Trust as the Foundation for a Successful Balance of Power in a Student Run Academic Makerspace

Evan L. T. Davies[1], Reed D. Morris[2], Amit S. Jariwala[3]
[1]G.W.W. School of Mechanical Eng., Georgia Institute of Technology; email: edavies@gatech.edu
[2]G.W.W. School of Mechanical Eng., Georgia Institute of Technology; email: reed.morris@gatech.edu
[3]G.W.W. School of Mechanical Eng., Georgia Institute of Technology; email: amit.jariwala@gatech.edu

Introduction

As academic makerspaces proliferate across the world, best practices and research on their impacts are emerging [1,2,3]. Various models for finances, staffing, safety, and responsibility are represented across the makerspace landscape [4]. One particularly vexing challenge for both new and established makerspaces is how to balance control, or power, in an academic makerspace between students and non-students (e.g., administrators, staff, faculty) for maximum success. Some universities treat their makerspace similar to a traditional lab space, under faculty control with paid students running day-to-day operations, but having little ownership [5,6]. Others think that it should be run by full-time staff, similar to how traditional machine shops are run [6]. Yet others embrace a student-run model, in which student volunteers are responsible for running all of the key aspects of the space such as operations, finances, equipment maintenance, and leadership. Trust is the foundation for a successful balance of power in a student-run academic makerspace, between the student leadership and the school administration.

The student-run model for an academic makerspace relies heavily on trust and communication between students and school employees, faculty and staff members. While nationally, makerspaces have significant positive impacts on the academic environment, there are significant concerns about the risks and liabilities that come with a makerspace. Schools are apprehensive that there is an increased risk of safety due to students having less experience than professional staff. Furthermore, students are not perceived to have any prior managerial and financial competency. As such, the natural reaction of many institutions is to place makerspaces under the control of those that they instinctively trust; i.e. faculty and staff. However, this can be restrictive for students. Students thrive in a space where they can freely develop new ideas in an unconstrained manner. They want to be able to go from ideation to creation without a high barrier to entry such as extensive training or qualifiers. Beyond the surface level opportunities that makerspace presents, students want to have a chance to refine skills in leadership and communication.

We report on the establishment of a delicate, yet enduring system of trust between the student leaders, administration, and faculty that underlines a highly successful student-run makerspace at the Georgia Institute of Technology, called the Invention Studio. The nature of this relationship has allowed the student leadership to effectively run the space with the school providing guidance and support as necessary.

Trust:

According to the Merriam-Webster dictionary, trust is defined as "assured reliance on the character, ability, strength, or truth of someone or something. One in which confidence is placed. [7]" Trust for a makerspace can be distilled down to communication, reliability, transparency, and asking for help. Communication is a requisite in any group endeavor, but it is especially vital when maintaining an "unprecedented" trusting relationship. Trust can't be a half measure, partners must trust that their counterparts are being honest and open with them. Lastly, a sure sign of a healthy, trusting relationship is to feel comfortable asking others for help in a difficult situation. While it is important for the institution to trust the students and give them a chance to succeed, it is equally important that students are able to trust that institution in return. This predominantly comes down to the students expecting the administration to support their decisions and provide guidance as needed.

Methods

A system of trust was evolved through iterative experiences over a period of ~8 years (March 2009-present) between the stakeholders in the makerspace (users, student volunteers, faculty, staff, departmental leadership). While the practices described in this work are mature, they are still evolving and represented is a snapshot in the evolution of the academic makerspace. Initial efforts have improved through learning from disturbances as well as proactive efforts of many hundreds of stakeholders over these years. Failures are an inevitable part of a student-run makerspace. What can be startling is how beneficial failing can be for students. Failures result in some of the most impactful and lasting lessons, but are only empowering if failures are treated as an opportunity to reflect and grow, not as a time to assign blame or punishment. An acceptance of the concept "need to fail" has allowed the space and the stakeholders to learn and evolve, not just from successes, but also from mistakes.

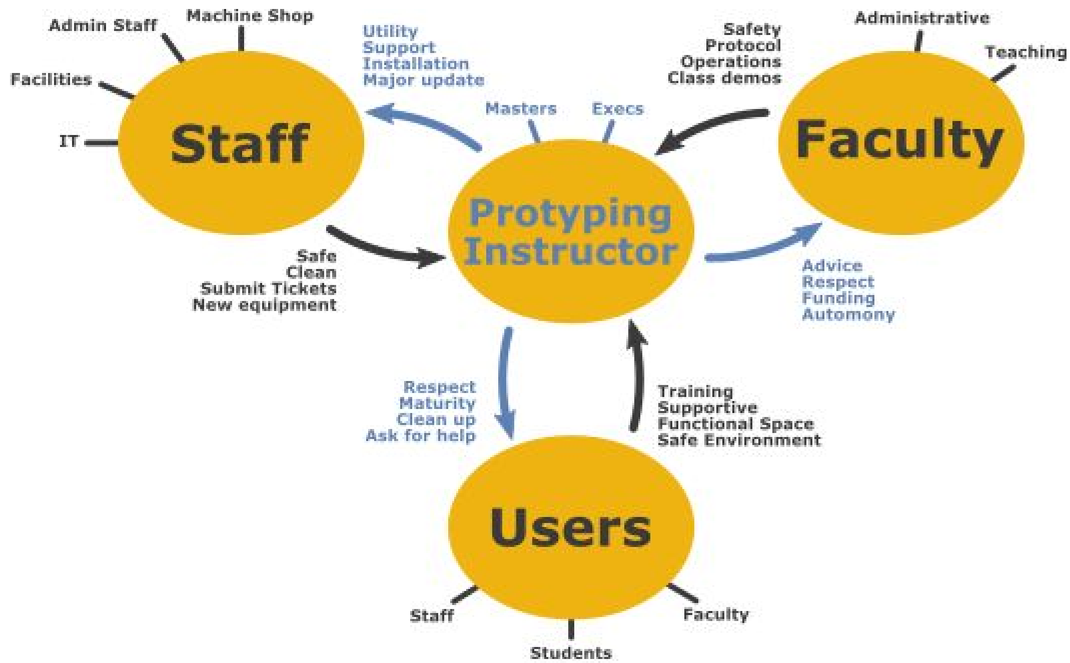

Fig. 1 Expectation of Various Stakeholders within the Invention Studio

Results and discussion

Overview of trust system between stakeholders:

The key stakeholders of the Invention Studio comprise of four groups: staff, faculty, student volunteers, and users. The staff comprises of traditional support members such as administrative staff, facilities, IT and machine shop. Faculty includes both administrative faculty and teaching faculty. The student volunteers are known as Prototyping Instructors (PI), not to be confused with Principal Investigator. The executive board (execs) is composed of elected student leaders and represent the Invention Studio student organization. Prototyping Instructors who have specialized in specific tools are known as masters and are responsible for providing advanced training of the tools, completing general maintenance, and providing input into the acquisition of additional tools. The users of the Invention Studio include not just students (undergraduate and graduate), but also staff members and faculty as well. To use the space, one is simply required to be affiliated with the Institution. For successful operation of the Invention Studio, it is necessary for the four groups to coordinate and to work together.

On a daily basis, a trusting relationship is comprised of clearly defined expectations and roles of all parties involved. Fig. 1 shows the expectations of the various key stakeholders involved with the Invention Studio (and any makerspace in general). The blue arrows pointing away from the PIs depict the expectations that the PIs have from the other stakeholders. The black arrows pointing toward the PIs are what the other stakeholders expect in return from the PIs. The overall theme of this relationship is trusting and utilizing the various strengths of the different stakeholders. All parties are heavily encouraged to ask for help and support from each other. For example, when the space is looking to buy new equipment, the Prototyping Instructors lead the search for what equipment and brand. They use feedback from the users to determine what features are useful, work with the faculty to determine the value added to the space and communicate with facilities to ensure that the proper utilities (water, power, air) are available.

Specific examples of cultural norms and practices:

Throughout its eight years of existence, the Invention Studio has evolved a set of cultural norms and practices that help maintain a steady relationship with the George W. Woodruff School of Mechanical Engineering at Georgia Tech. These cultural norms and practices are what reassure the school administration that the student leaders of the Invention Studio can be trusted and relied on to effectively and safely run the space. In general, these practices can be separated into four distinct groups: safety, communication, accountability, and leadership succession. This paper will highlight the key practices in each group.

a. Safety

The Invention Studio student leaders recognize that safety is the most important aspect of the space [8]. At best, the space is one major incident away from the students losing the autonomy that they so dearly enjoy and at worst the risk that space would be completely shut down. As such, when a Prototyping Instructor is on duty, they are given wide authority on what they are allowed to do to enforce safety. Regardless of whoever enters the space, the PI is expected to inform them if they require safety protection such as safety glasses, closed toed shoes, hair tied back, etc. If a PI thinks a user is being unsafe, or even if there are simply too many people in the room for the PI to safely observe, the PI is empowered to ask the user to leave, regardless if the user is a student, tour group or faculty. The PI knows that as long as their actions were reasonable, the student leadership and school administration will support the decision. The support of the school and student leadership is extremely important because this allows the PIs to err on the side of safety without the fear getting into trouble for asking an influential person to follow inconvenient safety rules. To help with accountability all the rooms have or are in the process of having security cameras installed. The security cameras play two roles: 1) Prevention 2) Reviewability. In general, users tend to behave when they know "big brother" is watching. If an incident does occur, video playback can also be used to evaluate what went wrong and guide future prevention.

Sufficient training for all volunteers is also crucial to maintaining the safety of the space. To ensure that all PIs are adequately trained, a training checklist has been implemented by the student leadership [8]. This checklist requires potential Prototyping Instructors to demonstrate proficiency in the most commonly used tools and the ability to train others in their use. As the tools in the Invention Studio change, so does the checklist to ensure that the potential PIs are being trained on the most current tools. In addition, if a particular skill deficiency is noticed throughout the general user base, the checklist is modified to emphasize training of this skill set. The checklist is maintained by the Director of Operations (student executive) who receives input from the masters of each room on what content is necessary.

b. Communication

Communication is a key aspect in maintaining trust between different groups. At the Invention Studio, there are key communication points within the organization and update/planning meetings with various school representatives. To coordinate the day-to-day activities, the student leadership meets on a weekly basis. The masters also have weekly meetings, whose summaries are then reported to the student leadership. These meetings are open to everyone and frequently the faculty advisor and support staff attend to provide insight and guidance as necessary. To keep all the PIs informed, there is a general meeting every month and a safety meeting every semester, both of which all PIs are required to attend. If an academic class intends to integrate the Invention Studio into required classwork, the student leaders try to meet with the faculty to coordinate the best use of the space without overwhelming the space and still keeping it accessible to other users. At the beginning of each fall and spring semester, the student leaders meet with the School Chair to share an update on the state of the space and the student organization.

c. Accountability

With large amounts of resources driving the growth of makerspaces it can be daunting to relinquish control of the budget management to students. In addition, some institutional policies restrict purchasing to specific parties. To ensure that the Invention Studio is financially responsible, the Director of Finance (student executive) works with the faculty advisor and the rest of the student leaders to develop a budget for the next fiscal year. The Director of Finance is then responsible for tracking expenses to ensure that the student organization follows the budget. The budget is not used as a rigid financial constraint within which all expenses are made, but rather to provide a guideline for planning the year long activities. Exceptions to the budget are allowed provided that they have adequate justification and funds are available. The Invention Studio (like any other unit on campus) is required to follow all of Georgia Institute of Technology policies and as such all purchases require the approval of the spend authority and the finance office before any purchases are processed. The majority of purchases are approved without a second glance (if they are already accounted for in the budget), however large purchases are discussed with guidance from faculty and staff to determine if they would indeed add value to the space and if any additional utilities are needed to be installed. This open and transparent process allows the student to have a direct say in what is and isn't purchased for the Invention Studio, while assuring the school that the student organization is maintaining financial accountability.

d. Leadership Succession

Due to the nature of the university system, the turnover rate for student volunteers is very high. The "lifespan" of a typical undergraduate student is around 4 years, and most students elect to become PIs after spending a few semesters. In a space that has become critical in supporting design classes, it is important to ensure that a smooth transition of responsibilities occurs every year. To allow for this, general elections for the new executive board are held, during the spring semester, a month before the prior execs are expected to hand over the reins. During this month transitional period, the previous execs are expected to train the new execs in their expected roles. In addition, the previous execs are expected to be accessible during the summer to answer questions about the role, particularly regarding initiatives set up during the previous year. Lastly, during the transitional period, a luncheon is scheduled with the prior execs, new execs and key faculty and staff members. This is a time for all stakeholder groups to discuss the previous year and set goals for the future. To simplify this process, an executive handbook is being developed as an easy to access resource for the new execs to use, providing role description, key contacts within various stakeholder and ongoing initiatives.

At the Invention Studio, each major tool, or tool groups, is maintained by students known as masters of the tool. Though this position they gain a specialized body of knowledge that they, in turn, are expected to teach to the next generation of students, their apprentices. To complete their apprenticeship, the apprentices must master the tool's advanced features, be able to repair and maintain the tools, and provide at least one workshop to teach other students about the tool. This generational approach allows for a transfer of knowledge to combat the effects of the high turnover rate from students graduating.

Disturbances

To illustrate the importance of this trust system, we present three examples of events in which the system was tested and endured. We provide a description of the event along with the roles of the student leadership and school administration, and the modified policies to prevent the same mistakes from repeating in the future. An analysis of three key scenarios and the steps that the leadership took to resolve the issues follows.

Event 1 involved an injury to a student and the resulting impact on the trust system and practice in the Invention Studio. To remove support material from 3D printed parts, users use metal scrapers. Despite not being very sharp, a careless gesture can quickly lead to a hand injury. In one such instance, a user cut themself and instead of informing the PI on duty, or using the first aid kit in the room, the user decided to go the bathroom to wash off the blood. Unbeknown to them, the user dripped blood all over the work table and then along the path to the bathroom. Since blood is classified as a Biohazard, when facilities discovered the blood, they were required to call the Institution's Emergency Health & Safety (EH&S) department. While reviewing this incident, security cameras showed that the user had deliberately avoided the PI on duty's attention to avoid anticipated consequences. As a result of this incident, the student leadership immediately enacted a new policy that required users to use safety gloves to protect their hands while using scrapers in the print room. The quick reaction from the student leadership and the security footage absolving negligence on the PI's part satisfied the EH&S and no other repercussions occurred.

Event 2 involved the coordination between academic classes and the makerspace. The Mechanical Engineering's Introduction to CAD class decided that all students would be required to 3D print their final project, to gain experience in designing for additive manufacturing. On paper this is a significant benefit to the students, however, in application, it turned into a major problem. Every semester the class size is 250 students, all needing to successfully print a multipart assembly in the span of two weeks. The problem was further exacerbated by the many parts that were poorly designed for additive manufacturing and resulted in high failure rates. In addition, the timeline to print the parts was set during the final competitions for other design courses, which were already starting to strain the ability of the 3D printer fleet to keep up with demand. This resulted in bottlenecked usage of the printers and many students were unable to finish their parts on time. The 3D print masters have an ongoing dialog with the faculty teaching the classes to trial new solutions. This has included having the print masters guest lecture about designing for additive manufacturing, which later was officially incorporated into the course curriculum. The studio has also explored reserving a portion of the printer fleet to use for the specific class and scheduling the classes to use the 3D printers during times when the space is closed to the general population. Lastly, a large capacity industrial grade printer was bought for the Invention Studio with the intention that it would be used primarily to support the CAD and design classes. This problem has no perfect solution yet and coordination with faculty will continue until an acceptable solution for all is found.

Event 3 involved a serious conflict between the student leadership and the school administration. A student with limited after hours access, granted by being involved with a competition team, abused their after hours privileges by working on a non-team related project. As such, the Invention Studio President unilaterally decided to revoke access to the space for the student as well as for the entire competition team, as per an oral agreement with the student's team. The School's administration overruled the decision to ban the whole team for a violation of a single user. Unhappy with this decision and believing that the student leadership's "sovereignty" was in jeopardy, the president, with a slim majority of the execs, choose to cease staffing the space in protest. As this event was nearing the end of the semester, this had immediate repercussions to the Institution's senior/capstone design competition. While the studio reopened within a few hours after discussions between faculty and students, this event highlighted the need to take a deeper look at the operational protocols and establish clear guidelines with regards to autonomy and control between the various stakeholders of the Invention Studio. The Dean of Student Affairs was invited to review this matter and provide guidance. An ad-hoc committee of faculty and a student representative from the Invention Studio developed a policy manual for the Invention Studio. The student organization's constitution was created with a clause highlighting the role of the joint student-faculty committee who would have overall oversight and act as an appealing body for redressing grievances. The organization's constitution also clarified the steps necessary to remove a rogue student executive from their position if an abuse of power ever occurred again in the future.The strike, while no means advisable, did produce some productive results. Faculty members were forced to acknowledge that the Invention Studio was a key cog in the academic setting and not some fun hobby spot. In addition, the amount of hard work that the student volunteers contribute to making the space successful was recognized. In return for these concessions however, it was made very clear to the Invention Studio that any future strike, or attempt at disrupting an academic class, would NOT be tolerated in any regard.

All three of the previously described events highlight a different facet of the relationship of trust between the stakeholders. Event 1 showcases how the student volunteers and facilities interacted to solve a safety incident and reduce the likelihood of similar incidents occurring again in the future. Event 2 reaffirms the importance of the student leaders, faculty, and users coordinating to avoid overburdening the resources of the Invention Studio. Event 3 highlights how dangerous it can be when the system of trust is severely damaged, but also how important it is to learn from past actions, good and bad. In any makerspace, large and small disturbances will occur that will impact the baseline level of trust. The key is to use the failures to grow and raise the baseline, so that the next time a similar issue arises, the tools for solving it are already there.

Conclusion

A large question in the academic makerspace community is who leads whom in the operation of a makerspace. The Invention Studio leadership model has shown that it is possible for student leaders to be successful at running an academic makerspace. The student-run model provides students with an opportunity for significant learning experiences, not only in making, but also in leadership, teaching, and responsibility. These opportunities would not necessarily be available in other staffing models. At its heart, a student-run makerspace is a partnership between student leaders and school employees that requires a fundamental trust between the stakeholders to be successful. This trust must be strong and flexible enough to survive and improve from mistakes and disturbances. This revolutionary partnership between the students and employees is helping to positively disrupt the academic mission and pave the path for a new tomorrow.

Acknowledgments

The authors of this paper would like to thank the following supporters of the Invention Studio and its mission:

The George W. Woodruff School of Mechanical Engineering - particularly School Chair, Dr. Bill Wepfer - for the
continuous commitment to hands-on education, and for the belief in and support of the student-run makerspace model.

Dr. Craig Forest, for inspiring the founding members of the Invention Studio, reminding the space of its history and roots, and for the constructive advice and encouragement on this paper. The Invention Studio would not be what it is today without his invaluable input and creative vision.

Dr. Julie Linsey, for the advisement, resources, and time devoted to the Invention Studio and its student volunteers.

Mr. Clint Rinehart, for his expert guidance and mentorship on tool operation and repair.

References

[1] R. S. Kurti et. al. “The Philosophy of Educational Makerspaces Part 1 of Making an Education Makerspace,” Teacher Librarian, 41(5), 2014, 8-11

[2] V. Wilczynski et. al. “Higher Education Makerspaces and Engineering Education,” in Proceedings of the ASME International Mechanical Engineering Congress and Exposition, 2016.

[3] J. Linsey et. al. “Understanding the Impact in University Makerspaces,” in Proceedings of the 1st International Symposium on Academic Makerspaces, 2016, 188-191.

[4] C. Forest et. al. “Quantitative Survey and Analysis of Five Maker Spaces at Large, research-Oriented Universities,” in Proceedings of 2016 ASEE Annual Conference & Exposition, 2016.

[5] John E. McMordie et. al. “Coaches and Their Impact: One Model for Empowering Teaching Assistants in an Academic Makerspace,” in Proceedings of the 1st International Symposium on Academic Makerspaces, 2016, 118-122.

[6] T. W. Barrett et. al. “A review of University Maker Spaces,” in Proceedings of 2015 ASEE Annual Conference & Exposition, 2015, 26.101.1-26.101.17.

[7] “Trust,” Accessed at https://www.merriam-webster.com/dictionary/trust July 21, 2017.

[8] A. Jariwala et. al. “Safety in a Student-Run Makerspace via Peer-to-Peer Adaptive Training,” in Proceedings of the 1st International Symposium of Academic Makerspaces, 2016, 81-99.