

Increasing Diversity and Access to Shops, Makerspaces and Libraries Across a Hands-On, Project-Based Engineering Curriculum

6th International Symposium on Academic Makerspaces

ISAM
2022
Paper
No.:
46

Callan Bignoli¹, Daniela Faas²

¹Callan Bignoli; Olin College; e-mail: cbignoli@olin.edu

²Daniela Faas; Olin College; e-mail: Daniela.faas@edu.edu

Introduction

From their inception, shop, lab, and fabrication spaces have been centers of exclusivity within engineering education, catering often to the stereotypical White, cisgender, male “maker.” Though it is now a decade old, an oft-cited 2012 survey sponsored by Make Magazine and Intel found that 8 in 10 people who identified themselves as “makers” were male; the study did not consider race or ability [1]. Research by Pepler et al. found three years later that nearly 64% of all makerspace users are White, even when factoring in makerspaces that focused predominantly on serving communities of color [2]. While data about LGBTQIA+ individuals’ use of makerspaces has not often been collected, Moorefield-Lang and Kitzie suggest that intentional inclusivity and scaffolded safety for members of these groups is essential to their engagement in such spaces [3]. Our colleague Debbie Chachra wrote a 2015 essay in *The Atlantic* about the invisibilization and devaluation of women and feminized labor in the maker movement [4], and Susan Faulkner has explained that “[w]omen are undercounted [as ‘makers’] because of the type of making they do, and many of them avoid makerspaces, the community-operated workspaces that tend to be dominated by men” [5].

Background

When they are not intentionally designed to be accessible, shops and library makerspaces can present barriers to access for students with a variety of gender identities who require the same access to fabrication tools as everyone else. We know from anecdotal data and our own experience at a small private engineering college in Massachusetts that not everybody is represented or welcomed in these spaces. Moorefield-Lang and Kitzie write, “LGBTQ adult populations... perceive the library as an important yet disappointing resource for identity-related information. Libraries often mirror broader society and culture, wherein LGBTQ identities are not the norm” [3]. Traditional fabrication and makerspaces present a wide range of challenges for students with non-heteronormative and non-white identities, including the ability to fully participate in hands-on learning. As larger numbers of students with different identities than “predominantly white and male” enter engineering schools, the question of who our engineering spaces are accessible to becomes increasingly relevant.

Research on usage of these spaces has shown a skew towards white and male participants, but there is very little data with regards to race, non-binary gender, and other identities.

In order to turn away from the history of exclusivity in makerspaces, we must focus on student growth, development, and access as an inherent part of the design of these spaces. Olin College, in its shops and library, has prioritized this work. This is a departure from traditional models where fabrication functionality is the primary consideration for the space. As part of our shift, we have assessed the relative effectiveness of our own policies regarding diversity including gender identity to promote student access.

While our data at this point is confined to anecdotes and our lived experience, we want to share findings from our experience developing policies and practices at Olin College to help encourage an inclusive and welcoming shop and library makerspace environment for students with a variety of gender identities, ability levels, and racial backgrounds. Olin has a unique approach to education that has significantly influenced our process. The college, founded in 1997, focuses on shifting pedagogical approaches within engineering, emphasizing project-based learning and teamwork. The mission and values of the school include centering student autonomy, giving learners a chance to choose the projects they want to work on, and encouraging them to contribute to what we call “building and sustaining the college.” We emphasize the importance of lifelong learning, ensuring team health for group projects, and co-creating knowledge.

Olin also views the existence of the shops and library as crucial components of our learning continuum. There is a heavy emphasis on design and prototyping for all students, and every one of them learns how to use shop tools and fabrication basics during their first semester. Immediately, students engage with campus fabrication facilities in the shops and at the library that include prototyping tools, such as 3D printers and sewing machines, and fabrication tools, such as water jets and mills. Many courses have major fabrication and prototyping components; that work might be a one-off part of an assignment, or it might take place over the course of the entire semester. Often the work completed is done in groups of two to five students.

While Olin College has always taken steps to bring access to all students by admitting a gender-balanced student body since its founding, the last few years have seen library and shop staff working very intentionally on breaking down barriers for students with a variety of non-dominant identities. Because a large part of this initiative has been rooted in student engagement, we worked to ensure students would be leaders in shaping our approach. Peer training models are used in both the shops and library to foster leadership and autonomy, and to give students the opportunity to teach. A culture of stewardship has been carefully built in both the library and shop spaces that extends beyond student workers and to the whole campus; our student workers make this possible, as they are expected to be ambassadors of the spaces they work for and within. As Benjes-Small et al. found in their 2017 survey of library makerspaces, the “success of their spaces [were attributed] explicitly to a core community of enthusiastic users” [6]. The aspiration is to consistently communicate pathways to empower all interested community members to use the resources, training, and guidance available on our maker-centric campus.

We agree with Mersand that “many makerspaces offer the opportunity for people to participate in workshops and classes, and participants have the potential to be a learner, mentor, and leader” [7]. Mersand points out that makerspace users “who direct and those who use the space often make a difference in the... activities engaged in, as well as the formation of community.” We also agree with Benjes-Small, et al. that “[d]eveloping a vision for the [maker]space ensures that it meets a goal and contributes something concrete to the workings of the library and university” [6]. Additionally, we are inspired by political sociologist Danielle Allen’s idea of participatory readiness, a way of understanding “citizenship [as] the activity of co-creating a way of life, of world-building...co-creation can occur at many social levels: in a neighborhood or school; in a networked community or association; in a city, state, or nation; at a global scale” [8]. We believe our makerspaces on campus are a site of this type of co-created world-building. Because fabrication and making is an integral part of engineering education at Olin College, we have many chances to give students the opportunity to be leaders and instructors in our makerspaces and shops, including the peer training model utilized by both the shops and the library. Values of community building and stewardship are at the heart of both of our departments on campus.

The mission of the Olin Shops and Labs is to provide “a collaborative space for learning and innovation; spaces to learn, to invent, to iterate, to create, and to mentor” [9]. They seek to empower all community members - including all staff and faculty, if they are interested - to use and master the tools of fabrication and prototyping through hands-on training and guidance. In the mission and vision documents of the Shops and Labs, there is deliberate, specific language intended to inculcate a sense of inclusive values: “[We] respect diversity: gender, gender identity and expression, sexuality, disability,

age, socioeconomic status, ethnicity, race and culture” [9]. In addition, there is a commitment to continuous improvement and iteration; that includes continuing to make community-driven changes and adjustments to expand, define, and live up to values of inclusivity. Guiding principles of the Olin Shops and Labs also clearly emphasize creating safe spaces for learning and prioritizing “empathy over efficiency.” There is a shared understanding that mutual respect, making mistakes, experimentation, and individual autonomy are all critical to learning and improvement.

Discussion

A. Efforts at the Library

Similarly, the Olin College Library’s core values revolve around empowering and welcoming our community members. The library’s mission statement includes a promise to “advocate for discovery, connection, and inclusion for all members of our community...we offer space, learning, and leisure opportunities for the continuous development of social consciousness, creativity, and self-awareness” [10]. In service of this, the library does everything it can to make exploration and creation free for all members of the community, providing access to sewing machines, plotters, fabric arts equipment and supplies, a large format vinyl cutter, screen printing equipment, and a variety of crafting materials.



Fig.1 Participants in the library at the Spring 2021 Community Weaving Workshop

The presence of crafting tools next door to fabrication machines and 3D printers is validating, especially for feminized makers: it presents multiple points of entry into what can be called “making,” and creates opportunities for community building and teamwork through training, collaborative work, and workshops. As a part of the library’s commitment to being the cultural heart of Olin’s campus, the staff, which includes eight student workers, invites the whole community to programs centered around collaborative making. The design and execution of these programs typically involves a broad swath of collaborators. In the spring of 2021, a librarian worked with Olin’s artist in residence and a student on developing a weaving workshop including laser-cut looms designed and prototyped by the student. The 40 participants

at the workshop included members of the faculty, staff, and student body. Several have continued with weaving, including one faculty member - a physicist by training - who has since begun teaching her own fabric arts classes on campus.

The eight student workers at the library are integral to the operations of the department and keeping it an inclusive, student-centered place. Half of the team is responsible for peer training in the library’s makerspace and specialized creation areas, including the sewing area, the workroom (home to screen printing equipment and the large format vinyl cutter, plus a wide variety of making and crafting supplies), and the Sound Studio, a small audio recording studio; the students are also experts in using the library’s circulating camera and audio recording equipment. In the spring of 2022, the team included four students who identify as transgender or gender non-binary and three that identify as female. Of that number, two are people of color.

B. Efforts in Shop Spaces

There were a total of 16 shop assistants in the spring of 2022. Seven identified as female, while 4 identify as transgender or gender non-binary. As Moorefield-Lang and Kitzie point out, “LGBTQ individuals value information provided by other LGBTQ people who share their experiences...LGBTQ youth may begin to exercise more trust in libraries that host inclusive makerspaces” [3]. Many library student workers are members of OPEN, the LGBTQIA+ student group at Olin, and several OPEN events are regularly held in the library. Throughout the academic year, the library creates a heritage or special cultural display each month. In June each year, student workers use the library’s makerspace equipment to create a hand-crafted Pride Month display. Beyond just making, the library orients all its services around inclusivity and develops its physical and electronic book collection with an emphasis on bringing traditionally excluded voices from STEM and science fiction to Olin’s community.



Fig.2 The library’s June 2021 Pride Month book display

A critical component for inclusivity in both the library and shop environment is visibility. That starts with hiring student workers who are historically underrepresented members of maker communities and continues with intentional design decisions around making shop assistants’ pronouns and identities easily visible to the peers they are training. As an example, there are shop assistant tiles on the wall at the entrance to the shops showing a picture of the student worker and including their pronouns (see figure below); these tiles also give students a chance to share facts about themselves that are not directly related to making or school activities.

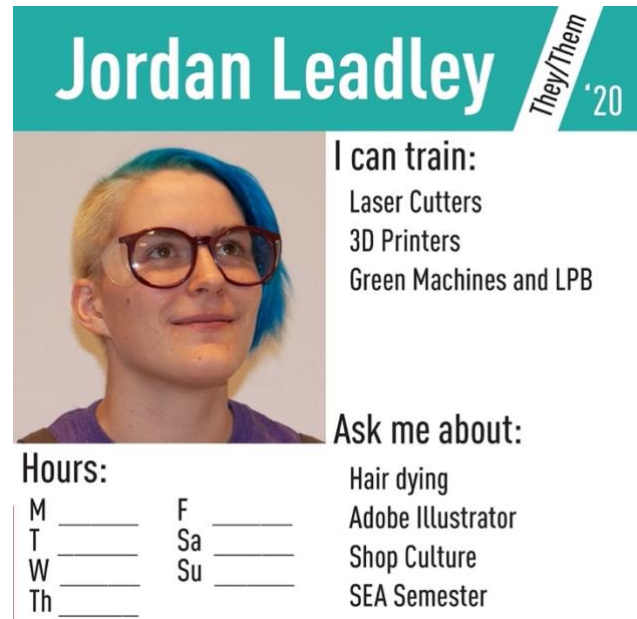


Fig.3 The shop’s student assistant tiles with pronouns

Bias and LGBTQIA+ safe space and inclusivity training are both required for all incoming shop assistants. At the library, the year’s student worker team meets up at the beginning of each semester to talk about making the library an inclusive and welcoming environment, and to emphasize the importance of patron privacy; marginalized individuals especially need the protection afforded to them by free intellectual inquiry and confidentiality. In both settings, hiring revolves around helping others and kindness. While technical ability and familiarity is important, students’ ability and desire to collaborate and respect each other is essential to foster a culture of truly inclusive learning. In addition, the shop purchased pronoun and identity patches for the shop assistant aprons (this was voluntary, but every single student requested a pronoun patch). Seven of the 16 shop assistants requested an identity patch).



Fig.3 The shop's pronoun and identity patches on shop aprons

Results

Our shift in the way we approach these spaces has increased their vibrancy. They have become the core of the Olin curriculum. In the beginning, the shops only provided support for a handful of courses and were primarily perceived as spaces for the vehicle teams. Currently, more than 70% of the Olin curriculum has some form of interaction with shops. It might be a direct interaction where a student takes a course that requires things to be made or indirect, where a student just wants to 3D print something for their dorm room. Furthermore, in any given year, the shops now conduct over 500 individual trainings. This has resulted in close to 90% of the student body being trained on 3D printers and 80% trained on laser cutting.

After this change in approach and mission began, one student said, "I've always loved making things and working in shop spaces and being a shop assistant really gave me the opportunity to get involved with the shop and be part of the shop community." Another said, "...me and the rest of the shop assistants have the opportunity to show [fellow students] what a wonderful, creative space this can be and how much freedom we are given to create." In the words of a third student, "We've been able to see a transition from it being a bit more of a hardcore mechie- or male-dominated space to a very open learning space for students here."

Though as of this writing the library does not collect statistics on how many students are trained on makerspace equipment, we do know our student assistants are engaged in peer training each week. Students utilize the library's equipment both for classes - the first semester core class Design Nature often involves sewing, screen printing, sticker making, and painting; the final semester Arts, Humanities, and Social Sciences capstone has involved everything from photography to podcasting to sculpture - and for their own hobbies, extracurriculars, and interests. In the 2021-2022 academic year, the library recorded two thousand attendees at its various programs, an impressive number for a student body that numbers around 361, and a visit count of over 80,000.

During the fall 2021 semester, library student workers and their friends created a haunted library, featuring dozens of handmade props and a storyline with actors at different "stations," and around half of the student body attended.

Training	3D Printing	Screen Printing	Laser Cutting	3D Forming	Handmade Mill	3-Axis CNC Mill	Drum	Lathe Fundamentals	Intermediate Lathe	3D Modeling	Plasma Cutting	Sheet Metal	Soldering	Woodshop Space	Woodshop Sew	Composites	Print Booth	Green	Year	Total Hours		
SP22 Complete	20	6	18	1	0	22	1	4	4	13	27	11	11	7	0	0	0	0	172	171		
FA21 Complete	59	6	25	19	3	39	3	11	11	26	43	29	29	12	34	9	34	168	167	459		
SP20 Complete	7	17	16	19	5	17	6	18	5	6	6	4	15	62	95	6	54	6	110	110		
FA19 Complete	38	65	27	3	6	18	5	6	6	4	15	62	95	6	54	6	54	6	504	410		
SP19 Complete	30	17	16	19	5	17	6	18	5	6	6	4	15	62	95	6	54	6	167	163		
FA18 Complete	19	22	5	2	26	1	6	6	9	4	30	172	16	33	130	42	195	42	459	351		
SP1 Complete	16	14	0	4	28	3	6	2	7	1	35	2	1	12	1	1	1	1	154	142		
FA17 Complete	64	18	4	4	15	4	16	4	4	4	191	12	1	1	1	1	1	1	138	270		
SP0 Complete	26	17	8	2	13	36	8	7	8	1	1	1	1	1	1	1	1	1	23	329	326	
FA16 Complete	40	16	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	191	82	
Total Camp since 2016	132	12	363	109	31	0	10	220	38	81	52	65	90	40	437	38	392	48	138	648	3081	2433

Fig.4 Training Summary by Tools from Fall 2016 to Spring 2022 (only completed tool trainings are counted)

At the time of this writing, the library and shops are collaborating on several projects, including co-managing a summer project team that will be redesigning spaces and storage options on campus. We will be working on continuing to align our spaces and offerings in a way that makes sense for student needs and user safety. One example of where this has already happened was in the decision to move the library's fleet of 3D printers into the shop spaces for easier maintenance and better ventilation; this also enabled the library to increase dedicated space for its very popular sewing machines. Because we know it is important for us to use data on student space usage to drive future decisions, we will be working more closely on collecting information about students' engagement with our offerings and will continue to collaborate on our training and safety procedures.

Future Work and Conclusion

Our future work will be centered around data collection, such as making sure we collect statistics for library peer training and understanding more broadly where we can make improvements. We need to understand better how we onboard students from underrepresented groups that did not have any prior access to these spaces during their high school years. We believe academic makerspaces have an enormous amount of potential to allow students to engage in autonomous world-building, community stewardship, and peer teaching. While we feel Olin's approaches in fostering makerspace inclusivity and student co-design have been successful, we seek to convene a larger discussion to understand what is happening in other engineering schools and schools with shops and library makerspaces and to continue to learn from each other.

References

[1] MAKE, "An In-Depth Profile of Makers at the Forefront of Hardware Innovation," MAKE Magazine, 2013. [Online]. Available: <https://cdn.makezine.com/make/sales/Maker-Market-Study.pdf>. [Accessed May 21, 2022].

[2] K. Peppler, A. Maltese, A. Keune, S. Chang, and L. Regalla, "Survey of Makerspaces, Part I," MakerEd, 2015.

- [Online]. Available: https://makered.org/wp-content/uploads/2016/01/MakerEdOPP_RB6_Survey-of-Makerspaces-1_final.pdf. [Accessed May 21, 2022].
- [3] H. Moorefield-Lang and V. Kitzie, "Makerspaces for all: serving LGBTQ makers in school libraries," *Knowledge Quest*, vol. 47, no. 1, pp. 46–50, 2018. [Online]. Available: https://libres.uncg.edu/ir/uncg/f/H_Moorefield_Lang_Maker_spaces_2018.pdf. [Accessed May 21, 2022].
- [4] D. Chachra, "Why I Am Not a Maker," *The Atlantic*, Jan. 23, 2015. [Online]. Available: <https://www.theatlantic.com/technology/archive/2015/01/why-i-am-not-a-maker/384767>. [Accessed May 21, 2022].
- [5] J. Axup et al., "The World of Making," *Computer*, vol. 47, no. 12, pp. 24–40, Dec. 2014. [Online]. Available: [10.1109/MC.2014.373](https://doi.org/10.1109/MC.2014.373). [Accessed May 21, 2022].
- [6] C. Benjes-Small, L. M. Bellamy, J. Resor-Whicker, and L. Vassady, "Makerspace or Waste of Space: Charting a Course for Successful Academic Library Makerspaces," In *At the Helm: Leading Transformation: The Proceedings of the ACRL 2017 Conference*, March 22–25, 2017, Baltimore, Maryland, 2017, pp. 428–36. [Online]. Available: <https://www.ala.org/acrl/sites/ala.org.acrl/files/content/conferences/confsandpreconfs/2017/MakerspaceorWasteofSpace.pdf>. [Accessed May 21, 2022].
- [7] S. Mersand, "The State of Makerspace Research: a Review of the Literature," *TechTrends*, vol. 65, no. 2, pp. 174–186, Mar. 2021. [Online]. Available: [10.1007/s11528-020-00566-5](https://doi.org/10.1007/s11528-020-00566-5). [Accessed May 21, 2022].
- [8] D. Allen, "What Is Education For?," *Boston Review*, Apr. 26, 2016. [Online]. Available: <https://bostonreview.net/forum/danielle-allen-what-is-education-for/> [Accessed May 21, 2022].
- [9] Olin College Shop, "Policies," n.d. [Online]. Available: https://libraryfreedom.wiki/html/public_html/index.php/Main_Page/Meetings/LFPCamp2022/Agenda. [Accessed May 23, 2022].
- [10] Olin College Library, "Spring 2020-Fall 2022 Strategic Plan," 2020. [Online]. Available: <https://library.olin.edu/strategic-plan.php>. [Accessed May 21, 2022].