

# Following Diversity in a Student-Run Makerspace: Trends in gender, engagement, and usage

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## Introduction

The MIT MakerWorkshop is a student-run engineering space on MIT's campus where any member of the MIT community (students, faculty, staff, alumni), can work on any project ranging from research to classes to hobbies and gifts. The space opened in 2015 with the goal of fostering a diverse community in a hands-on learning environment by enabling Users to complete the full engineering process from ideation and brainstorming, to design and modeling, to making and validation [1]. Each year, the MIT MakerWorkshop community celebrates a birthday to commemorate the opening of the space (Fig. 1).



Fig. 1 MIT MakerWorkshop's annual birthday celebration

The space is supervised and maintained by 40+ student volunteers known as 'Mentors.' Each Mentor is responsible for supervising the space two hours a week and is also part of a 'Machine Team', where he/she helps maintain one of the machines or machine groups in the shop. Every Machine Team is led by one Mentor, a 'Machine Master.' Machine Masters are typically appointed by the executive board. Additionally, each year an Executive Committee (Exec) with 8 positions – President, Vice President, Mentor Coordinator, User Coordinator, Information Manager, Treasurer, Safety Officer, and Social Chair – is elected by the Mentor community to organize and lead the space. While the space is primarily affiliated with the Mechanical Engineering department at MIT, there are a variety of channels through which Users and Mentors from other departments can become a part of the community [2].

In order to continuously study the usage of the space and monitor the growing community, the MIT MakerWorkshop has collected extensive data since inception. With over four years' worth of data ranging from machine use and trainings to User and Mentor engagement, this paper presents some of the first trends discernable. A key takeaway from the data analysis is that the MIT MakerWorkshop has fostered an extremely diverse community with respect to such things as gender, community engagement, and machine use.

## Data Collection

In order to continuously study the usage of the space, the MIT MakerWorkshop uses the MIT-wide makerspace iPad application, Mobius, to record User login data, as well as an internal database created to record User and Mentor training information [3]. Data collected includes User/Mentor demographics, shop and machine training dates, and machine usage. Collecting this data allows for the monitoring of trends in the User/Mentor community, how they have changed over time, and helps guide the future leaders of the space to determine how to best serve this continuously changing space. As more data is collected over the years, it will be possible to determine if the trends noticed are statistically significant.

## Diversity Trends

### A. GENDER DIVERSITY

An important piece of information that is collected is the gender diversity in our User and Mentor pool. Fig. 2 below shows the gender breakdown of active Users in the space over the four years since opening as compared to the gender diversity of the Mechanical Engineering (ME) department as a whole. An active User is defined as a unique individual that pays at least one visit to the space during the given academic year (June 1 - May 31). The data indicates that the gender divide in the Mechanical Engineering department at MIT stayed fairly consistent over the last 4 years at around 37% female and 63% male. When the MIT MakerWorkshop first opened in 2015, the gender ratio was 32% female to 68% male, a larger gap than inherently in the Mechanical Engineering department. Over time, the percentage of female active Users in the community approached that of the department, eventually surpassed it at 44% for the most recent academic year. This

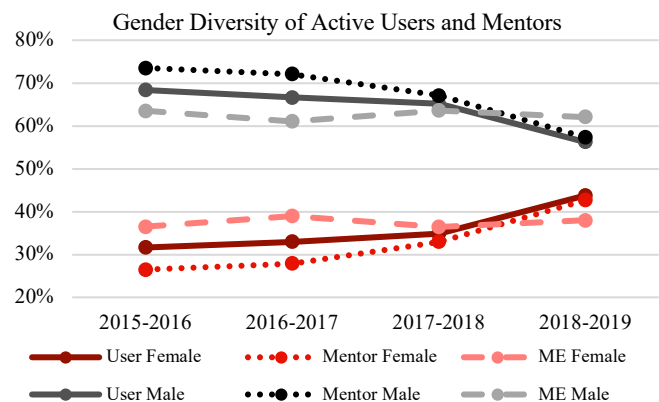


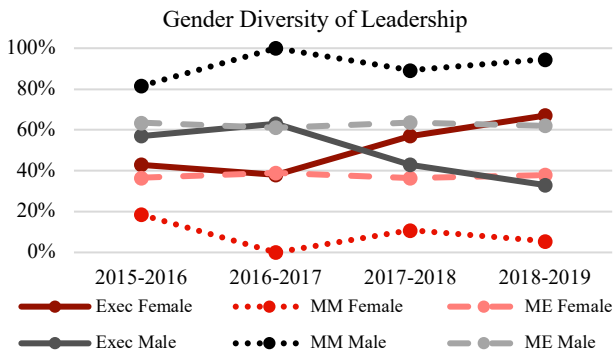
Fig. 2 Gender diversity of active User (solid) and Mentor population (dashed) at MIT MakerWorkshop over time as compared to the MIT Mechanical Engineering (ME) department [4].

indicates that the increased percentage of female active Users in the community was not a result of a rise in female students in the department.

As can be seen in Fig. 2, the percentage of female Mentors has also increased over time in a trend similar to the User population. Given that there has been no specific recruiting efforts of females or other underrepresented minorities in engineering to join the MIT MakerWorkshop either as Users or Mentors, the results suggest that something about the space itself is promoting gender parity. Some have suggested that Users might be drawn to the MIT MakerWorkshop because those who supervise the space are selected to be very friendly and approachable, and are tasked with creating a welcoming space that may appeal more to those who have never been exposed to a machine shop or maker space in the past.

The gender diversity of the leadership roles in the MIT MakerWorkshop were also studied and plotted against the gender data of the Mechanical Engineering department in Fig. 3. The percentage of females on Exec were consistently above that of the department and increasing in recent years. The growth of women on Exec is higher than that of the overall active User population. At the moment, it is unclear what the causation is for this trend. While the gender ratio on Exec has actually reversed (more females than males), the female representation among the Machine Team Masters (MM) could be improved. The data suggests that females are encouraged empowered to engage and take on leadership roles in the MIT MakerWorkshop, though it is unclear at the moment why these tend to be at the Exec level and not at the Machine Team level.

As mentioned previously, the MIT MakerWorkshop has not focused on female-specific recruitment for its Users. As shown in Fig. 3, there has always been a strong presence, relative to the department, of women on the executive board. This could make the shop more approachable for women seeking a makerspace community, as they may feel less alienated than in heavily male-dominated shop communities.

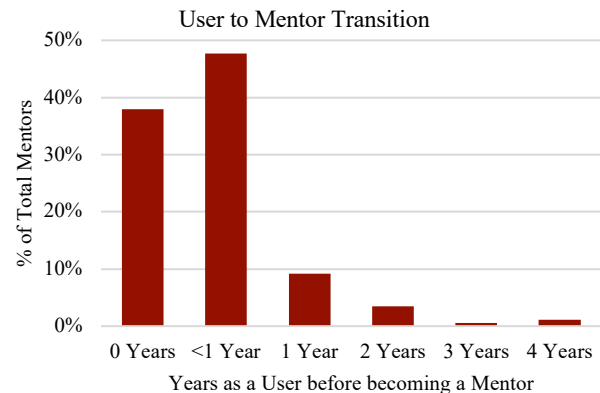


**Fig. 3 Gender diversity of leadership in executive board positions (solid) and as machine masters (MM, dotted lines) at MIT MakerWorkshop, as compared to the MIT Mechanical Engineering (ME) department (dashed) [4].**

We recognize that gender is non-binary and the MIT MakerWorkshop welcomes those of all gender identifications. In the demographic data collected, Users and Mentors may choose to identify as “Female”, “Male”, “Other” or to leave the question blank. Given that the number who identified as “Other” was 0% for most years and less than 1% in general, the data presented in this section focuses on the overwhelming number of people who have chosen to identify as female or male.

### B. DIVERSITY OF COMMUNITY ENGAGEMENT THROUGH LEADERSHIP

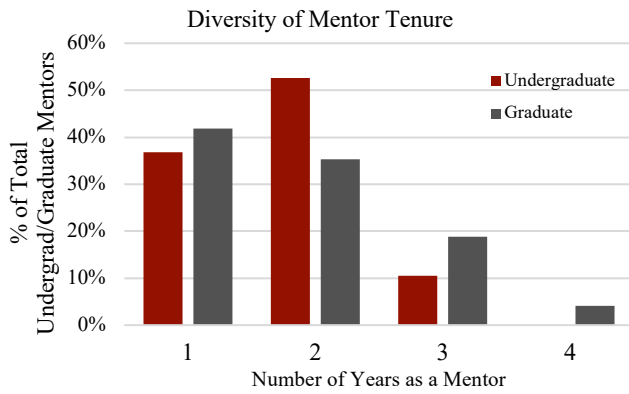
Because the MIT MakerWorkshop is a student-run space and community, the turnover for Mentors in the space occurs more frequently than shops that are run by full-time staff. To understand the ever-changing Mentor population, the User-to-Mentor transition was investigated. As shown in Fig. 4, 62% of the Mentors became Users in the shop before becoming a Mentor. The majority of these Mentors (48%) applied and became Mentors within the first year of being a part of the community. This indicates that many of the Mentors were inspired to give back and contribute to the space in the first or second application cycle after joining.



**Fig. 4 Time that Mentors are Users of the MIT MakerWorkshop. 62% of Mentors are originally Users and engage quickly with the community as Mentors.**

To understand the rate of turnover of Mentors better, the diversity of Mentor tenure for both the undergraduate and graduate populations of Mentors is shown in Fig. 5. Most of the undergraduate students stay on as Mentor for two years. The MIT MakerWorkshop looks for exceptional undergraduate students with both enthusiasm and experience; as a result, most of the undergraduates are in their third or fourth year by the time they become Mentors. There is a small subset of students that have joined the community as an undergraduate and continued on in their graduate career. Most graduate student Mentors stay on as Mentor for one year. This could be due to many students being in a two-year Master’s program, and it may take up to one year for students to gain experience and become acquainted with the space as Users.

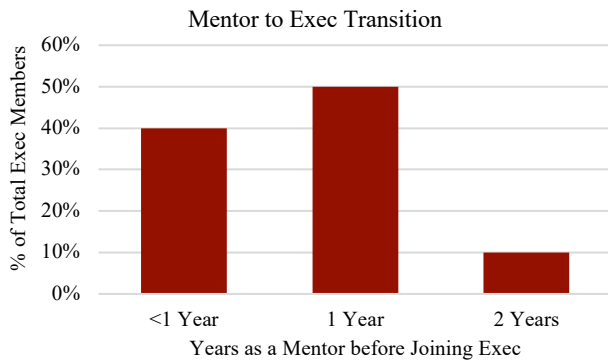
Following the progression of increasing responsibility, the Mentor-to-Exec transition was analyzed and shown in Fig. 6. Half of exec members were Mentors for one year before



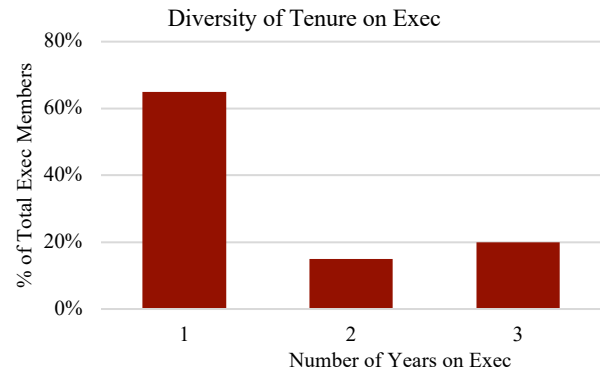
**Fig. 5** Mentor tenure at MIT MakerWorkshop for those who are undergraduate (red) or graduate (gray) students.

transitioning to an Exec position. Of the remaining half of Exec members, most transitioned to an Exec position within the first year of being a Mentor. This follows the earlier trend that students are becoming inspired to step up and pick up more responsibility in the shop within the first year of becoming involved.

As a follow-up, the diversity of tenure of members on Exec was also looked at and is shown in Fig. 7. Most exec members only serve one year (one term) on exec before stepping down. While this means the turnover of leadership is high, this also means that even new Mentors are able to step into an important leadership role and quickly implement their ideas in the space, further conveying that the community is friendly and approachable. This also leads to having a wide variety of ideas and experiences in the shop. Knowing this, the MIT MakerWorkshop is able to focus on the importance of proper leadership transitions to prevent from communication loss in leadership turnover. There are a variety of reasons why most Mentors are on Exec for one year. Many of these Mentors reach graduation after going through the User-Mentor-Exec process. Some Mentors, after the transition process, choose to focus on academics, preparing for qualifying exams or graduation, or research.



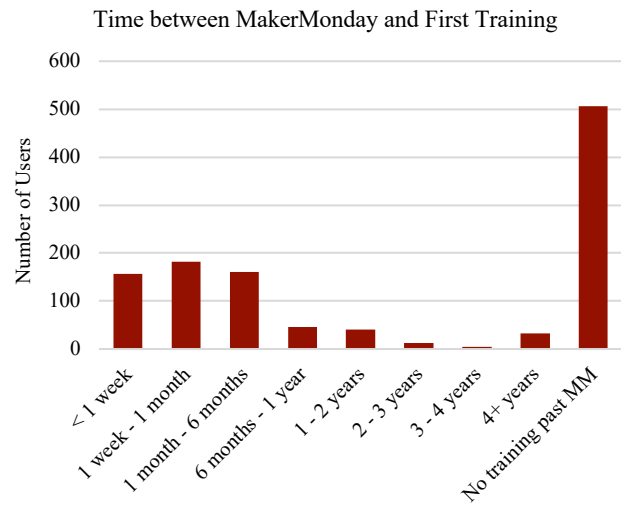
**Fig. 6** Time that Executive Committee (Exec) members were Mentors before being elected to Exec at the MIT MakerWorkshop.



**Fig. 7** Tenure of members serving on Exec at the MIT MakerWorkshop.

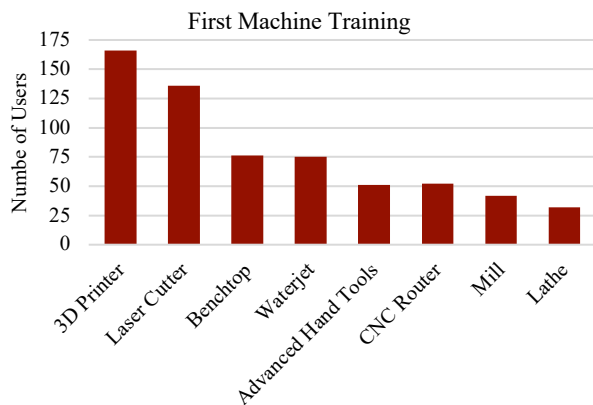
### C. DIVERSITY OF TRAINING AND MACHINE USE

Every Monday of the semester, a general machine safety training – Maker Monday – is offered [5]. This training also includes the use of basic hand tools and power drills. Machine Specific Trainings are typically offered at least once a week for each machine in the space throughout the semester. To understand if trainings are offered frequently enough to meet the demand, the time between Maker Monday and first Machine Specific Training was analyzed and is shown in Fig. 8. This data pointed out that almost 500 Users do not attend any trainings beyond the initial Maker Monday. This could be that Users choose not to continue using the space after the initial safety training, or that these Users only utilize the hand tools and power drills in the space. A large number of Users receive their first Machine Specific Training within the first week of becoming a User. This shows that Users are able to begin using machines in the shop quickly and that trainings are offered frequently enough for Users to get the proper training when needed. Many Users also join the community initially because they have a specific class or project they need to complete. Therefore, these Users are often motivated to receive their training quickly (<1 month).



**Fig. 8** Time that Users take between attending a Maker Monday and completing their first training at the MIT MakerWorkshop. Almost 500 Users did not seek any training past Maker Monday.

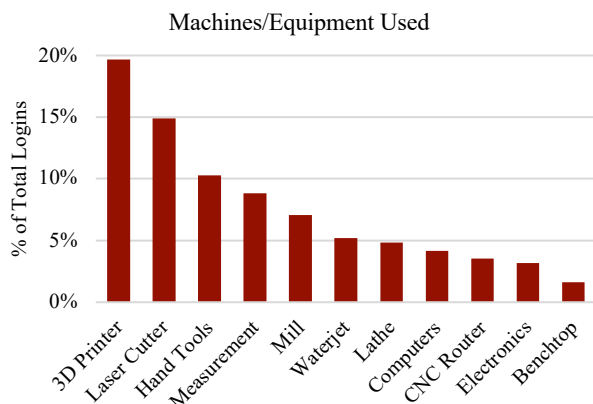
Looking at the first machine trainings that Users receive in Fig. 9, Users first seek out training on the 3D printer, laser cutter, benchtop machines (bandsaw, cold saw, belt sander, drill press, etc.), and waterjet, respectively. These trainings are relatively quick (<1 hour), allow for multiple trainees per training, and have no prerequisites. These are also perhaps the most critical machines for basic rapid prototyping.



**Fig. 9** First machine that Users received training on at the MIT MakerWorkshop.

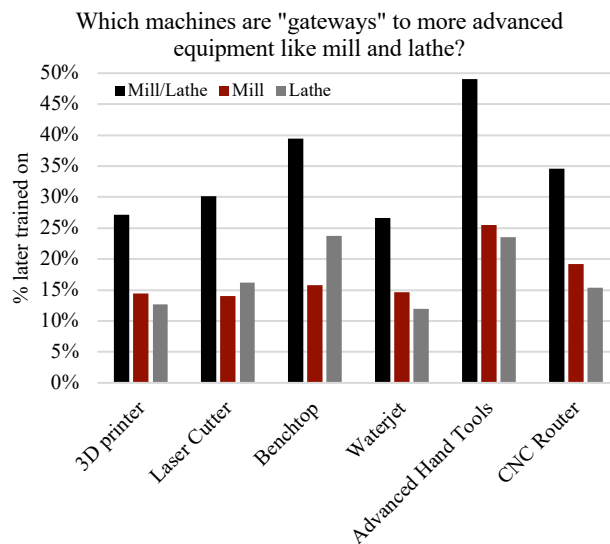
Upon entering the MIT MakerWorkshop, Users login and self-report the machines they plan to use in the space. Analyzing this data, shown in Fig. 10, it is clear that the most utilized machines are the 3D printer and laser cutter, respectively. They are machines that most Users are trained on and are versatile and useful for a variety of course, research, and personal projects. It is also worthy to note that measurement is the fourth highest used equipment in the space. This further supports and confirms that the MIT MakerWorkshop is not only a makerspace, but an engineering space, where members of the community can validate their projects.

In the MIT MakerWorkshop, training on the mill and lathe require a prerequisite course. This course is a standard requirement for undergraduate students in the Mechanical Engineering department, and can be taken by graduate students in a variety of other shops. The last facet of machine usage



**Fig. 10** Most frequently used machines at the MIT MakerWorkshop.

diversity explored was if usage on any of the machines that do not require prerequisites eventually led to mill and/or lathe training, shown in Fig. 11. It appears that training on benchtop tools and advanced hand tools have the most Mentors following up with mill and/or lathe training eventually. This could make sense, since often, making parts on a mill or lathe require pre- or post- processing of the part on one of the tools in benchtop or advanced hand tools.



**Fig. 11** Follow-on trainings for the mill and lathe at the MIT MakerWorkshop based on which machines Users first received training on.

### Conclusion

Diversity in the MIT MakerWorkshop, whether demographic or otherwise, can be tracked over time through data collected through daily login as well as semesterly surveys. While the community has increasing trends of diversity, there is room for improvement.

Collecting extensive User and Mentor data over the years has allowed quantification and tracking of the space's growing community and needs. By collecting more usage data, a plethora of other findings could be made to further inform future shop purchases, improvement projects, and outreach growth. With additional years of data, statistical significance of trends first identified in this paper could be determined.

Currently, the majority of our usage data is taken through shop login and voluntary surveys that Users and Mentors complete throughout the academic year. As a result, these surveys are kept concise and limited to information that is more critical to understanding shop usage. To increase data collection for the future, a passive data collection system could be developed. An ID-activated login/logout for the shop could automatically collect login data for Users; the ID-activated system could also then be expanded for machine usage to allow for better tracking of machine usage time, leaving room to expand the questions asked in the login survey.

### Acknowledgements

The authors would like to thank MIT's Provost Martin Schmidt, the MIT School of Engineering, the Martin Trust Center, the Richard H. Lufkin Memorial Fund, the MIT Department of Mechanical Engineering, Prof. Dennis Freeman and the MIT Project Manus initiative for providing support, encouragement and funding for the MIT MakerWorkshop. The authors would also like to thank Prof. Martin Culpepper for serving as an amazing faculty advisor (Maker Czar) for our space. Finally, the authors would like to thank all Mentors, past and present, for all their time and dedication into designing, building, and maintaining the MIT MakerWorkshop.

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