

# Growing A Network of Makerspaces in California Community Colleges: Moving Towards Implementation and Adoption

Carol Pepper-Kittredge<sup>1</sup>, M.H.R.O.D., B.S., Deborah Bird<sup>2</sup>, M. Arch, Dip. Teach.,  
Brie Lindsey<sup>3</sup>, Ph.D.

<sup>1</sup>Carol Pepper-Kittredge, Project Manager, CCC Maker, Sierra College; e-mail: cpepper-kittredge@sierracollege.edu

<sup>2</sup>Deborah Bird, Technical Assistance Provider, CCC Maker, Pasadena City College; email: dabird@pasadena.edu

<sup>3</sup>Brie Lindsey, California Council on Science and Technology; email: brie.lindsey@ccst.us

## INTRODUCTION

The California Community Colleges (CCCs) serve 2.1 million full- and part-time students, making it the largest system of higher education in the United States [1]. Students who attend CCCs have a variety of educational goals, as well as demographic and socioeconomic backgrounds; they represent the state as a whole, from those who want to quickly up-skill to remain competitive in their current but evolving careers, to those who intend to transfer to a four-year institution to earn a bachelor's degree or beyond, to continuing students who have already earned a degree and want to explore other career pathways. One way the CCCs are fulfilling their mission of providing quality, relevant education to this broad spectrum of learners and to prepare students for high-value jobs across California is by engaging in the Maker Movement via the CCC Maker initiative [2]. As presented at ISAM 2016 [3], the California Community Colleges Chancellor's Office has invested \$17M to grow a statewide network of CCC-based STEM/STEAM-focused makerspaces. The process of designing and implementing a network of makerspaces at a large scale and across a complex array of communities with different needs and goals has proven a tremendous learning experience so far. As we continue this work, we are glad for the opportunity to share what we have learned with other teams—ideally made up of various stakeholders from administrators, faculty and staff to students, business owners, and other community representatives—envisioning their own larger network of makerspaces, be that a collection of different makerspaces across a single campus [4]; makerspaces linked throughout a single community from K-12 to college, and beyond to industry-based or informal learning environments [5]; or makerspaces built across other statewide educational systems, for instance as the California State University system is preparing to do in the near future [6]. This paper describes the 2017-2018 CCC Maker Implementation Phase with 24 colleges (of 114 total), including tools and resources used to support and document their work, and shares lessons learned along the way.

## BACKGROUND

The CCC Maker initiative is a three-year effort to establish a statewide network of makerspaces throughout the CCC system, in order to meet the ultimate goal of enabling students to embrace the evolving innovation economy in California and beyond. The project is led by a team of workforce development specialists; faculty; strategic planning, communications and marketing professionals; and special service providers; all informed by a diverse advisory committee

representing education, research, industry and the maker movement at large. Of the 114 colleges in the state, 62 colleges have engaged in aspects of the initiative—with 34 awarded some amount of funding—which indicates the high level of interest throughout the state and illustrates the potential for impact even beyond those 24 colleges ultimately awarded continued funding after a competitive bid process. Recognizing the reach this initiative—which is intended as a catalyst for the makerspace network, not an ongoing mechanism for support—may have on a broad array of stakeholders, the leadership team posed five overarching value statements to guide the network as it emerges and grows [Table 1]. Continually revisiting and working toward these ideals is crucial as the noise of the great number of daily tasks required to create and coordinate such an undertaking—with its scale, scope and complexity—could easily drown out the signal of the overall mission: to create a broad and inclusive environment to support the development of creative, innovative, and resilient students who reflect all of California.

The details and outcomes of the first phase of the initiative, a six-month-long “lean launch,” were presented at ISAM 2017 [7]. During this phase, the leadership team encouraged participating college teams to consider four main areas of focused development for the duration of the project, the outcomes by which the project would be measured: *community of practice*, *work-based learning*, *curriculum*, and the *makerspace* itself. Accordingly, teams were selected for continued funding based on the strength of their unique implementation plans, formulated through a Design Thinking process [8] which included an ecosystem map of their local and regional partners and resources; a logic model, showing the rationale, time frame, and long term impact of the project; an institutional self-study, to critically evaluate current

Table 1. CCC Maker Value Statements

Through the CCC Maker Initiative, and the creation of a network of California Community College makerspaces, we aim to:
1. Create a culture that evolves by embracing risk and failure, open source, and re-invention
2. Build connections within and beyond the CCC Maker network to accelerate the adoption of makerspace culture and educational integration
3. Tell our story to share knowledge and inspire innovation
4. Improve makerspace access for underserved and underrepresented populations to empower all students to achieve educational, career and entrepreneurial goals
5. Redefine what it means to be ‘well educated’

institutional data, campus climate, and student needs; a work-based learning strategy to create an internship pipeline; and lessons learned from a community-building event that engaged students, campus stakeholders, and the community.

A Technical Assistance Provider (TAP) was designated to provide assistance to the college teams both individually and as a group. The TAP, part of the CCC Maker leadership team, is largely responsible for devising strategies and tools to realize the innovative vision of the initiative. The TAP delivers crucial guidance to college teams on navigating cross-campus policies such as curriculum classification and approval processes, work-based learning liability issues, and fiscal and contractual procedures, as well as managing many of the day-to-day tasks associated with network formation, including goal setting, communication, ongoing evaluation, and coordinating with special service providers to bring in additional resources. Beyond providing practical support, the TAP also ensures teams are focused and motivated through an oft-difficult process of experimentation and discovery.

### IMPLEMENTATION

According to research on the diffusion of innovation and adoption within organizations [Figure 1], groups adopt new behaviors or ideas after deciding for themselves that the new concept has merit—adoption is not forced through by single entities, but “soaked up” by a group over time. [9] With this in mind, the leadership team has now shifted operational strategies. Whereas the first phase featured technical assistance that was more generic, process-oriented, and aimed at all participating colleges to establish a baseline of knowledge across the network, subsequent phases increasingly rely on a collection of activities and resources tailored to fit each college’s organizational structure, culture, community, and goals. Compared with the lean launch phase, the TAP’s role in the implementation phase has shifted towards facilitative. For instance, whereas colleges were initially tasked with examining their institutional data for startup plans, implementation quarterly reports to the leadership team inherently require deeper analysis of self-generated data. And while teams were instructed during the lean launch phase to design a student-centered making activity (which was informed by TAP-coordinated and -delivered resources and evaluated as part of the application for implementation funding), teams have since been expected to take those lessons learned to independently design events based on feedback from their communities. This shift has empowered colleges to take ownership of the process, an essential step toward building programs responsive to their own communities’ needs.

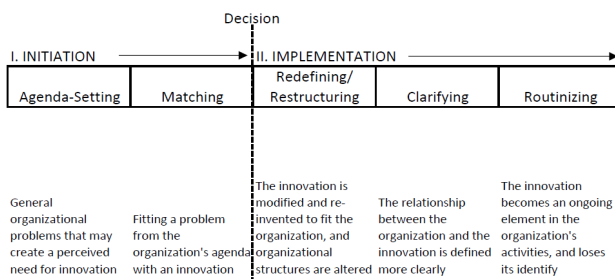


Figure 1. Initiation to Implementation

**Implementation kickoff.** The implementation phase officially began in August 2017 with a 2-day kickoff meeting of 67 project team members representing the 24 colleges awarded implementation funding. The first day was devoted to internal work. The second day, invited experts shared their work on various aspects of academic makerspaces. At this meeting, the college teams were informed of the shifting role of the TAP—from one of proscriptive guidance at the individual level, to an on-demand model focused on empowering college teams to address specific, complex college issues resulting in work plan modifications, schedule changes and budget reallocations. The gathering also brought the network together to celebrate successful implementation proposals, share initial plans, and engage in hands-on design thinking activities [Fig. 2].

At this meeting, colleges were challenged to address a difficulty familiar to many who have begun to build makerspaces in established educational systems: how to embed a space that thrives on a culture of collaboration and communication, risk-taking and failing, adaptive iteration and rapid prototyping, within a system that is inherently resistant to these very qualities. Like many large systems, California’s CCs have a good deal of bureaucracy as a result of being public entities with extensive oversight, numerous disparate stakeholders, rapidly changing communities to serve, and the administrative and disciplinary siloing frequently found in many educational institutions. The complexity and the resistance to change commonly encountered in such organizations necessitates enthusiastic champions who understand how the system works—from policies at the CCC system level to politics *within* each respective college.

For a network of makerspaces to take root and thrive within a large system, not only must team leaders become these champions on their own campuses, but colleges must also enact change system-wide. In order to support these teams as change agents, the leadership team employed strategies popular in Silicon Valley [10]. College teams that had been led through a design thinking process, where they explored the creation of a makerspace as a solution to their college problems, were now challenged to refocus on the network, and determine what the network should become.

Approaching the system as a series of scalar problems that could be solved by a network of makerspaces—mirrored in each team’s approach to their unique college’s system—has turned out to be a fruitful way to frame what at first blush is an intimidating and unwieldy project. This framework has also been empowering for the college teams, who were directed to look at building a makerspace as a *solution* to problems they want to solve within the system, rather than as an obstacle itself. This mindset, coupled with a conscious effort to adhere to the values outlined in Table 1, have helped to guide more holistic efforts toward each of the four outcomes than would have been possible otherwise.

**Implementation Toward Outcomes.** The four main outcome areas of the project— (1) community of practice, (2) the makerspace, (3) internships/work-based learning, and (4) curriculum—relate to each and every value outlined in Table 1. A clear illustration of this comprehensive linkage is

communication; across all outcomes, different forms of communication (“Tell our story”) are critically important.

In building and informing the (1) community of practice, sharing knowledge and stories of success and failure has inspired other teams and allowed the network to learn together. Early adopters telling stories of widely positive student and faculty responses to emerging makerspaces across the network—norming the practice—increased institutional support in places where there had been little before.

Telling stories of how college (2) makerspaces are developing has informed other network members about tools, techniques, and space considerations they could build into their own spaces and about the need and ways to market makerspace programs and events to bring in more participants.

The (3) internship outcome requires skillful communication, in the form of outreach to employers and students, sharing experiences with peers to convey the value of a work experience through the makerspace, and to encourage networked engagement at the regional level. The development of (4) maker-based curriculum, both within each college and across the whole network, benefits from interdisciplinary communication that facilitates rapid transmission of best practices, improves relevance and encourages creative experimentation. Finally, because this initiative is a three-year starter program for the network, telling college stories about how the network is collectively impacting California will be crucial for gaining ongoing support and sustainability.

Another important aspect of all outcomes is fostering appropriate mindsets, early. The transmission of beneficial habits of mind was achieved via the power of mantra. Following the example of Noisebridge, a San Francisco-based makerspace the leadership team toured while defining the vision for the network, and which takes as its motto Bill and Ted’s “Be excellent to each other,” [11] the team developed several mantras for aspects of the project outcomes. The leadership team, and especially the TAP, deliberately started with Design Thinking language, repeating these mantras at every opportunity and through various forms of communication.

To make progress in the four outcome areas, the TAP worked with each college to provide resources that both fit each college’s needs and also adhered to the value statements of the overall initiative. Many tools and strategies that were first tested out in the startup phase were continued and augmented in subsequent periods as colleges became more involved in their projects. The full suite of components employed to help college teams achieve the four project outcomes deserve a publication of their own, and indeed CCC Maker, with MakerEd, recently developed a startup guide based on CCC Maker’s experience [12]. For brevity, each outcome area will be presented below in terms of its primary network-defined problem statement, the overarching strategy to solve it, the value statements that are most closely associated with the chosen strategy, and a selection of tools, activities, habits of mind, and resources shared with the colleges to support their work.

*1. Community of Practice.* The overarching strategy from the beginning of the initiative has been “Community First,” as the leadership team agreed at the outset that none of the



*Figure 2. College teams get hands-on at meet-ups. The hard work of building the network is offset by the fun had while making.*

outcomes would be achievable or sustainable without a thriving community to meet them. This strategy, and the notion (mantra) that “We Are All In This Together” have permeated the project in all outcome areas, most clearly in the formation of the com-

munity of practice, at all scales. This strategy was chosen to directly address the challenge common to many large educational systems: isolation, both within colleges (silos disciplines) and between colleges across the state, all embedded in a risk-averse culture that resists change. Value statements 1 and 2 [Table 1] most closely align with this strategy, so resources and tools to grow a culture of sharing and risk- and failure-tolerance were shared with colleges to build connections within and beyond the network. These tools largely revolved around different ways to share information. Indeed, another mantra for this outcome has been, “If you don’t share it, it doesn’t count.”

Webinars (via Zoom) have been the preferred way to share research, strategies, and training from leadership and various service providers to the entire network, and are available on the CCC Maker website. Additionally, college expertise is recognized through college-led webinars that are a valuable resource to the rest of the network. Workplace by Facebook is a team collaboration tool that has allowed colleges to share events, curriculum under development, student projects, equipment demonstrations, and operational issues. Other sharing platforms include full edit access to ccmaker.com to develop content meant for broadcast beyond the network, including links to college makerspace websites, activities, and social media; press release templates; and social media training. Meet-ups, in the form of regional and statewide symposia and workshops, professional development events, and convoys to Maker Faires, are welcome activities that strengthen community. And whereas early symposia were designed to showcase makerspace research and facilities outside of the network, as the initiative matures, these events are more often planned in coordination with select CCC Maker colleges, helping participants to appreciate and learn from the breadth of expertise within their own network.

*2. The Makerspace.* Building a makerspace from scratch can be an intimidating process, especially when one doesn’t know what to build. Early in the initiative, many teams pictured a makerspace as an inaccessible and uninviting lab room full of intimidating equipment. Further, some teams had difficulty securing space right away, experienced construction delays, or were constrained by facilities limitations. To combat these obstacles, the strategy reframed the problems through design thinking, to recognize that the success of a makerspace depends largely on who uses it, and that

many maker activities can be conducted with provisional makerspace resources such as mobile carts and popup spaces. These strategies map to value statements 1, 3, and 5; communicating with the eventual users and making the space welcome to them became the focus for many teams. Helpful mantras for this outcome are, “Everything is a prototype” and “The only thing you can do wrong is nothing”.

The resources that proved useful under this outcome were a mix of research presentations via webinar, symposia, and professional development events. For instance, CCST has summarized highlights from ISAM conferences each year, bringing space design lessons from the entire academic makerspaces community to the network. In addition, they have provided a research-based discussion of equity and access in the maker movement, especially related to makerspace outfitting and messaging. Symposia and other meet-ups always include a tour of the host institution’s makerspace. As more CCC Maker colleges open their makerspaces, virtual makerspace tours will become common. Again, sharing operational and equipment tips and projects on Workplace and in blog posts on [cccmaker.com](http://cccmaker.com) are ways colleges document their makerspace progress.

**3. Internships/Work-based learning.** There is a disconnect between academic and career learning experiences, which can be an obstacle for connecting potential employers to CCC educational programs. The strategy to address this issue was to frame work-based learning opportunities as integral to informed academic and career planning, and essential to solving employers’ workforce needs. Value statements 3 and 5 relate well to this strategy, and the focus has therefore been on targeted outreach to employers and students, as well as communicating the importance of 21st century skills [13], growth and entrepreneurial mindsets. Teams were reminded to seek opportunities to create “relevant and authentic learning experiences” for their interns. In addition to providing network-wide informational webinars about payroll and contracting processes, the TAP has worked individually with each college to help navigate the various organizational structures that impact internship programs on different campuses. In response to the broad range of campus-specific funding issues and policies related to internships, the TAP has expanded the definition of an appropriate work-based learning model beyond the traditional off-campus internship to include: makerspace-based team internships solving employer-defined problems, and employer-sponsored intensive maker workshops based on the ‘hack-a-thon’ model. The TAP is currently developing a guidebook that describes the processes and advantages of team-based internships to be shared with stakeholders across the network.

In addition to the TAP’s consultations with individual colleges and the network at large, symposia have been held to bring together student interns, faculty, business intermediaries, industry representatives, and CCC Maker colleges who have already found success in implementing their work-based learning programs. Events such as these allow those with expertise to share with the rest of the network best practices and suggestions for success, as well as directly align makers with workforce development.

**4. Curriculum.** Academic makerspaces have the potential to

integrate the maker ethos into curriculum development, yielding culturally relevant, interdisciplinary, applied learning experiences that emphasize creativity, discovery, and the process of learning over the final result [14]. Realizing this potential is challenging because a maker-centered curriculum is at odds with what is currently practiced in many institutions: a siloed, theory- and content-based manner of instruction which is meant to lead students to predetermined solutions to sometimes irrelevant problems. Value statements 3 and 5 relate to these issues, and therefore require a strategy to focus on expanding the definition of “well-educated,” and communicate the value of applied, interdisciplinary, soft skills and lifelong learning. Accordingly, teams are beginning to think and speak of a maker curriculum as a holistic learning continuum, incorporating both formal and informal activities ranging from single activities or training sessions to workshops, to courses, to entire programs of study. To help teams keep this spectrum in mind, leadership often uses the mantra, “Everything is connected.”

Tools to support work in this facet of the project included professional development to help teams devise multilayered learning outcomes embedded in a real-world context. In addition, symposia and webinars presenting practice and research on curriculum development have been delivered to the network, and workgroups are currently forming to work collaboratively on interdisciplinary curriculum. Colleges have tested new curriculum ideas in workshops and through experimental courses while developing formal curriculum or starting the protracted curriculum approval process.

**Reporting.** Reporting requirements in the CCC system are traditionally compliance-oriented, closed to the public and *summative* in nature. In contrast, the CCC Maker initiative established a support-based, open-access reporting system intended to provide *formative* feedback in real time. Colleges submit both qualitative and quantitative data quarterly to show development of their programs; reports include a description of progress, a success story and a current challenge related to each outcome, and 17 key metrics developed by the TAP [Table 2].

The utility of such reporting is four-fold. First, both qualitative and quantitative data are useful for formative assessment, both by the college team and by the TAP, who may provide specific suggestions or resources based on trends seen in a college’s reports over time. Second, leadership can assess the value of tracking various metrics as the project progresses, and make adjustments as necessary. Third, all college teams can see their progress within the network via the data dashboard on the CCC Maker website, where they can view data in aggregate, or parsed by college or metric. Finally, data recorded throughout the startup and implementation phases will help colleges communicate the value and impact of makerspaces on their campuses to attract funders and meet the eventual goal of becoming self-sustaining. Moving from the ‘rearview mirror’ of lagging institutional data to a forward-looking model of actionable real time data is an ongoing process. CCC Maker is still in startup mode, and therefore the network is still working to define the most useful metrics and coaching college teams to ensure data integrity. Rigorously describing trends across a wide range of

colleges is not yet appropriate. However, it is clear that a rapid acceleration of activity is occurring. The ecosystem size has almost doubled, with substantial increases in student, faculty, and employer participation. The expansion of facilities is also contributing to the growing internship pipeline, increased curriculum development, and proliferating makerspace activities. With the short time frame, the primary goal of data analyses will be to build institutional support and network sustainability, and to demonstrate benefits.

### OBSERVATIONS AND CHALLENGES

Growing a network of makerspaces across the CCCs has been rewarding and challenging in equal measure. Many lessons learned relate to the importance of community, emergence, and leadership in developing the network.

**The importance of a “Community First” strategy from the outset cannot be overstated.** The success of colleges who actively engage their local ecosystems and the network is a testament to the power of collaboration. Not only is the ecosystem a vital source of champions, in-kind resources, and feedback about how to build a makerspace that is relevant to the community it serves, it is also a potent tool for developing a sustainability model. At their April 2018 meeting, the initiative’s statewide advisory committee suggested using their ecosystem map as a “customer resource management” tool, and made clear that employers need to hear student stories and understand the human potential for creative talent that comes out of the makerspace environment. CCC Maker colleges can become “solution centers” for employers—a community asset to increase their competitive edge as well as a talent touchstone for future workforce. This idea is a challenge, as it is a new way of doing business for educators. Models such as maker apprenticeships should be explored as possible solutions for replication, including community-based apprenticeships [15] [16] and business-led apprenticeships [17] [18].

By far the most powerful and preferred activity for communication among network members has been the various meet-ups coordinated by CCC Maker leadership and various service providers. Face-to-face opportunities plainly encouraged deeper and more enthusiastic discussion and collaboration. In-person events create a stronger sense of community that is not as readily achieved electronically, even with video web-conferencing platforms such as Zoom. Comfort and mutual respect gained at these events can help foster a culture of inclusion, sharing, and risk tolerance.

**Emergence is success.** As the initiative matures, leadership has continually reevaluated what success really looks like. It has become clear that supporting the emergence of diverse structures and activities at various scales is more productive than trying to force the network to achieve a predetermined outcome. In other words, leaders must let the network grow organically. Further, signs of emergence should perhaps be recognized as a tipping point, a signal to leadership to step back and let the network *happen*. For instance, one example of this tipping point in practice at the makerspace level might be student staff offering workshops without direction from makerspace coordinators.

A beautiful illustration of an emergent structure on a larger

**Table 2. CCC Maker Metrics from Q1-Q3 [19]**

Community of Practice	Q1	Q2	Q3	Total
Professional Development Activities	48	99	93	<b>240</b>
Blog Posts	31	68	90	<b>189</b>
Faculty Engaged - Cumulative	8	312	395	<b>395</b>
Elements in Ecosystem - Cumulative	1673	2509	3056	<b>3056</b>
Employer Matching Hours	426	36	798	<b>1260</b>
Volunteer Hours	0	2657	1385	<b>4042</b>
Matching Funds (in \$)	-	-	-	<b>1.9M</b>
<b>Makerspace</b>				
Engagement Activities	191	249	521	<b>961</b>
Total Students in Makerspaces	2682	2300	4963	<b>9945</b>
Student Hours (Average)	-	-	-	<b>(3:49)</b>
Badges	81	71	258	<b>410</b>
<b>Internships</b>				
Employers recruited - Cumulative	104	134	167	<b>405</b>
Students Recruited for Internships	70	144	274	<b>488</b>
Students in Pre-Placement Training	32	95	154	<b>281</b>
Students Completing Internship	0	2	38	<b>40</b>
<b>Curriculum</b>				
Courses Accessing Makerspaces	181	114	167	<b>422</b>
Advisory Meetings	41	35	40	<b>116</b>

scale within the network is the formation of regional sub-networks that share resources and connections while balancing complementary expertise. One such example arose in the Sacramento area, where two established college makerspaces, HackerLab Powered By Sierra College and the Folsom Lake College Innovation Center, closely supported a new startup makerspace at Sacramento City College (SCC), and conducted related workshops at other colleges in the region. As another example, a trans-regional network emerged northwest of Los Angeles, comprising a group of colleges with complementary strengths. The group gained partnership-building experience from alliances between Allan Hancock College and local partners, creative adaptations for pop-up makerspaces from Moorpark College, and strong employer relationships held by College of the Canyons. This collaboration led to an April Makerspace Festival involving 30 colleges and schools, which drew 2,500 people to the College of the Canyons.

Another example of an emergent characteristic that is essential to the success of the network is the establishment of the maker mindset, which happens over time and cannot be forced. Built on “Growth Mindset” research [20] where students accept risk, learn from failure, thrive on self-motivated learning, and practice unknown capabilities, the Maker Mindset democratizes learning and gives students “full capacity, creativity, and confidence.”[21] Colleges that implemented spaces based on traditional workforce development principles (training incumbent workers) or student success strategies (increasing the number of students earning a degree or certificate) have progressed more slowly than college makerspaces with shared student communities and open-source learning resources, aiming to develop maker mindsets in their students. In Santa Cruz, Cabrillo College has avoided the traditional defaults by actively bridging be-



tween the arts, sciences and technology. Initiated by Arts faculty and management, the makerspace implementation plan involved outreach to technology programs and liberal arts while unapologetically embracing the local motto to “Keep Santa Cruz Weird.”

**Leadership from mission-aligned internal and external stakeholders is necessary.** While this isn’t new information with regard to transformative change [22], the variation in leadership structures among the 24 colleges is striking. Colleges with unbalanced makeup (e.g., more heavily administrative, or primarily faculty-comprised) currently lag colleges that more fully engage diverse ecosystem partners in their implementation. A fruitful balance was found at SCC, which had envisioned a makerspace well before the CCC Maker initiative, but lacked support from its internal ecosystem. SCC’s project leader recruited faculty, students, and management through inclusive messaging, open house meetings, input solicitation, and delegation. SCC’s new space was secured as a result. Faculty are actively engaged in design thinking professional development, and students now largely manage the makerspace. As a unified entity, SCC was able to embrace the role of regional innovator, urban resource, and student empowerment center.

An entity that can support individual college team goals while also steering the collective toward achieving organizational outcomes is important. In this initiative, the TAP has been instrumental in filling this role and helping colleges realize the CCC Maker initiative goals by defining and meeting their own.

**Ongoing challenges.** A project of this size and joining so many diverse stakeholders cannot be without its challenges, of course. In an attempt to avoid overwhelm and give teams the confidence to start iterating immediately, the TAP’s curricular focus has been largely on badging and soft skills development, rather than on a more holistic view of curriculum; this feels shortsighted in retrospect. The narrow focus and need to provide more background *before* tackling curriculum resulted in a slower development of maker-based curriculum than anticipated. Despite this delay, a small number of colleges have tremendous expertise in this area and will lead from within. [23]

Perhaps the most troubling challenge is the persistent inability to reflect the diversity of the CCC communities in the makerspaces, despite recognition of the value of including underrepresented populations, the conscious intention to be inclusive, and the relatively high percentage of these populations that attend CCCs. Diversity clearly impacts prosperity, as “companies in the top quartile for racial and ethnic diversity are 35 percent more likely to have financial returns above their respective national industry medians.” [24] At this point in the initiative, it is clear that simply valuing diversity and equity is not enough to ensure it. While some colleges are finding success, the goal of a broadly inclusive network is not yet being met. Looking forward, the network might learn from the successful CCC Maker model colleges. For example, the mature makerspace project at Sierra College consciously maintains diversity in both project management and student leadership with two women assigned as

student-makers-in-residence. City College of San Francisco is beginning discussions on campus through professional development based on research into equity and access in the maker movement, and is just beginning to implement strategies. SCC, on the other hand, has focused considerable effort and communications on inclusivity to reach economically challenged students who are disproportionately from underrepresented student populations.

Finally, though the focus of the CCC Maker network has been on creating community since its inception, not all teams participate fully in growing the network—for instance, neglecting to attend events, document projects, or maintain regular communication with other network members. Mandating specific types of participation will not create the community bonds that are both the necessary foundation for success and success itself. Recognizing this gap, leadership is beginning to employ various motivational strategies based on social rewards and recognition to increase participation.

With little more than one year remaining in the initiative, and with a relatively small leadership team, the need to plan for a productive legacy for the initiative creates pressure. The leadership team believes that, in keeping with an iterative process, the initiative is a prototype that must yield its lessons then be reset for further exploration. With such a short time remaining, colleges must work quickly to achieve institutionalized sustainability for their makerspace systems. To mitigate the possible loss of funding, the leadership team is exploring ways to support the network as a whole beyond the end of the funding period by supporting and empowering colleges to mentor their neighboring colleges and K-12 systems as demand for makerspaces continues to grow. The next generation of CCC makerspaces will be informed by the lessons learned and best practices of the early adopters of CCC Maker 1.0.

## CONCLUSION

The CCC Maker initiative is actively exploring innovative ways to prepare students for successful careers in a rapidly changing economy driven by accelerating technological change, diminishing real income, and the rising cost of college. Through a variety of strategies reflecting the initiative’s values, CCC Maker is growing a network of makerspaces to meet this goal. However, many challenges remain in the adoption of makerspaces in higher education: tensions persist between innovative and traditional educational practices, the democratization of learning promised by the maker movement cannot be fully realized until underrepresented students join the community, and some public institutions are reluctant to fully sustain makerspaces to support workforce development. In this atmosphere, the CCC Maker initiative is shifting practices and action from a compliance to a growth mindset. Colleges are supported to take risks, embrace failure, and leverage partnerships. The statewide advisory committee is guiding the initiative beyond its current scope and scale, to create an environment where businesses collaborate with CCC makerspaces to solve real-world problems and maximize our human and social capital. Our community embraces the transformative potential of this movement—its time has clearly come.

## REFERENCES

- [1] California Community Colleges Chancellor's Office. "Key Facts," 2018. Retrieved from [californiacommunitycolleges.cccco.edu/PolicyInAction/KeyFacts.aspx](http://californiacommunitycolleges.cccco.edu/PolicyInAction/KeyFacts.aspx)
- [2] California Council on Science and Technology, "Promoting Engagement of the California Community Colleges with the Maker Space Movement," 2016.
- [3] C. Pepper-Kittredge and P. DeVoe, "Creating a Network of Community Colleges with Makerspaces: California's CCC Maker Model," In *Proceedings of the 1st International Symposium on Academic Makerspaces*, 2016, Paper No. 47
- [4] M. Culpepper et al. "One Hand Washes the Other: Creating a Network of Makerspace Nodes from Disparate Units in a Large University," In *Proceedings of the 2nd International Symposium on Academic Makerspaces*, 2017, Paper No. 113
- [5] R. Mabry, S. Valery, and B. Lindsey. "Santa Maria's Central Coast Makerspace Collaborative: A Network of Internal and External Partners," In *Proceedings of the 3rd International Symposium on Academic Makerspaces*, 2018, Paper No. TBD.
- [6] C. Ayala, Dean of School of Education, Sonoma State University, personal communication, April 2018.
- [7] C. Pepper-Kittredge, P. DeVoe, and D. Bird, "We Are All In This Together," In *Proceedings of 2nd International Symposium on Academic Makerspaces*, 2017, Paper No. 115
- [8] T. Brown. *Change by design: How design thinking transforms organizations and inspires innovation*. New York: Harper Business, 2009.
- [9] E. M. Rogers. *Diffusion of Innovations, fifth edition*. New York: Free Press, 2003.
- [10] Y Combinator. "Startup Library," 2018. Retrieved from <http://www.ycombinator.com/resources/>
- [11] Noisebridge. "Noisebridge Vision," 2018. Retrieved from [www.noisebridge.net/wiki/Noisebridge\\_Vision](http://www.noisebridge.net/wiki/Noisebridge_Vision)
- [12] G. Mohammadi, "The California Community College Makerspace Startup Guide – Preparing Students for Jobs of the Future," 2018. Retrieved from <https://ccmaker.com/about/startupguide/>
- [13] Partnership for 21<sup>st</sup> Century Learning. "Framework for 21<sup>st</sup> Century Learning," 2007. Retrieved from [www.p21.org/our-work/p21-framework](http://www.p21.org/our-work/p21-framework)
- [14] K. Peppler, E. Halverson, and Y. B. Kafai, eds. *Makeology: Makerspaces as learning environments. Vol. 1*. New York: Routledge, 2016.
- [15] Creative Reaction Lab. "Community Design Apprenticeship Program," 2018. Retrieved from <http://www.creativereactionlab.com/community-design-apprenticeship-program/>
- [16] Made in Brownsville. "MiB Creative Apprentice Program," 2018. Retrieved from <https://madeinbrownsville.org/apply/>
- [17] Creative Alliance. "Apprenticeships," 2018. <https://creativealliance.org.uk/young-people/>
- [18] Adidas. "Apprenticeship at Reebok," 2018. Retrieved from <https://careers.adidas-group.com/teams/future-talents/apprenticeship-at-reebok?locale=en>
- [19] CCC Maker Initiative, "College Metrics," 2018. Retrieved from <https://scopewave.clicdata.com>
- [20] C. Dweck, G. Walton, G. Cohen. "Academic Tenacity: Mindsets and skills that promote long-term learning," Bill & Melinda Gates Foundation. 2014. Retrieved from <https://ed.stanford.edu/sites/default/files/manual/dweck-walton-cohen-2014.pdf>
- [21] Dougherty, Dale. "The maker mindset." In *Design, make, play*. Routledge, 2013. 25-29.
- [22] M. Tian, M. Risku, and K. Collin. "A meta-analysis of distributed leadership from 2002 to 2013: Theory development, empirical evidence and future research focus." *Educational Management Administration & Leadership* 44, no. 1 (2016): 146-164.
- [23] Z. Dowell and B. Lindsey. "Making Across the Curriculum," In *Proceedings of the 3rd International Symposium on Academic Makerspaces*, 2018, Paper No. TBD.
- [24] V. Hunt, D. Layton, and S. Prince. "Diversity matters." *McKinsey & Company* 1 (2015): 15-29.