

# Sustaining a diverse and inclusive culture in a student run makerspace

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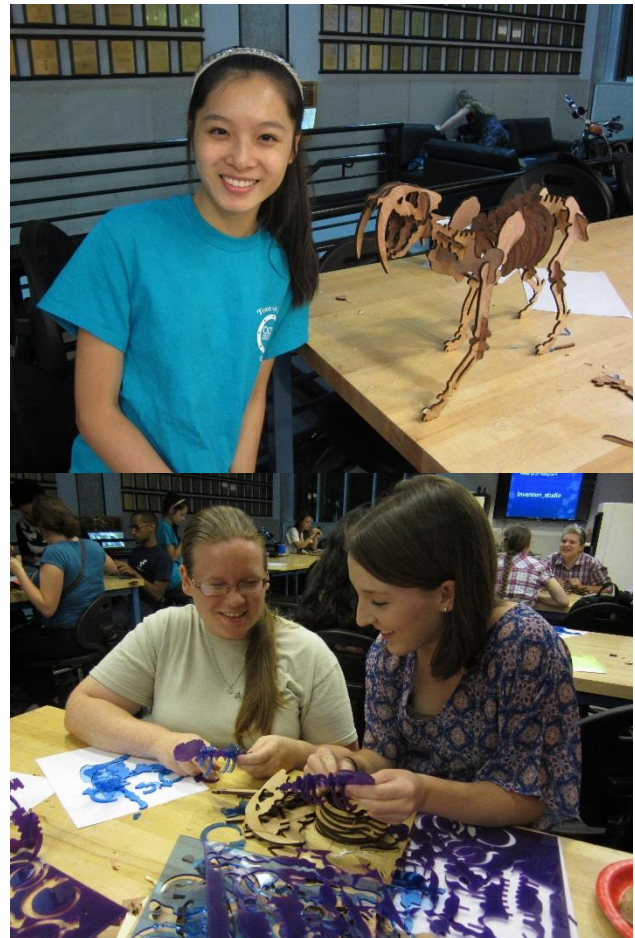
## INTRODUCTION

The Invention Studio at Georgia Tech a student run makerspace equipped with over \$1 Million worth of fabrication equipment within a 4,500 square foot facility. The space is free for all students, faculty and staff of Georgia Tech to use, regardless of major, age or experience. The most unique aspect of the Invention Studio is its student-led culture; more than 75 students, known as “Prototyping Instructors” (PIs), volunteer three hours a week to staff the space. During this time, the PIs oversee the safety of users, provide one-on-one machine training and offer design advice for projects. On a typical day, nearly 400 students use this space for various projects, ranging from class assignments to research to personal projects.

The Invention Studio is located in the heart of the mechanical engineering building on campus. Although the Invention Studio is open to all students, we find through observation that the majority of daily users are mechanical engineering students. There is a drive for diversification within our users and volunteer PIs to help foster innovative collaboration in class, research and start-ups. Recently, studies have observed a positive correlation between knowledge diversity and innovation within companies [1]. Since its founding in 2009, the Invention Studio has run various outreach programs and workshops to reduce the barriers to entry and to stimulate interest in the makerspace. Through various outreach activities, the studio was able to reach diverse groups of people through a variety of teaching methods aimed at promoting STEAM topics. These activities help the Studio accomplish one of its core missions, which is to instill creative confidence outside of the course curriculum. This paper presents some of the best practices and programs developed to foster diversity and inclusion in higher education makerspaces.

## REDUCING BARRIERS TO ENTRY IN MAKERSPACES

Before developing sustainable programs for diversification, existing barriers to entry for the Invention Studio must be identified. Qualitatively, the Invention Studio has observed four main barriers to entry over the



*Figure 1: Photos from the Ladies night at the Invention Studio*

past eight years: anxiety due to lack of experience, a lack of information regarding equipment and usage, a fear of alienation, and a pre-existing notion that makerspaces are only for engineering. Here we list various techniques used to reduce each barrier and promote inclusion.

### A. PROVIDING EQUIPMENT TRAINING SESSIONS AND TOURS

A significant barrier to entry observed among most users of the Invention Studio is the preexisting notion that

machining experience is needed when using the space. While this may be true for traditional machine shops, our student run makerspace culture promotes “learning through doing” under student supervision for all our machines. Basic machine training is offered by PIs on a walk-in basis during open hours and advanced machine training group sessions are organized throughout the semester. These group sessions are targeted primarily at users who wish to become Prototyping Instructors, but are open for anyone [2].

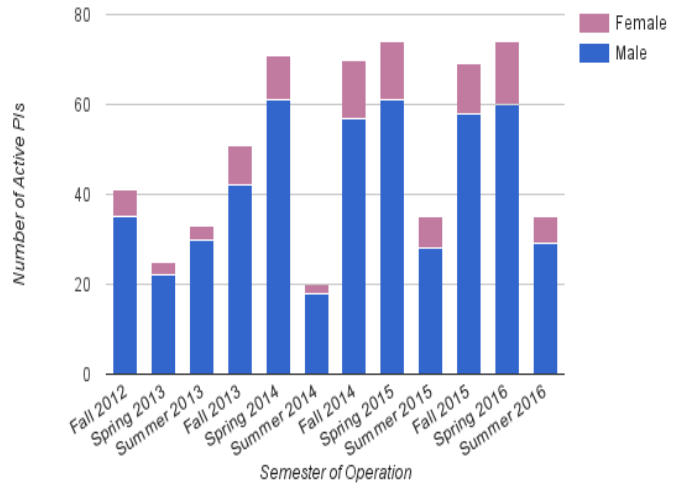
In order to increase awareness about the Invention Studio among the students, the Studio hosted numerous advertised workshops focused on providing fabrication experience to newcomers. In 2016, the Invention Studio hosted an event titled “Collectible Creations” to provide group based hands-on training on various machines through a simple project. Advertising was done through the Student Center Programs Council (SCPC) at Georgia Tech to reach a larger spread of students. The event consisted of hour-long workshops over a three-day period, in which four different projects were available each day. Projects included a laser cut 3D puzzle, a waterjet steel figurine, a 3D printed candy dispenser and an electronic LED Altoid tin bike light. Recorded attendance was over 150 students.

Weekly tours of the Invention Studio are provided to inform students of the resources available within the Studio. Numerous tours are offered to primarily target freshman level courses, specifically GT1000, a first-year seminar that works to ease students from all majors into college life. On an average, over 100 new students per week attend these tours.

**B. PROMOTING INCLUSION THROUGH GROUP EVENTS**

During Fall of 2014, the Invention Studio hosted its first and largest outreach event titled “Ladies night at the Invention Studio”. The event developed as a way to generate more female interest in the studio; out of the 65 Prototyping Instructor’s, only 9 were female at the time. The Invention Studio had run workshops in the past, but none had been specifically targeted towards introducing women to the Maker culture. Even within the Georgia Tech community, females are only 31% of the total student body. Within engineering, the percentage is only 28%. The national average of female engineering students is at 18% [3]. With such a small female population, it can be difficult to find like-minded female students, or even to inspire women to become designers and innovators.

The event consisted of participant’s laser cutting their own 3D acrylic or wood puzzle (Figure 1). The laser cutter is a great tool for introduction into fabrication; it requires no previous knowledge in engineering and can be easily taught to a large group. After cutting their own puzzle, the students would build their puzzles among other



**Figure 2: Gender demographics for the Invention Studio**

participants, giving them an opportunity to meet similar-minded students and start to build a tighter-knit female community. By the day of the event, over 300 RSVP’s were received, as well as a request from the director of the Women in Engineering group to video record the entire event.

Attendees had a very positive experience, and they said: “If you guys hosted something every other week I would come to it [workshops] every time because it’s such a neat opportunity!”, “I would like more events where I can learn tools and make something creative”, and “Please have more events to build things! This was such an awesome idea!!!”. Faculty members who attended the event stated “This event was amazing. Students had a great time. It was a wonderful outreach activity for the Invention Studio and a great way to increase membership and PIs [student makers] long term!” The demographics from the event are seen Appendix A.

Since the first event in Fall of 2014, the student leadership has made “Ladies night at the Invention Studio” a biannual occurrence, with each event showing similar demographics. The number of female Prototyping Instructors has risen since the introduction of “Ladies night”, as seen in Figure 2.

**C. PROMOTING DIVERSE INTERESTS**

How does a makerspace reach out to students whose interests lie outside engineering? Science, technology, art and math (the four additional components of STEAM education) can be incorporated into makerspace culture through targeted workshops, much like the biannual Ladies Night event. One recent event, titled “Steel Roses,” proved to be an effective introduction to metalworking for

students. This workshop walked participants through creating a rose out of a steel sheet and rod (**Figure 3**). The students used the waterjet cutter to create the flat pattern for petals and leaves, then the belt sander, spot welder, and pliers were used to shape their rose. Students were creative with how they shaped their rose. Some were quite ornate, while others were more simplistic. This project connected engineering and art, as students had to consider how the steel would behave as they bent it into shape. “Steel Roses” had room for 36 attendees. Upon being announced on social media, the workshop slots filled within an hour. Within a day, nearly 100 students indicated interest in the event. Gender and department of study were recorded for all 36 participants and are presented in Appendix B. Over the following week, many students returned with their roses to heat treat and color them. One participant decided to become a Prototyping Instructor from her experience at the workshop.

Another popular workshop incorporating art and engineering is “Introduction to Stained Glass”. Using the copper foil technique, participants wrap cut glass pieces in copper foil and solder them together along the seams to create colorful patterns. Over 100 students have participated in this workshop in the three years it has been hosted.

During Summer of 2016, the Invention Studio hosted a workshop titled “Give a Helping Hand!” In this workshop, participants assembled 3D printed plastic prosthetic hands as gifts for children whose families cannot afford conventional prosthetics. Each participant was given 31 3D printed parts, wires, Velcro, and fasteners and asked to assemble the parts into a fully-functional prosthesis. The finished hands were donated to the Hand Challenge, an initiative to give prosthetic hands to children in need. This event was marketed heavily toward biomedical engineering students to attract them to the Invention Studio, though all majors and years were welcome. Attendance was evenly distributed among seven different majors as shown in Appendix C. Participants were primarily fourth year students, along with one alumnus, some graduate, third year, and second year students. Interestingly, one attendee was a student at nearby Clayton State University majoring in Information Technology. He had no formal connection to Georgia Tech and attended purely out of interest in makerspaces and 3D printing.

#### D. THE IMPORTANCE OF STUDENT LEADERSHIP

A critical component to outreach success is having efficient and effective student leadership in place. For a workshop or event to run smoothly, student leaders must be organized and communicate clearly with each other and workshop participants. In the Invention Studio, workshops are typically a collaboration between the Director of



*Figure 1: Photos from the Steel Roses workshop*

Programming, Director of Communications, Director of Finance, and other Prototyping Instructors who are interested in helping. Programming coordinates event times, dates, venues, and activities. Communications handles promotion and advertising. Finance purchases materials and records spending for the event. This system has worked well to prevent overburdening a single student in organizing large events. When the management is efficient, few problems occur and workshops run smoothly, making participants happier and less frustrated.

#### CONCLUSION

By providing equipment training sessions and tours, promoting inclusion through group events, and encouraging diverse interests, the Invention Studio is able to lower the boundaries to making for students across campus. While some students are brave enough to walk in and immediately use the space on their own, the vast majority need guidance to build confidence in the space. The Invention Studio’s successes in diversification and

inclusion are primarily due to the student-run culture. Newcomers feel they can relate more easily to other students, lowering anxiety and creating a space of psychological safety. A student leadership that delegates work proficiently is also important for outreach success.

However, there are still barriers to entry that may deter students from utilizing the space. Namely, students must still purchase their own building materials, except for 3D printing filament. Access to materials, whether out of expense or out of close proximity to the space, can be problematic for students. Currently, the School provides materials for those who wish to complete the PI checklist. Those who are PI's can apply for a "Maker Grant"; the student submits a full proposal for a project, detailing new skills and techniques they will learn. Proposals go through an approval process with the student executive board and the Director of Design & Innovation. If approved, the PI can receive funds for materials and supplies to build their personal project. The student organization is also currently working on establishing a materials' cabinet. Students will be able to purchase building supplies and hardware inside the Invention Studio; this will help those who may not have access to transportation.

Providing a variety of workshops and events is key to attracting a diverse group of students. Traditionally, women and non-engineering majors have stayed away from using the space for personal projects, likely out of a feeling of alienation. However, by hosting events that cater to diverse interests, it is possible to attract diverse groups and make them feel welcome in the space.

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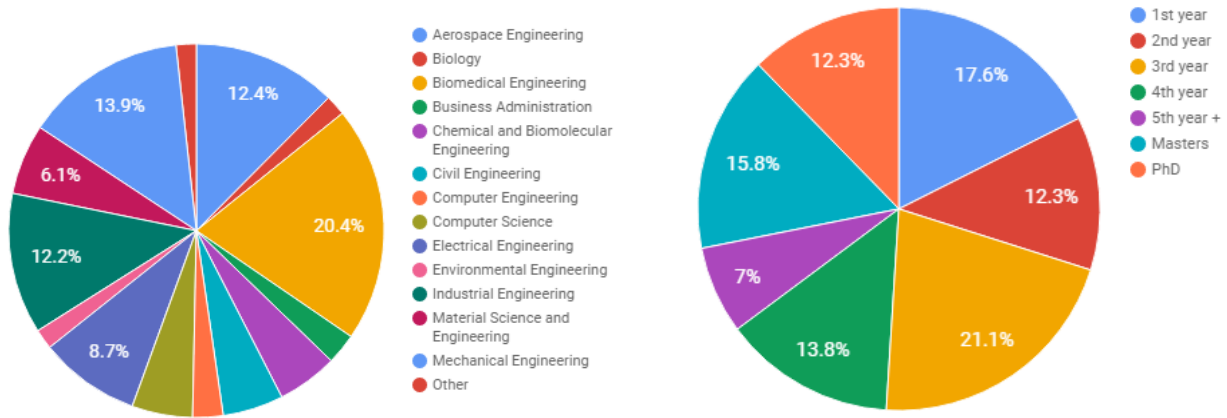
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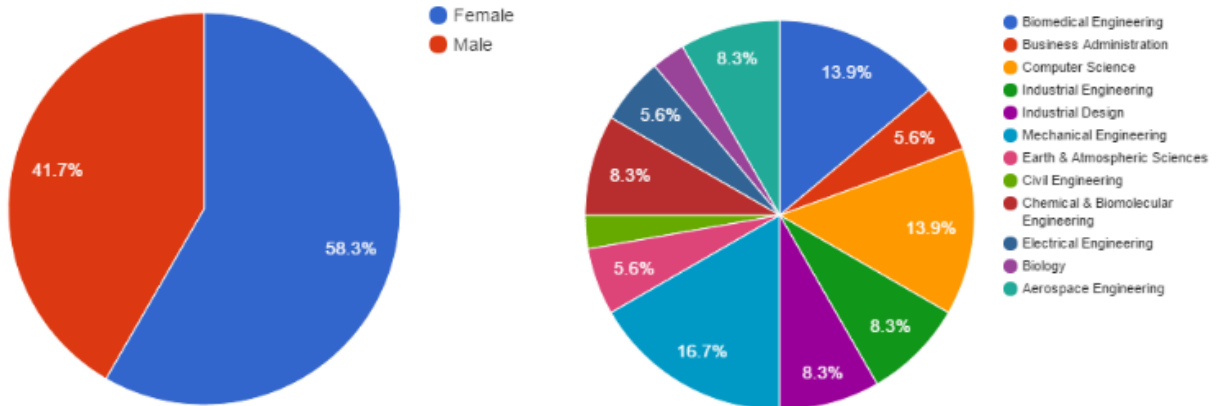


**APPENDIX A: LADIES NIGHT DEMOGRAPHICS**



**APPENDIX B: STEEL ROSE WORKSHOP DEMOGRAPHICS**

**Gender**



**APPENDIX C: GIVE A HELPING HAND WORKSHOP DEMOGRAPHICS**

**Year**

