Building a safety-based culture for a student-run makerspace

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INTRODUCTION

MIT MakerWorkshop* is a new student-run machine shop on MIT's campus. It was founded with the goal of providing extra operating hours; making access more transparent; and sharing fabrication skills among students. Staffing the shop exclusively with students has enabled these goals, but the large staff of varied skill levels presented a unique need to build a safety-centered culture. Makerspaces run by a small staff ensure consistency in culture because they are present every day. When a shop has 30 or more volunteers, designing a safe culture is crucial for sustainability. A student-run shop with large staff and high turnover needs real mechanisms for normalizing safety.

MIT MAKERWORKSHOP

MIT MakerWorkshop is supervised and maintained by 40+ student volunteers known as 'Mentors.' The student Mentors are responsible for the maintenance and operation of, and the training of Users on all machines in the space. To facilitate these tasks, Mentors are divided into teams responsible for a specific area of the shop or group of machines (e.g. Mill Team is responsible for the upkeep of and training of Users on the mill). Each team has a Machine Master, a Mentor who coordinate the other team members to ensure tasks are accomplished. Furthermore, the Mentors elect students to serve on the executive committee, who in turn make major decisions about topics such as policy, purchasing, and membership, in conjunction with the space's faculty advisor, known as the 'Maker Czar.' Currently, the facility has over 800 trained Users comprised of undergraduate students, graduate students, faculty, and staff.

METHODS

To ensure the sustainability of the space, MIT MakerWorkshop was designed with a safety culture in mind from the beginning. Safety was instilled in the organization by making it central to trainings, transparent standards, and the students' sense of ownership.

Mentors, organized into Machine Teams, provide trainings to Users. Every week, each Machine Team is responsible for posting training hours on the website for easy, transparent training registration. The trainer points out the Emergency Stop (e-stop) location at the beginning of every training. Safe operation is the most important learning objective. Beyond safe operation, each training provides instruction on work piece fixturing; necessary Computer-Aided Design/Manufacturing (CAD/CAM) software and important techniques for proper machine operation. These sessions can take between 30 and 90 minutes depending on the User's level of experience and the machine.

Certification happens at the training if the trainer believes that he or she would be comfortable with the user operating the machine on his or her own during the trainer's shift. Almost all trainings end in certification. This high passing rate relies on MIT MakerWorkshop commitment to continuous learning. Users are encouraged to ask questions at the end of trainings. Every machine has a refresher guide designed to help any user who has completed a training double check their knowledge when they return to the machine.

Safety training is taken even more seriously for the Mentors, student volunteers who have supervisory and management roles to the community. Every prospective Mentor is vetted for their 'safety-mindset'. Fig. 1 shows our acceptance rate for new Mentors. The application process requires at least two existing Mentors to recommend an applicant. Beyond that, every member of the community has a chance to review the prospective Mentors and draw attention to safety concerns. The philosophy is that it is easier and less risky to teach advanced machine skills than it is to instill a safety mindset.

New Mentors complete basic trainings for each machine before receiving a separate 'supervision training'. Supervision training emphasizes the importance of safety, and makes sure that Mentors know what risks to look and listen for. After peer vetting and supervision training, the Maker Czar certifies that the new Mentor is ready to ensure the safety of Users in a supervision check-off. As shown in Fig. 2, anywhere between 5 and 30 new Mentors go through this training in a given semester.

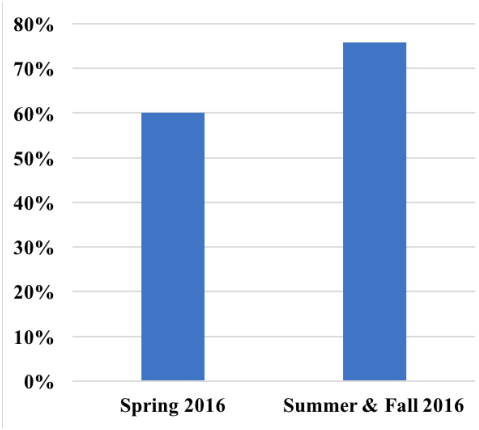

Fig. 1 Acceptance rate of new Mentors based on skill and safety mindset. Note that in Spring 2016, 10 students applied to become Mentors, while for the Summer & Fall semesters, 29 students applied. This Fig. shows that, even though the space was hard-pressed for student volunteers in Spring

* Formerly named MIT MakerWorks

2016, MIT MakerWorkshop did not compromise on our safety-based culture and settled for a lower acceptance rate.

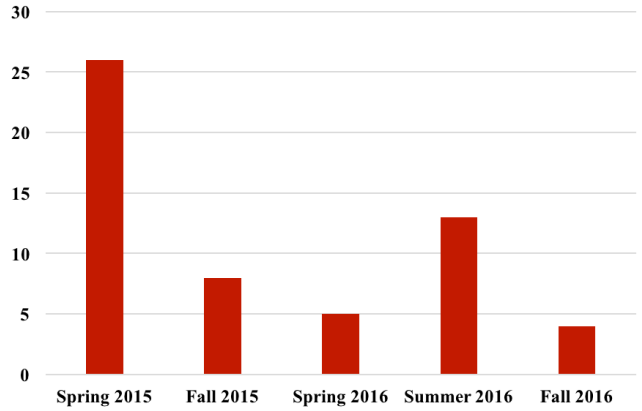

Fig. 2 New Mentors trained each semester. Note that a large number of Mentors (>25) were trained in Spring 2015 prior to the grand opening of MIT MakerWorkshop. After this semester, on average 8 Mentors are trained each semester. In the event of >5 Mentors, multiple supervision training sessions are offered to ensure the average number of Mentors per training does not exceed 5, allowing for a more in-depth and focused training.

Transparent rules and standards are essential to safety in a student-run shop. With a large part-time volunteer staff, miscommunication or confusion is much more possible. Thus, simple and clear rules, written in digestible formats, convey critical safety points like dressing-standards and do's/don'ts. Off-hours access is an important incentive for recruiting Mentors and allowing the space to adapt to User needs. Off-hours access is allowed with specific rules. This policy avoids the needs for exceptions, which can lead to a culture of not following rules. The Off-hours Access Policy is shown in Appendix I as an example of a simple policy guide. Additionally, all machines are classified below the policy as MW1 Class, MW2 Class, and MW3 Class where the classifications are based on the probability of injury when using the machine, and the severity of injury. The least dangerous machines are considered MW1 Class, whereas the most dangerous are MW3 Class. For instance, a User on the 3D printer has a high probability of injury when using the machine, however the injury is not likely to be severe. Fig. 3 shows that the community appreciates the lack of exceptions.

Even with clear policies, off-hours access still has a higher risk of misuse than standard operating hours. To address this risk, cameras are installed and transparent off-hours access rules are posted in the shop. Every Mentor opening the space on off-hours must have a buddy present. That buddy needs to be trained on each class 2 or 3 machine in use. Fig. 4 shows that the clear, public posting of this policy ensures that the majority of the mentors know the policy, know where it is posted, or feel comfortable asking about it.

A universal sense of ownership among the community is critical to safety. If students feel responsible for the sustainability of the space, they will apply the extra effort to operate machines safely. Orientation, or 'Maker Monday,' is the first part of building that sense of ownership. This training is followed by a session on hand tools and proper workpiece fixturing. Every user must go through a 'Maker Monday' to access the space because culture and expectations are the foundation of safety. After orientation, users must get training or certification for each machine in the shop.

At these 'Maker Monday' orientations, the Mentors emphasize an important point that is repeated often in the community: this space exists because students choose to respect the safety policies all the time. There is no tolerance for ignoring Mentors or making exceptions to rules in a safe shop. This mantra is explained to users who find the rule-following tedious. Because the shop is not necessary for any course, Mentors are able to kick out any user for improper or unsafe behavior. Fortunately, no Mentor has needed to exercise that responsibility. When explaining this cultural strength of MIT MakerWorkshop to new users, Mentors set the expectation that new users will not change this record.

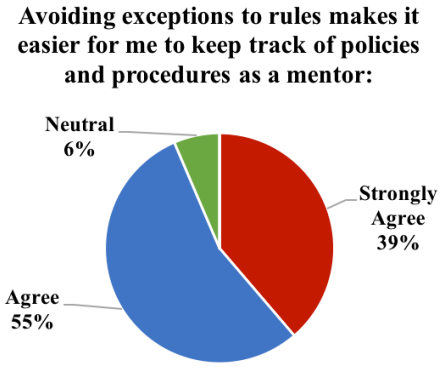

Fig. 3 Shown in this Fig. are the results from a survey sent to all the Mentors of the MIT MakerWorkshop in Fall 2016. Of the 31 respondents, the vast majority of them reported that that avoiding exceptions makes is easier to enforce safety policies. Note that no respondents chose "Disagree" or "Strongly Disagree" to this question.

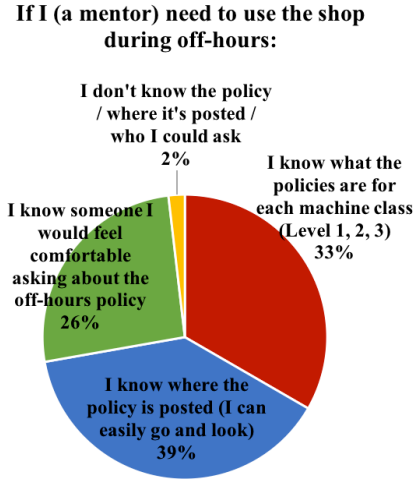

Fig. 4 This Fig. shows the results from a survey sent to all the Mentors of the MIT MakerWorkshop in Fall 2016. Of the 31 respondents, almost all of them either know the policies for operating the machines off-hours, know where the policy is posted, or feel comfortable asking someone about the policy.

RESULTS

In its 1.5 years of operation, there has only been one minor injury at MIT MakerWorkshop. A user sliced his thumb with a putty knife while removing a part from the 3D printer bed. This incident motivated a change in the User shop orientation, 'Maker Monday', to further emphasize the importance of proper fixturing and the hazards of hand-tools. This example of improper tool use was used as a lesson to learn from. At MIT MakerWorkshop, we continue to strive to create an environment where the rules are clear, exceptions are avoided, and Users feel comfortable and empowered to ask questions. By making the safety culture central to every aspect of training, policy, and operation, we hope to ensure MIT MakerWorkshop is a safe space.

CONCLUSION

At MIT MakerWorkshop, safety is not only a number one priority, but it is emphasized through the community of Mentors who run the space and detailed in policies that are easy to understand and enforce. Additionally, clear, publically posted policy guides allow for the dissemination and retention of safety policies.

ACKNOWLEDGEMENTS

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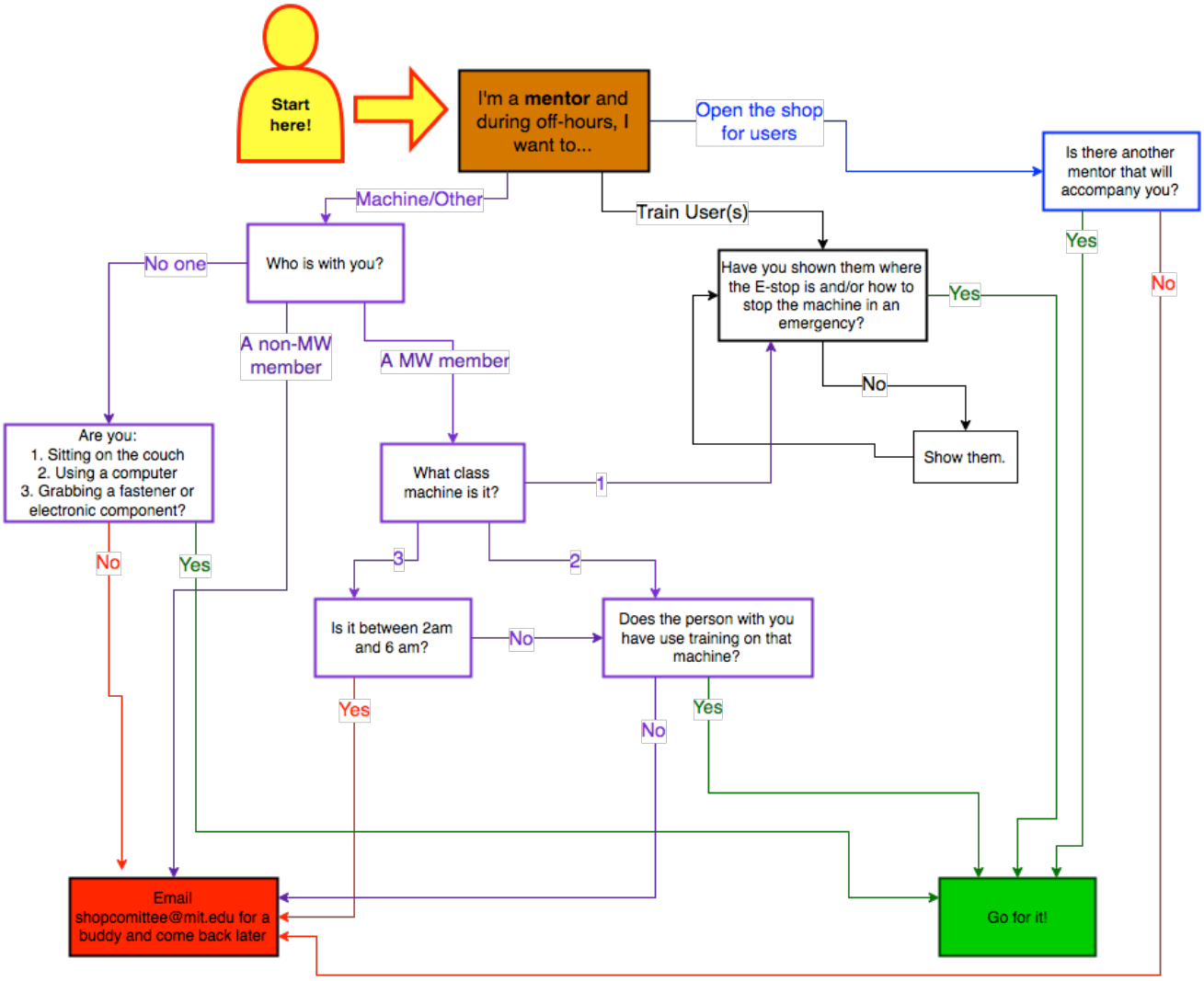
APPENDIX I: EXAMPLE OF SIMPLE POLICY GUIDES - MENTOR OFF-HOURS ACCESS POLICY.



MW1 Class		MW2 Class		MW3 Class	
Machine	*(Probability, Severity)*	*Machine*	*(Probability, Severity)*	*Machine*	*(Probability, Severity)*
Cordless drill	(2,1)	Laser Cutter	(1,2)	Angle grinder	(3,2)
Palm Sanders	(2,1)	Water Jet	(1,2)	Circular Saw	(3,2)
Dremel Tool	(3,1)	Band Saw	(2,2)	Lathe	(3,3)
Jigsaw	(2,1)	shopbot	(2,2)	Milling machine	(2,3)
Non-powered hand tools	(3,1)	cold saw	(2,2)	Drill Press	(3,3)
3D Printer	(3,1)	soldering iron	(2,2)	Belt/disc sander	(3,2)
gen. electronics	(1,1)			Miter Saw	(3,2)
				Bench grinder	(3,3)