making projects, but I didn't

quite feel like I had a reason to make something there yet. Our instructor scheduled a tour of the makerspace and showed our class that we could use any of the resources available in the space in our projects. While we were touring, I felt so inspired.

When we returned to class, I sat down and started to draw out my design to figure out which pieces I needed to use the makerspace for in order for my project to become what I envisioned. After I worked out my project on paper, I figured out the dimensions and design and was ready to try out the tools in the makerspace. When I finally walked over, I was initially intimidated seeing everyone using the machines because I didn't even know where to begin, let alone how to use the machines.

SEEING THE POTENTIAL

I sat down at a computer and looked around for help, kindly asking one of the staff members for help using the machines since it was my first time. Without any hesitation, they walked me through the process of how to use the Epilog laser cutter and how to configure my design using the program. As I watched my design go from the computer to being etched on the wood, I remember thinking, “Woah, this is amazing!” The thought that an idea that I came up with could appear before my eyes was inspiring. That moment is when I realized how beneficial the makerspace could be to me and how I could continue to implement my own ideas and creations into anything I wanted to make.

While I was waiting for my design to be etched, I showed my design sketch to the art department director, Daniel Donnelly, and he recommended that I submit my piece to be considered for the CCC Maker MakeShift Makerspace Ecosystem Summit in Irvine,

“My brain was flooded with the endless possibilities of how I could make my ideas and designs come to life using the makerspace.”

California. To be honest, I originally had no clue what I was submitting my piece to because I didn’t have much knowledge and background about the makerspace itself. When my piece was selected to represent Butte College at the CCC Maker summit, I was shocked and excited to know that something I created was being recognized. I learned that over 50 students had submitted their creations and only 12 were chosen.

I grew up in a small town where there weren’t a lot of opportunities to put myself and my work out there, and here I was about to head to Irvine to talk about my piece and how the makerspace helped me create my idea. When I arrived to the event, it was much bigger than what I was expecting. From

meeting fellow makers to exploring Orange Coast Community College to sharing my creation and thoughts about the makerspace, I realized that I had found myself immersed in a community full of innovative people who all share the same passion for creating and making things as I do. It was surreal to think that using the makerspace for the first time would lead me to this opportunity to discover what this amazing community of makers is trying to establish for students.

EXPLORING POSSIBILITIES

Overall, I was able to take away a lot from using the makerspace and from the summit in Irvine. Driving home from the airport in deep thought, my mom looked over at me and ask what I was thinking about. With passion in my voice, I told her, “After everything I was able to experience through the makerspace and at the CCC Maker summit, I realize I’ve been thinking small this whole time, and that there’s so much more I can do and create. I need to think bigger!”

After I got home from my trip, I got out my sketchbook and started jotting down ideas that came to mind. I thought about how I could incorporate everything I learned into designing furniture and starting my own business. For the first time, I began to have an entrepreneurial mindset and wanted to keep designing and creating things. As an interior architecture major, I realized how I could implement the makerspace into my own educational and career goals. I could make house models, and bring my furniture ideas from concepts to real life. I’ve already started to sketch out a few chair designs for

my next personal project to help get me ready for the furniture design class I'll be taking next spring.

It's amazing to see how the makerspace has impacted and inspired me in such a short time along my educational journey. My only hope is that we continue to see the makerspace expand and impact more students. Everything I took away from the makerspace has helped me become a better maker and to think bigger.

“This whole experience has empowered me to change my mindset into something bigger.”



CASE STUDY



ORANGE COAST COLLEGE MAKERSPACE SPURS INNOVATION ON CAMPUS BY REFLECTING LOCAL INDUSTRY AND STUDENT INTEREST

“One of our biggest successes is embracing maker culture across campus and creating an innovative workspace where students can experiment freely without fear of pressure or failure. Seeing the excitement of students when they realize they get to use all this equipment is awesome.”

—GARRETT HILL, OCC MAKERSPACE COORDINATOR

Orange County, California, is world renowned for being the epicenter of the action sports industry, with a long list of globally recognized companies, from Hobie surfboards to Vans shoes, calling the area home. What does that have to do with

community college makerspaces? In the case of Costa Mesa’s Orange Coast College (OCC), everything. While hearing the hum of 3D printers may be expected in most academic makerspaces, having the opportunity to shape your own custom surfboard is virtually unheard of elsewhere.

The CCC Maker Initiative required that participating colleges go through a series of steps to help map their particular ecosystems to ensure that the makerspace they developed would be one their larger community actually needed and wanted. As a result, OCC’s MAKERSPACE is an apt reflection of



the surrounding area's ecosystem, with tie-ins to the action sports and aeronautic industries, custom built to serve the unique interests of the students and staff.

OCC, which has been serving the community for over 70 years, is one of the largest community colleges in the country, with a student body of over 25,000, roughly four times the national average. Previous to the CCC Maker grant, the school had digital fabrication offerings in the Technology Center, home to a variety of disciplines, including architecture, robotics, welding, manufacturing technology, and aviation. Like many institutions, though, access to these tools was restricted to students enrolled in relevant classes. The OCC MAKERSPXCE team, led by tenured architecture professor

Steve Fuchs, wanted to expand that access to all students, along with a campus-wide infusion of maker culture and hands-on learning.

“There’s a vibrant community, enabled by maker culture, that gets to the heart of what I’ve been passionate about for years ... Cultivating a diverse and empathetic network is half of the value of an education.”

Fuchs, a lifelong maker, left a graduate teaching position in Chicago in large part because the institution didn't want to create a makerspace and embrace maker culture, something he has long been passionate about. Raised in an entrepreneurial family where everyone created in the workshop together, the value of hands-on learning and working collaboratively had been ingrained in him. Along his career trajectory, he spent years attending community college, worked in fabrication shops and alongside prominent architects and designers, and earned his master's from SCI-Arc, a progressive architecture school known for balancing making and meaning. Project-based learning repeatedly emerged as the north star. At OCC, Fuchs was originally hired as a studio professor and digital fabrication expert in the fields of architecture and design.

Fuchs shares, “There’s a vibrant community, enabled by maker culture, that gets to the heart of what I’ve been passionate about for years. My childhood experience as a military kid was all about our families sharing resources and making do with what we had, including making and fixing things together. Cultivating a diverse and empathetic network is half of the value of an education.”

In 2016, Lisa Knuppel was hired as OCC's dean of Career Services and director of CTE grant development, and when the CCC Maker grant became available, she and Fuchs collaborated on the application. Fuchs and others at OCC had already been doing some interesting and related things—such as bringing robotics into design and not just into advanced manufacturing—with the impetus of celebrating design more on campus and creating a space for designers to make physical objects, in support of the curriculum. For the last seven years at OCC, Fuchs has challenged his students and the broader campus with a recurring question: Should design belong to any one department when it's so prevalent across many disciplines? The grant helped the OCC team reinforce and expand upon the school's existing offerings, including gaining traction in creating an open lab for design experimentation.

CULTURAL MINDSET SHIFT

Along the journey, the makerspace team realized that bringing their vision to life wasn't just a matter of creating a physical space with certain tools, accessible to all students—

it was a matter of shifting the cultural mindset prevalent at OCC. Knuppel notes, “It’s been a lot of work, but I can tell you that there’s been so much gain.”

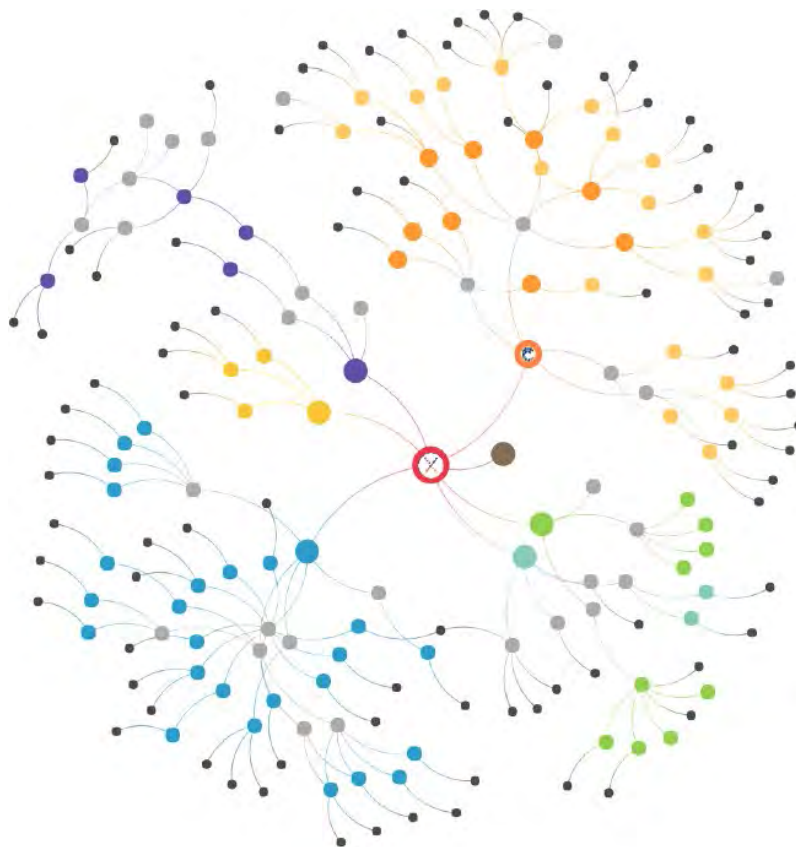
The OCC problem statement for the CCC Maker grant succinctly summarizes the issues they faced: “One of Orange Coast College’s (OCC) main institutional problems is that we are not currently capitalizing on bringing high technology to underserved populations in our region, especially in relation to increasing the adoption of design and maker

culture on our campus. Overall, we are focused on career technical education (CTE) and transferring to institutions of higher education, but we are not targeting opportunities to increase integration with our local economy and regional expertise. While we do have a job and internship center, OCC’s capacity to increase internships and account for skills-based learning needs to be supported by a larger ecosystem, so we can offer more opportunities for student success and meet the demands of California’s 21st century economy.”

The team laid a solid foundation by mapping their extended ecosystem (shown at left) and through preliminary outreach to potential industry partners in the area, as well as to departmental partners within their institution. Initially, when Fuchs and Knuppel began trying to drum up support from within, they were met with resistance that was perhaps based on not seeing the makerspace’s potential for spurring innovation across the entire school. Knuppel notes, “Transformation, especially when you’re dealing with something as big as campus culture, is not easy, but you only do it by doing it, pushing forward in a positive and inclusive way. We spent a lot of time on strategy: Who am I going to talk to, what language are we going to use, how am I going to put this information out there to overcome that resistance?”

Though the space is physically housed in the Technology Center, they’ve strived to persistently break down disciplinary silos

and emphasize campus-wide inclusivity, quickly correcting anyone who erroneously refers to the space as an Architecture department offering. There still remains some confusion about and resistance to the makerspace’s openness on campus, but mindset shifts require time and persistence.



Legend

- OCC MAKERSPXCE
- Orange Coast College (OCC)
- Non-Profit
- Education
- Local Community
- Business & Industry
- Government
- Philanthropy
- Individuals

STUDENT AND STAFF ADVOCATES

As the space developed, those who experienced it, students and staff alike, have become its biggest advocates. The shift in how making and the makerspace were viewed happened organically and authentically from within. Trang Ly, the makerspace administrative assistant, shares, “One of our greatest successes has been reaching not only the students but the staff as well. Some of our staff are innately makers, but they don’t have a space to be able to explore that. The makerspace encourages staff, students, and faculty to all interact with each other and learn from each other.” Ly also does outreach to potential incoming students, and she says that showing them what the makerspace has to offer is a big sell. Being able to access digital fabrication tools at an affordable school increases the value of the community college.

One of the ways the MAKERSPACE has become so successful and supported is by being receptive and responsive to the requests of departments and student clubs, as well as individual students. For instance, OCC has a thriving Fashion department, and the makerspace team reached out to see if there were any tools they’d be interested in having access to. The exchange led to the makerspace adding a garment printer as well as an embroidery machine, both of which have ended up being a huge draw for many students. Once in the space, folks have the opportunity to see what else it has to offer, expanding the reach. As well, there is curricular tie-in beyond the Fashion department. Fuchs teaches a branding class and notes the value of students being able to bring their brands to life using a maker’s mindset and OCC’s makerspace equipment.

The embroidery machine empowers students to bring their designs to life.

Campus clubs, in particular, have been drawn to the space for access to its tools and have been instrumental in spreading the word and encouraging adoption of the space. Many clubs who previously had to go off campus to have promotional items

like T-shirts created now come to the makerspace. Club members have also noted that the makerspace has allowed them to interact with a wide variety of people, introducing new perspectives and skill sets, leading to collaborations with other clubs, faculty, and industry partners.

Hill, as the makerspace coordinator, elaborated on the importance of responsiveness to student needs. He said they have a lot of students come in and say they want to learn a specific technology. Then, a week later, the makerspace will have a whole workshop set up where they provide students with the resources to learn what they want to learn in the way they want to do it. He shares, “That’s really changing a lot of student’s lives and how they look at going to school. They may have been thinking about a project for a year or two,



and now they can see it come to fruition and tangibly hold it. Students just light up when they can do that.”

Knuppel adds, “As the word spreads about the makerspace, who can use it, and what you can do in it, I hear students come into the career center or my office and ask what classes they have to take to be able to use it. When they learn that anyone can use it, they get so excited.”



REDEFINING “MAKER” AND “WELL-EDUCATED”

The makerspace team has strived to intentionally add tools that celebrate all forms of making, even ones not typically associated with the word “maker,” in an effort toward broad appeal. For example, they’ve added video and audio equipment, as well as DJ equipment. Fuchs notes, “To tie into the curriculum, I even found a way to use the same control surfaces to make geometry systems where we can use the DJ knobs to control a design’s dimensions and other parameters in a live 3D modeling environment.”

Another example is the surfboard-shaping machine Fuchs worked hard to bring to campus. Essentially a sort of CNC mill for surfboards, the machine offers a unique opportunity for students to apply digital fabrication to an artform with deep roots in the immediate geographic region. From fiber arts to music production, the MAKERSPXCE is spurring innovation on campus, actively expanding not only what it means to be a maker, but what it means to be well-educated in the 21st century.

As the Dean of Career Services, Knuppel knows that in the 21st century job market, “It’s not just the degree that’s going to be of value, but your experience. It’s not always your degree that gets you the success, whether that’s employment by someone else or clients, if you’re freelance. The makerspace helps legitimize and solidify what you can do.” The makerspace is home to vibrant internship programs and opportunities to build portfolios regardless of discipline. The team is also working to fine-tune a badging system as a way for students to be able to highlight skill sets to potential employers.

Ly adds, “Being well-educated is when students are able to think through process: Find out what the problem is and go through the process of getting to an end product or

solution. The makerspace sets them up for exploration. It has changed student license. The innovation we bring to campus has allowed them to do much more than what they thought they could.”

CAMPUS-WIDE SUPPORT

The team’s hard work, persistence, and vision has paid off with signs of campus-wide support and adoption. While at first they were reaching out to the campus Marketing department to share the cool happenings in the space in hopes of garnering coverage, now the Marketing department is seeking them out. But perhaps most encouraging is when the makerspace was highlighted as one of the most important initiatives of the college. Recent developments over the past year point to a makerspace expansion to twice its size in the near future, and OCC’s 2030 development plans call for brand new makerspace facilities to support all programs on campus.

Administrative assistant Trang Ly teaches how to use the space’s T-shirt printing machine.



FINAL THOUGHTS FROM THE FIELD

Reflecting on the systemic shift that has taken place over the past two years, Knappel observes, “When we first started talking about the makerspace, people looked at us like, ‘What does that have to do with me? That’s an architecture thing.’ But now we have participation and openness, and the college has come to embrace innovation as part of what OCC is about. It’s really paved the way for us to do some other innovative things with technology. People are open to hearing about innovative ways to use the space and do programming and open up new related programs, like augmented reality, in other divisions. It’s been really transformational.”

STUDENT VOICE

ACCIDENTAL ENTREPRENEUR: HOW THE FABLAB HELPED ME CHANGE CAREERS AND PURSUE MY PASSIONS

BY LEAH VASS



You might say that the Laney College FabLab is the genesis of my chocolate business. I first heard about the FabLab through a newspaper article. What, there's a space where you can use all this cool equipment *for free*? Pinch me! But of course, you have to be a Laney student, so it was time to peruse the class offerings. Right there in the class catalog, I spied "Culinary Arts 208 Confitserie: Chocolate and Candy"! I've always baked and made chocolates. A bad day at work? You would usually find me whipping up a batch of tarts or rolling chocolate truffles to make things right with the world again.

Being at a personal crossroads and feeling unexcited about my then-current career track, I decided to take a semester sabbatical to get some new skills under my belt and explore a field I've *always* been interested in: cooking the sweet stuff, specifically chocolate. As it turns out, Laney's Baking and Pastry Program is very professionally oriented. It's not for dabblers and hobbyists—it's a carefully designed program that teaches all the skills one needs to be a professional pastry chef, baker, or confectioner.

Silly me thinking I could just waltz in, take an advanced class, and be a

chocolatier. But I guess silly is my middle name. After begging, pleading, investing in the uniform and tools, and getting my food safety certification to prove to the department head that I wouldn't be a safety hazard to myself or my classmates, I was finally allowed into the class. I was in heaven! Imagine, finally learning *why* my chocolate didn't always temper the way I thought it should. Now I could start making desserts that looked as good they tasted.

So, at this point, I'm now a Laney student and I'm ready to start using the FabLab—except I don't know any of the necessary software programs. I graduated from high school in the Stone Age, so my computer skills are not very sophisticated. But I'm motivated: There are fun machines in that FabLab and I want to use them. Like most people, I think the laser cutter/engraver is the sexiest machine, so I know I need to learn Adobe Illustrator to create my vector files. But where to learn that? The Graphic Arts department, of course. And now I'm looking at another semester at Laney. But

“My route was rather circuitous, even backwards, but it worked.”

that's okay because I'm loving the Baking and Pastry program and want to take International Patisserie next, the class where you learn all the great European allstars, like opera cakes and full British afternoon tea.

By now you've got the idea. Like any good experience, I just kept wanting more. But I hadn't planned on taking more than one semester off, and though I had a part-time job, I was making much less than I had *and* making chocolate is expensive. There are the molds and other equipment, not to mention buying the chocolate itself. Moreover, though I love chocolate and eat more than my fair share, it became clear that I needed to find a way to subsidize my chocolate education and get valuable feedback on my chocolates. And so the *Ta Bouche Chocolate Club* CSA (community-supported addiction) was born.

Graphic arts is a commercial field. The art has a job, and that's to sell an idea or a product. One of our first assignments was to create a logo. Most people made logos for existing or bogus companies. A few made logos for friends' businesses. Being on the chocolate wave, of course, I made one for my hypothetical chocolate business. I've since made three iterations, but that first one was my ticket to using the laser engraver at the FabLab. I finally had a good reason and a vector file!

My engraved wooden boxes for the Chocolate Club were so pretty and reusable, my clients started bringing them to parties. The feedback was great—except often they left them and couldn't get them back. Whoops, that wasn't the idea! Now I needed a cardboard box that could be given away but that wouldn't take up much storage space. Back to the FabLab. And so the flat-pack customizable Ta Bouche packaging program was born. And so was Ta Bouche Chocolate Couture.

I now make chocolates for social and corporate events and still have the Chocolate Club for friends and family. My route was rather circuitous, even backwards, but it worked. All from the initial desire to use the FabLab, I became an *accidental entrepreneur* and have a delicious new career.



CASE STUDY



SACRAMENTO CITY COLLEGE MAKERSPACE SERVES STUDENT POPULATION BY FOCUSING ON DIVERSITY

“Equity and access are the umbrella that covers everything we do. The ultimate goal is that we’re a welcoming environment for everybody.”

—TOM CAPPELLETTI, SCC MAKERSPACE PROJECT DIRECTOR

Diversity is not only deeply woven within the fabric of Sacramento City College (SCC), it is the fabric of this institution that has been serving residents of the state’s capitol for over 100 years. The ethnic profile of the nearly 25,000 students enrolled includes roughly 32% Hispanic/Latino, 26% white, 19% Asian, 10% African American, and 7% multi-race. This diversity extends beyond ethnicity to gender and age as well with the majority, 57%, identifying as female and 23% of enrolled students over 30 years old. And economically, over 50% of the student population is either low income or below the poverty level. How can one makerspace effectively appeal to and serve so many different students? By making diversity, access, and equity the lens through which all decisions are made.

From its inception, the objective of the SCC Makerspace has been to create an explicitly positive interdisciplinary space “where students are actively mentored and encouraged to collaborate and develop ideas together, to wander and explore via project-based

learning,” in a space complementary to the traditional classroom. Currently housed in Rooms 108 and 110 of the Cosmetology building, the SCC Makerspace has been a seed just waiting to grow.

THE SEED

Years before CCC Maker funding provided the opportunity to actualize the space, two instructors, Tom Cappelletti and Missy Anapolsky from the Design & Digital



Media Department, both with years of professional business experience and teaching expertise discussed the possibility of creating a small scale makerspace on campus. As designers, they knew the inherent value of interdisciplinary teams and how this collaborative style of learning more closely emulates the real work environment

They had incorporated this concept into their unit plan eight years ago, when they proposed taking an underutilized classroom next to the design lab and making it a

flex space open to a number of departments. Because unit plans prioritize immediate needs first, usually more faculty, computers, software, or other equipment, their vision for a creative space remained on hold.

“The minute you receive tenure, you’re expected to actually push the envelope, but a lot of people don’t take advantage of that.”

Eventually, Cappelletti used a sabbatical release to study the potential of makerspaces, during which he learned about the 2016 California Council on Science and Technology’s (CCST) [white paper](#) titled “Promoting Engagement of the California Community Colleges with the Maker Movement,” along with the CCC Maker Initiative. SCC was awarded a CCC Maker Implementation grant, and the hard work of making a makerspace to serve their diverse student population began.

BOLD APPROACHES

CCC Maker’s first publication, the “Makerspace Startup Guide,” emphasizes the need for the core members of the makerspace team to be bold. Cappelletti, passionate about the mission, effectively mastered the fine art of always saying yes and not taking no for an answer. He learned the ins and outs of the administrative system to find loopholes and identify possibilities to help the makerspace. He credits his bold stance to his position: “I’m tenured, so I have the ability to take risks. The minute you receive tenure, you’re expected to actually push the envelope, but a lot of people don’t take advantage of that.”

A few years ago, Cappelletti and Anapolsky had also planted the seed by offering a well-received, impactful design thinking workshop that had opened faculty eyes to the power of experiential iteration, problem-solving, and learning. Many had taken these concepts back to their classrooms. So when the core team began doing outreach to assemble allies, they were able to garner immediate support, from both faculty and students.

DIVERSITY THROUGH OUTREACH

To spread the word and drum up broader support, the SCC Makerspace team poster-bombed the campus, spoke to students and faculty, hosted open houses and meetups, and targeted outreach to student clubs. The posters, a series of bold designs created by graphical communications student Sam Liff, were emblazoned with simple messages like “We Make,” “You Are a Maker,” and “Sac City Makes,” accompanied by stylized images of people playing instruments, sewing, collaborating. The message was clear: We are all makers, and the makerspace isn’t an exclusive, elite space, but one meant for the entire student population.



Cappelletti notes that reaching out to the over 50 campus clubs was one of the most important steps they took. Engagement with clubs ranging from the Queer-Straight Alliance to the Society of Hispanic Professional Engineers alerted a broad demographic to the possibilities of the makerspace and encouraged involvement. Another key to cultivating a welcoming space was hiring students as diverse as the student population, representing all races, ethnicities, and sexual orientations.

Each person working in or using the space then becomes an agent of change in encouraging others to participate, in a very grassroots and organic manner. As former student Michelle Zamora puts it, “You have to experience it, but the one time that you do, you become a salesperson for it. I think we yearn to communicate with one another in that kind of openness that’s in the space. There’s no way that you can’t be yourself in the makerspace.”

A UNIQUELY POSITIVE SPACE TO GROW

It’s no accident that SCC Makerspace has become a welcoming safe haven for a varied student demographic to experiment, learn, and grow.. From concept to creation, Cappelletti shares, “Our whole intention was that when you walk into the makerspace, through these doors, you pass into your potential.” The team found that the cornerstone was maintaining positivity in the space.

Everyone who comes in is required to sign a Positive Mental Attitude Pledge. All are welcomed in the space, but the ask is to leave negativity at the door. Cappelletti explains, “One person can bring everybody down. When the space as a whole is populated by positive people and someone walks in, they can feel that, and that’s what attracts them.

As part of the makerspace greeting process, everyone who walks in is welcomed, first timers are given an orientation by a student staff member, and encouraged to participate. The point is to make everyone feel personally addressed and invited to engage. A robust calendar of workshops offers entry points for a whole array of interests. Zamora notes, “It’s a really open learning environment where people feel really safe asking questions. The vibe is that it’s okay to ask for help across a room, and anyone there is willing to share what they know. It’s mostly students, and we’re learning from each other. There’s no hierarchy.”



STUDENT CAREER TRAJECTORY IMPACT

Nothing shows student impact quite like individual stories of success. Zamora is a prime example. As a continuing education student, she joined the makerspace team and eventually spent 15 months being the creative director for the space. She was later commissioned by CCC Maker to make a video series documenting makerspace impact at a number of colleges. She now runs her own independent design business. (Read her personal essay on page 75.)

Another student is Chad Kramer, who was excelling in one of Cappelletti's design courses but was going to have to drop out for financial and family reasons. Cappelletti, recognizing his potential, offered a guaranteed 15-hour a week job at the makerspace to keep him in school. Chad is now an instructional assistant in the space and attending Sacramento State.

Christian Espinoza was working at fast food restaurant El Pollo Loco, and although he had dreams of becoming a designer and running his own business one day, he felt those dreams were out of reach until he was introduced to the offerings at the makerspace. Espinoza now has his own custom CNC furniture business. (Read his personal essay on page 24.)

Cody O'Ferrall had earned a liberal arts degree from a college in New Mexico but was unsure what he wanted to do. Strong in math and with a passion for coding, he considered studying to become an app developer. After being hired as student help then becoming an instructional assistant he got involved in the Everyone Can Code Initiative, the Apple-sponsored program that teaches iOS development classes, where he discovered his passion for teaching. He's now working towards his master's degree and developing an app that offers math tutoring using machine learning.

With its strong focus on democratizing access and promoting entrepreneurship, SCC Makerspace was a logical site for the initial pilot program of CCC Maker's Makermatic team internship model. During a 20-hour structured internship, a team of student interns from SCC were paired with the California State Fair, to tackle the real-world problem, of how to increase attendance. Their successful results ensured ongoing industry relationships.

FINAL THOUGHTS FROM THE FIELD

A lifelong activist, Cappelletti is very much invested in the social justice component of makerspaces. And having directly seen the impact that the SCC Makerspace has had on their student body, he is setting his sights on trying to uplift colleges in California's impoverished Central Valley through the creation of community college makerspaces. He proposes a Peace Corp-like initiative to have ambassadors from other community colleges go there and help. He shares, "Our new governor is all about lifting up the hopes of the Central Valley, and he's already mentioned that it's an area that's been ignored for too long. If there's any equality at all, it's in community colleges. That's a possibility in any community."



Be sure to check out the SCC profile video: bit.ly/CCCM_SCC

STUDENT VOICE

FROM STUDENT TO ENTREPRENEUR: HOW SAC CITY MAKERSPACE LIT THE PATH

BY MICHELLE ZAMORA, SACRAMENTO CITY COLLEGE



When I graduated Cal Poly, I moved home and was getting all these odd jobs. I remember working at Farm Fresh to You selling vegetables door to door and thinking, “What am I doing with my life? I just graduated a four-year university, and here I am.” I had earned a degree, yet I still didn’t know what I wanted to do with my life. I also remember wishing there was some sort of space with tools and video/camera equipment and computers where people could explore what they wanted to do early on. I came home and wrote about it. That was four years ago.

Around that time, I started taking design courses at Sac City College. My last semester there, Tom Cappelletti, Design and Digital Media professor and current Studio Design instructor, introduced the CCC Maker grant, during our first studio class. I immediately jumped on board because I remembered having a similar concept idea years ago. I felt that having a space where you could explore your talents and your creativity was necessary to know what you want to do in life. That’s why it’s so close to my heart.

In the past year, our makerspace team at Sac City has created a space where students from every walk of life can feel at home and make things. I’ve watched

as the core team slowly got to know each other—the kind of getting to know a person that only comes from working closely with them, the kind you get by observation and sheer time spent with one another.

*“I remember thinking,
‘I can make, literally,
whatever I want!’”*

What we learned in the first year of making a makerspace was this: We care. We weren’t afraid to get our hands dirty. Everyone involved in this project worked, for the most part, for free. There was a task at hand and the people who happened to be in the midst of the whirlwind of the Maker Movement on Sac City’s campus jumped at the opportunity to help. Whatever needed to be done, someone knew how to do it, and if we didn’t, we learned how.

Trainings on the machinery were down and dirty. While it may not have been the most official way of doing things, we eventually learned how to use the machines—by making things. And when one of us learned one machine, either together or by ourselves, we would show the next person how it was done. It was a ripple effect.

The laser cutter was the first machine I learned how to use. It’s a very “oo-ahhh” kind of experience when you first see what it can do. And as a creative, watching its capabilities made my mind go wild with possibilities. I remember thinking, “I can make, *literally*, whatever I want!” Obviously, that’s not true with just the power of a laser, but that’s what it felt like when I first saw the light.

After about three months of unpacking and labeling and trying to make the physical space look orderly, we opened our doors to the campus community. We poster-bombed the campus to make sure we were doing our part to spread the word about the space and its offerings. The people who knew about makerspaces walked by and saw a sign or knew someone who had been in. By the second week of the fall semester, we already had over 200 members signed up, and we had return makers every day.



Mostly our deficits were supplies and expertise—organizational, business, marketing—but we all pitched in and did what we could. The students didn’t seem to mind—they were just extremely stoked about the new space and excited about what they could make and how they could grow their businesses using the space and tools. I was happy to teach them anything I knew and so were the rest of the entirely student-run staff, who had themselves *just* learned how to operate most of this machinery.

As the whole process of becoming involved in the makerspace movement has unfolded, it was natural for me in the beginning to document our process. Everything was just so new, and I wanted the world to see the work we were putting in to make this happen. My first movies were filmed on my iPhone, interviews were impromptu, and lighting and

audio weren't a thing I spent much time thinking about. I just wanted to capture people making because it was happening so often all around me.

I've been fortunate enough to use and hone my storytelling skills to create a business for myself. With the support of our CCC Maker grant and networking in the makerspace, I've surfaced from this experience with new direction and new

opportunities for my career, and I can't be more grateful for the space and the people who helped me along the way. We built a place that allows for making. In that, we succeeded, and there's still so much work to be done. We must work together to sustain powerful environments like these.

“Everything was just so new, and I wanted the world to see the work we were putting in to make this happen.”

CASE STUDY



SIERRA COLLEGE EXEMPLIFIES POSSIBILITIES OF ACCESS AND EQUITY THROUGH COMMUNITY PARTNERSHIPS AND OUTREACH

“Whether on campus, in the makerspace, or in the community, we encourage people to join, learn, grow, and make a better life for themselves. We don’t give up on people.”

—HEATHER LINCOLN, CREATIVE CONSULTANT FOR SIERRA MAKERSPACES

Sierra College is unique among the CCC Maker community colleges in that it includes three campuses (Rocklin, Truckee, and Grass Valley) spanning four Northern California counties, covering roughly 3,200 square miles. What’s more, not only do the Sierra

College campuses feature their own mini makerspaces, but the institution has successfully formed partnerships with three pre-existing community makerspaces—Hacker Lab, Curious Forge, and Truckee Roundhouse—to create an impressive network of possibilities.

These partnerships exponentially multiply offerings and access for Sierra College students, as well as create a viable bridge between students, local maker communities, and area industry. This network of makerspaces is showing what’s possible when a college embraces and supports the local maker ecosystem. By virtue of covering such a large and diverse geographic region, one of Sierra College’s main focal points has been



offering hands-on learning opportunities to the entire range of student and broader community demographics.

SHARED PASSION OF THE MAKERSPACE TEAM

The core makerspace team at Sierra is entirely comprised of people who deeply believe in the transformative potential of makerspaces, making them passionate and empathetic advocates. Team leads Steve and Louisa Hunter, who bring a combined 80 years of experience in professional and educational hands-on fields, have been involved in the Maker Movement long before the CCC Maker Initiative and are fervent proponents of the benefits of experiential learning. Steve Hunter explains how years ago, “School boards canceled our vocational programs because they were expensive, had high liability, and required lots of space. Now we have generations who haven’t had hands-on experiences through their education. It’s not natural or conducive to good learning process. Human beings didn’t learn life skills without related kinesthetic activities. Curriculum-based kinesthetic activities must be brought back into the classroom at all levels.” And makerspaces are natural bridges for this.

Learning through doing has not only been shown to yield deeper subject understanding, it’s also proven effective for students who might not otherwise be engaged or succeed. Hunter notes one math course at Sierra that integrates

“Because it’s hands-on, because it can be related to something students see every day, it makes sense to them and they progress through that class in a much more successful manner.”

building and experimentation to teach math concepts. For example, second order quadratic equations are taught using the construction and launching of catapults. The class, which was specifically designed for at-risk students who’ve never been successful in math, has an exceptionally good completion rate because of the level of engagement. Hunter explains, “Because it’s hands-on, because it can be related to something students see every day, it makes sense to them and they progress through that class in a much more successful manner.”

Denise Bushnell, a full-time faculty member in the Business and Information Technology departments, grew up in an entrepreneurial family with a father who was a self-taught inventor and engineer. She shares, “I saw the need for a shift in the way that we do education, and we have such an opportunity in the community college environment. It just made sense to me.” As the chair of the Career Technical Education Committee, which is part of the Academic Senate, Bushnell has been an ardent evangelist for makerspaces.

Sierra Makerspaces creative consultant Heather Lincoln, who helps faculty and students become familiar with the makerspaces and get comfortable using the tools, credits the makerspace for the inspiration to finish her degree. She shares, “The Sierra Makerspaces team encouraged me to finish a goal that I hadn’t made a top priority. Joining the makerspace made me part of a bigger picture. I could just be an artist and make things by myself, and that’s fine. But being part of this team has really made me stick with it and encourage others to get into the whole maker mindset.”



Makerspace student ambassador Sebastian Romanet was studying mechatronics at Sierra College but was planning to drop out and attend trucking school before he was introduced to the Hacker Lab powered by Sierra College makerspace. The community helped him realize his talents and pursue his passions (read his personal essay on page 44). Romanet shares, “This is the kind of place that I’ve always imagined, where I could go and experiment. When I was a kid, nothing like this existed, so it’s good to know that it’s here now and I can do something to help make it successful.”

As an ambassador, he does outreach to students and faculty, visiting classes to spread the word about the makerspaces’ offerings. He notes, “I get to see the whole process, from the first time I see a student in a class I visit all the way up to seeing them in the lab working on something that they’ve been inspired and motivated to create. It’s all about showing people what’s available and that it’s okay for them to try.”

COMPREHENSIVE OUTREACH AND EVENTS

The Sierra College makerspace network turns the phrase “build it and they will come” on its head. Instead of building full-scale spaces from scratch for each campus, partnering with pre-existing area makerspaces enabled them to tap a readily available resource, complete with ties to the local community. And instead of waiting for the community to discover the network, the Sierra Makerspaces team developed a robust outreach plan that features a wide variety of events—including ones that are multi-generational, student-focused, and geared toward faculty professional development—to appeal to the broadest audience.

Everyone is encouraged and welcome in the makerspaces, and that’s reflected in everything from the marketing material to the most valuable asset: the people who work in the spaces. As Lincoln notes, “The people involved are very intuitive, and they’re ‘people people’ so we see attributes in people they don’t necessarily see in themselves,



and we draw them out.” She explains that oftentimes people don’t see themselves as makers or have confidence that they can participate in the activities going on in the makerspaces. One icebreaker technique used is to create small projects for newcomers to tackle so they’re not overwhelmed by the volume of tools in the space.

PROFESSIONAL DEVELOPMENT FOR FACULTY

Mathematics professors Katie Lucero and Lynn Harrison-Benavidez developed and led a three-day professional development workshop at Hacker Lab powered by Sierra College, to introduce faculty and staff to the concept of making and the offerings of the space, so that they may consider how to incorporate hands-on projects in their curricula. As Steve Hunter points out, “You don’t want to shove maker activities down somebody’s throat who has never experienced maker activities and expect that they’ll see the light as to how it will help their students. That doesn’t work.”

Instead, the first two-thirds of the seminar were spent doing fun projects that participants got to take home with them, lowering the barrier to entry and creating a sense of ownership. Hands-on activities progressed from familiar, analog projects like making candles to learning how to use the laser cutter. Only on the final day were they asked to develop a hands-on activity that would help their students learn. The results were impressive, with faculty from a wide range of disciplines coming up with an array of activities. A member of the History department, for instance, developed a fabric collage project representative of clothing from the Colonial Era. Faculty Maker Nights are also well-received, and the intentionally relaxed, informal atmosphere encourages participants to feel at home in the space.

MULTI-GENERATIONAL EVENTS FOR THE BROADER COMMUNITY

To appeal to the broader community beyond students and faculty, the Sierra Makerspaces host large-scale, all-ages events open to everyone. Holiday-themed making sessions, such as Spooktacular, as well as Family Maker Night—where the space is set up with a multitude of maker stations as an invitation to do projects—have been quite successful.

Another big draw has been a collaboration with the Arts Council of Placer County called “Reinvent the Runway” which features a runway show of community-made fashions crafted of reclaimed materials. And outside of the makerspaces, hosting exhibits at the Rocklin Mini Maker Faire, Maker Faire Bay Area, and the Maker Show at



Truckee Roundhouse helps to inform the community of the possibilities that await them at the Sierra College makerspace network.

Beyond hands-on experiences, yet another way that Sierra Makerspaces have supported equity and diversity is by hosting a symposium of women in STEAM (science, technology, engineering, art, and math) fields. During this illuminating panel discussion, 11 women of varied backgrounds, cultures, and professions shared perspectives and experiences. The common underlying thread is that they're all makers. When students see themselves in a mentor or role model associated with making, their view of what's possible shifts.

As creative consultant, Lincoln helped kickstart a Girl Scouts program in the

makerspaces, developing curriculum for the Girl Scouts to get exposure to making and earn STEAM skill badges. She shares, "I'm proud of the inspiration I've been able to give people. What I've enjoyed most is seeing someone's eyes light up after they get a concept or move past a hurdle, when they were hesitant to consider themselves makers."

FINAL THOUGHTS FROM THE FIELD

Through the engagement of faculty members, students, and community partners, Sierra Makerspaces enabled the college to explore new ways of teaching across disciplines and incorporating the entrepreneurial mindset into curriculum. As a result, students have enjoyed the freedom to explore their career interests and gained the confidence and tools to fuel their passions. Denise Bushnell notes, "From a faculty perspective, being able to offer students opportunities that traditional education doesn't provide and give them options and abilities that they may not have considered is important. To see them blossom because it's different and tactile and they have something to show for it is really what it's all about. I think we've just scratched the surface of what we can do." Moving forward, the Sierra Makerspaces team is committed to providing students with authentic experiences that put them on a direct path to rewarding careers that empower them personally, socially, and economically to impact their communities.



Be sure to check out the Sierra College profile video: bit.ly/CCCMsierra

FINAL THOUGHTS FROM THE CCC MAKER TEAM

The voices in these narratives come from across the entire CCC Maker ecosystem, and they capture the lively conversation that has accompanied this initiative. The willingness of these students and project teams to share their stories represents a commitment to the foundational principle of the CCC Maker Initiative—that it is a deliberate and intentional creation of community around the principles of empowerment, access, and equity.

These case studies and essays also tap into an ongoing conversation across the network, about the future of work and our responsibility to our students to prepare them for an uncertain and rapidly changing future. In this way, the sustainability of the makerspace programs at these colleges is directly tied to the current and future success of our students in their career, civic, and personal lives.

The CCC Maker leadership team has been privileged to work with so many dedicated professionals over the course of this three-year initiative. We celebrate the work of these college communities and anticipate the success of the work yet to come.