

Maha N. Haji¹ and Margaux Filippi²

¹Maha N. Haji; ATA Engineering & Dept. of Mechanical Eng., MIT; e-mail: mhaji@mit.edu

²Margaux Filippi; Dept. of Mechanical Eng., MIT; e-mail: margaux@mit.edu

INTRODUCTION

MIT MakerWorkshop is a student-run engineering space on MIT's campus that opened in 2015 with the goal of fostering a student community in a hands-on learning environment where modeling, prototyping, and validation resources coexist [1]. The space is run by 40+ student run volunteers known as "Mentors". Now entering its fourth year, a number of the Mentors have since graduated from MIT and have entered the workforce. The Georgia Tech Invention Studio has observed the impact of spaces focused on build-test-education through positive responses from alumni on self-reported measures, including post-college employment, design and manufacturing skills, safety and teamwork skills, and outlook on engineering [2]. With the goal of improving MakerWorkshop's preparation of students for life outside of the Institute, this paper reports the results of a survey-based study of Mentor alumni and outlines plans for future industry-focused events and alumni outreach.

The MIT MakerWorkshop caters primarily to the students, staff and faculty in the Department of Mechanical Engineering and the Martin Trust Center for Entrepreneurship. MakerWorkshop is unique in its culture and in its mission: it is one of the few makerspaces on MIT campus that is student-run [1, 3] in partnership with MIT Project Manus and under the umbrella of the MIT Department of Mechanical Engineering, as illustrated by the diagram in Fig. 2. It also offers unique opportunities within the department, in part thanks to the breadth of tools and machines available, including extensive measurement and instrumentation equipment. The focus of this paper is the effect of MakerWorkshop on the student Mentors who have since graduated from the Institute and are pursuing careers in industry.

The main result of the study is that the majority of the Mentor Alumni surveyed credited their experience at MakerWorkshop with helping them in their career. While at MIT, most of the Mentor Alumni had used the space "extremely often" for coursework and thesis/research work and felt that their involvement in the space increased their knowledge of machines, design, and leadership skills. A great number of Mentor Alumni felt that their involvement was beneficial to receiving their current job, and many of them had since used the design and prototyping skills they developed at MakerWorkshop in their current positions.

MENTORS

A. THE ROLE OF MENTORS

The MIT MakerWorkshop is currently staffed by 40+ Mentors, student volunteers (drawn from both the graduate and undergraduate communities) who manage and run the organization. Mentors take two hour shifts every week supervising the space and also dedicate approximately three additional hours training users and maintaining machines. The Mentors are organized into machine teams (Fig. 2), each supporting maintenance and training on each of the major pieces of equipment in the space and are free to develop their own training protocol and rules of machine use [3, 4]. Since its inception in 2015, the MakerWorkshop has had over 130 student Mentors who have trained over 1,070 users on equipment ranging from 3D printers to CNC mills.



Fig. 1: The MIT MakerWorkshop, which houses numerous prototyping, fabrication, testing, and measurement tools.

B. MENTORS AS LEADERS

Beyond supervising the shop during open hours and mentoring users, opportunities for leadership as a Mentor come in the form of leading one of the machine teams as a "Machine Master" or a member of the Executive Committee (ExCom). Machine Masters are appointed by ExCom and are responsible for coordinating training, managing inventory, and maintaining the machine(s). ExCom members are elected by the Mentors once a year and are responsible for managing administrative duties of the shop, such as setting its vision, managing finances and machine capital, creating shop policies, interfacing with other entities within and outside the Institute, and managing the staff.

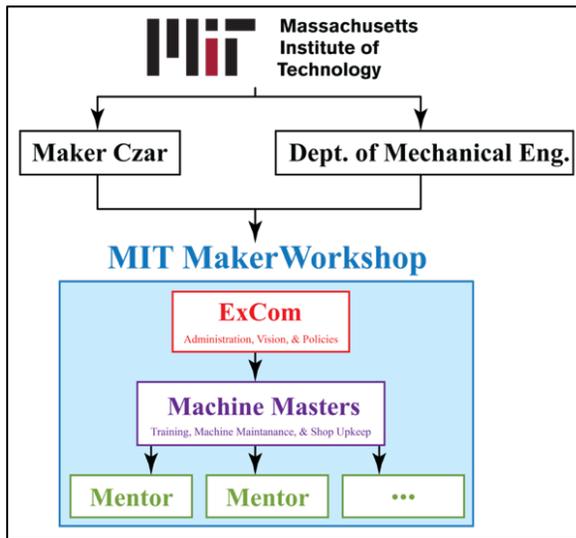


Fig. 2: MIT MakerWorkshop Governance Chart [3].

ALUMNI

Now entering its fourth year, MakerWorkshop has seen 13 cohorts of Mentors staffing the space during fall, spring, and summer semesters, for a total of over 130 Mentors. Of these Mentors, 64 have since graduated and left the Institute (not continuing at MIT for either a Master’s or PhD) and were considered for this survey. In the past, many alumni cited that their time at MakerWorkshop, especially in a leadership role such as a Mentor, was extremely valuable in receiving their industry job offers and in their current positions. The aim of this survey was to try to quantify these results and seek feedback on how MakerWorkshop can improve industry career preparedness for its users and Mentors alike.

IMPACT ON ALUMNI

A. SURVEY CREATION

In the spring of 2018, an online survey was distributed to all Mentor Alumni of the MakerWorkshop, both graduate and undergraduate with links to an online survey using Google forms. Responses were solicited for a two-week period and are summarized here.

The survey asked respondents to reflect back on their time at MIT to gauge how MakerWorkshop impacted their time at the Institute as it related to coursework, research/thesis work, and start-up related activities. Following this, respondents were asked to consider their experience as a Mentor in particular and to evaluate how it had impacted their design, analysis, prototyping, design validation and leadership skills. Finally, respondents were asked to determine what effect, if any, they thought their involvement with MakerWorks had on their job offers and what skills they have since used in industry.

B. SURVEY RESULTS

The survey link was included as part of a larger email newsletter geared towards alumni. Of the 64 Mentor Alumni who received the newsletter, 45 opened the email (70%) and 18 submitted responses to the survey link provided, corresponding to a response rate of 28.1%, a rate significantly higher than that of typical MIT surveys.

Of those who responded, 78% graduated in 2016 and 2017 (Fig. 3), when MakerWorkshop had been open for at least two semesters, and the majority of graduates had been Master’s students (Fig. 4).

What year did you graduate from MIT?

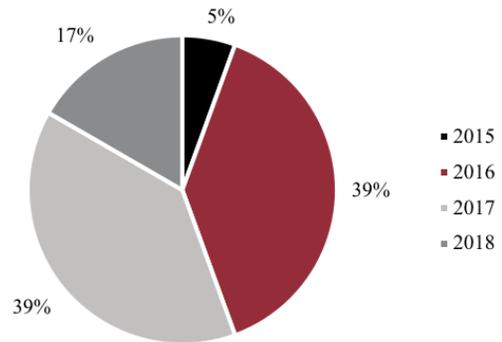


Fig. 3: Graduation years of the respondents of the Alumni Mentor survey.

What degree did you receive upon graduation?

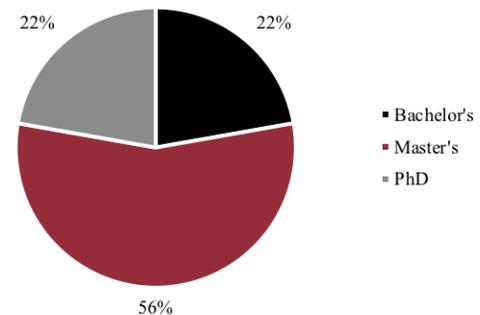


Fig. 4: Degree received by the respondents of the Alumni Mentor survey.

Overwhelmingly, survey respondents reported that MakerWorkshop positively impacted their time at MIT (Fig. 5) due to such factors as giving them access to tools not available elsewhere (72%) and giving access during evenings (61%). Respondents also cited that the community at MakerWorkshop had a large impact on their time at MIT, citing that “the ownership and student community made it preferable to other spaces” and “the space gave them the ability to network with other MIT students and faculty.”

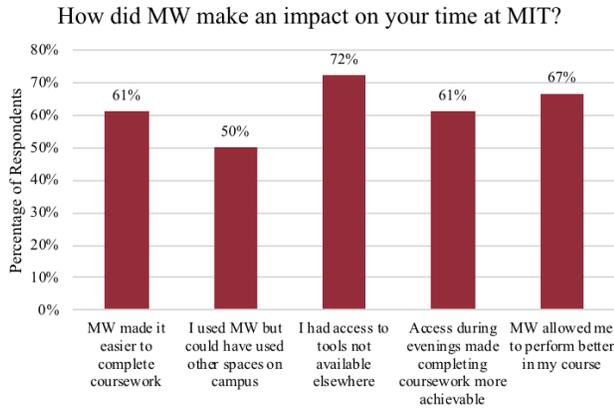


Fig. 5: Impact of MakerWorkshop on respondents' time at MIT.

Looking at uses of MakerWorkshop with regards to coursework, thesis/research work, and start-up related activities in particular (Fig. 6), respondents had used the space most often for coursework (56% reporting it was indispensable or they used it frequently), with thesis/research work being a close second (44%). The vast majority of respondents had never used the space for start-up related activities (72%). This may be due to the fact that the MakerWorkshop's sister space at MIT, ProtoWorks, is housed at the Martin Trust Center for Entrepreneurship and therefore is more accessible to members working on start-ups.

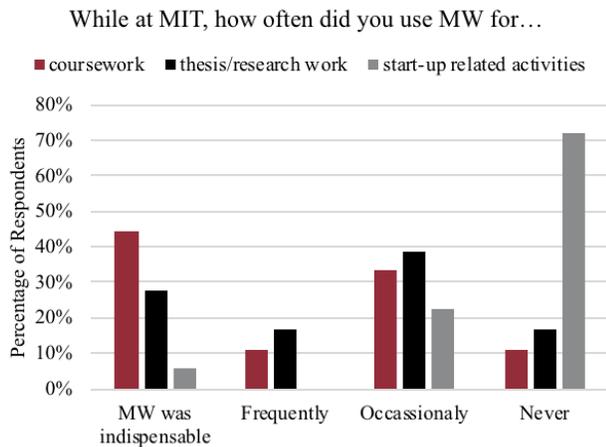


Fig. 6: Use of MakerWorkshop for coursework, thesis/research work, and start-up related activities.

With respect to the impact of being a mentor at the MakerWorkshop on respondents' job offers (Fig. 7), 61% stated that participation as a Mentor was beneficial to securing them a job, and 50% cited leadership experience as a Mentor being of specific importance.

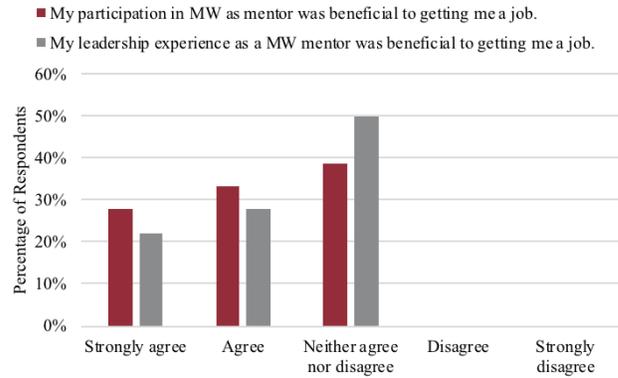


Fig. 7: Impact of being a MakerWorkshop Mentor on job offers.

Mentor alumni were also asked to gauge how MakerWorkshop specifically impacted various skills (Fig. 8). Nearly all respondents cited that MakerWorkshop had substantial or great impact on their knowledge and operation of machines (94%), with both design (72%) and leadership (67%) skills also being greatly impacted.

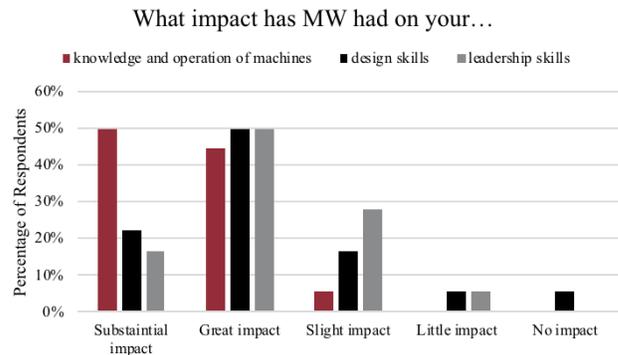


Fig. 8: Impact of being a part of MakerWorkshop on various skills.

When asked about specific hands-on skills learned at MakerWorkshop and used at their job (Fig. 9), survey respondents cited prototyping (83%) and design (67%) as the two most used skills.

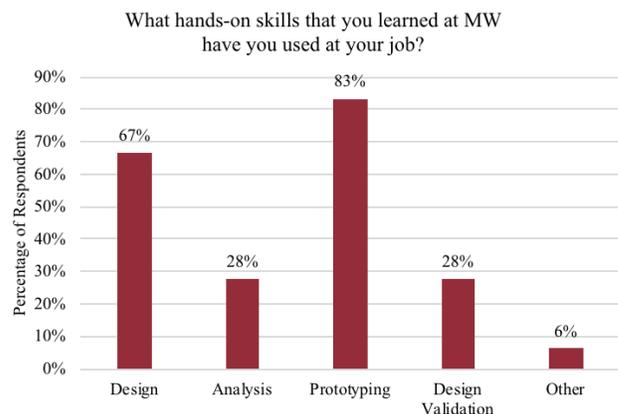


Fig. 9: Hands-on skills learned at MakerWorkshop used in jobs since graduation.

FUTURE ENGAGEMENT AND OUTREACH

A. ALUMNI MENTORS

Launched in the spring of 2018, MakerWorkshop approved a new policy by which MIT Alumni can now become Mentors of the MakerWorkshop. The goal of including MIT alumni as Mentors in the MakerWorkshop community was to bring expertise and knowledge into the MakerWorkshop community and provide connections and mentorship to younger Mentors and users.

Given that alumni's schedules may not be as flexible as those of students, the requirements for Alumni Mentors were changed to either be a two-hour shift per week for the term (20 hours / term) or the contribution of 20 hours per term equivalent of work for the shop, such as developing and conducting trainings, spearheading special machine development, or building infrastructure. To-date, these Alumni Mentors have taken weekend shifts which have allowed the shop to expand outside business hours. Alumni Mentors provide a direct conduit to careers post-MIT. Including them in the MW community is crucial to improving the space's preparation of students for industry.

B. ASK-A-MAKER

Many alumni and current users have cited that design reviews and more access to design feedback could help MakerWorkshop be a better asset to students during their time at MIT as well as in preparation for their careers outside the Institute. To that end, a new mailing list known as "Ask-a-Maker" was launched with the goal of enabling members to ask, respond, and casually discuss everything related to design, analysis, fabrication, assembly, mass manufacturing, electronics, measurement, software, entrepreneurship, and everything in between. The goal of this listserve is to be a space where people can discuss anything involved in Making Things Work and is open to everyone, people need not be affiliated to MakerWorkshop or MIT to join (see <https://groups.mit.edu/webmoira/list/ask-a-maker> to join). As the listserve grows in members and use, we hope to use key metrics to evaluate its effectiveness in meeting its educational goals for increasing design discussions and fostering an even greater sense of community.

C. INDUSTRY-SPONSORED EVENTS

The Mentor community of the MakerWorkshop has been seen by a number of companies as prime targets for job recruitment. Mentors have knowledge not only in design and prototyping using a variety of fabrication equipment and techniques, but they also have management experience through their staffing of the student-run space and supervision of users. Given that Mentors are the ones who also maintain the machines, they also have the skills to solve unexpected problems creatively when machines go down.

To help foster more connections between Mentors and industry, MakerWorkshop aims to increase the number of industry-sponsored events held at the space or with Mentors

and users of the space. As an example, in fall 2017, a MakerWorkshop Mentor-specific information session was held with the NASA Jet Propulsion Lab. Another mechanism by which companies can interact with the MakerWorkshop Mentors is through the hosting of Fab. Fridays (where "Fab." can be considered an abbreviation for "Fabrication" or "Fabulous"), social events for both Mentors and users that often incorporate working on a small-scale project with the goal of strengthening the community of MakerWorkshop, while furthering the mission of a hands-on learning environment [5].

CONCLUSION

The mission of the MIT MakerWorkshop is to foster a student community in a hands-on learning environment where modeling, prototyping, and validation resources coexist. Previous studies have shown that MakerWorkshop has done an excellent job in fostering an environment that is conducive to learning [6] by providing a space and equipment for a community of innovators that focus on deterministic designing and problem solving. At the same time, MakerWorkshop is well-poised to impact students well beyond their time at MIT. This survey of Mentor alumni showed the majority felt that MakerWorkshop was beneficial to them getting a job, was greatly impactful on a variety of skills, and they continue to use skills learned at MakerWorkshop in their industry careers.

Moving forward, additional initiatives are being developed to further prepare MakerWorkshop members with skills needed to succeed in industry through engagement with the alumni community of MIT as Alumni Mentors, the Ask-A-Maker listserve for the discussion of all things making, and the expansion of industry-sponsored events.

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