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The Student-led Development, Design, and Implementation of an Interdisciplinary Makerspace

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Abstract

As universities increasingly strive to create campus environments that encourage interdisciplinary innovation, the maker and hacker space movement has gained significant traction as a solution with great promise, potentially empowering students to bring their own ideas to fruition. Identifying and designing spaces that can appeal to students across campus can be a particular challenge, especially from the perspective of faculty and administration. Faculty design teams aided by student advisors can be seen as a logical answer to this problem, but what of student teams leading the movement on their own campuses? As a team of eighteen undergraduate students that hail from different disciplines, we are currently in the beginning stages of implementing a fully-functional maker space in the primary library for undergraduates.

Our planning was and is strongly informed by the Stanford d.school method of design thinking consisting of five fundamental steps of: empathizing, defining, ideation, prototyping, and testing. Using this method as a framework, we will describe our experiences with the development, design, and implementation of a student-led makerspace. Given that it is rare for students on our campus to take on a task as seemingly large as developing a makerspace, we feel it is necessary to highlight the resources and infrastructure needed in terms of people, facilities, and funding to create a sustainable program. This process is an inherently iterative one, and we will explain the key lessons learned during the development and implementation of the space.

Our discussion of the makerspace's implementation will be supported by both quantitative and observational data from the first months of our space being created. Through this paper, we aim to present our methods and experiences with the hope that students interested in the makerspace movement as starting points for students interested in starting their own spaces on campus.

Introduction

Supported by the National Science Foundation-funded University Innovation Fellows program, our initial team of four students was formed with the objective of enhancing a culture of innovation and entrepreneurship at our university. Discussions amongst our team with other students and faculty members at our institution consistently focused on how best to allow students to take control of their learning experiences. Having worked on a proposal for a similar space before, our mentors introduced the idea of a "tinker" space of sorts, where students would be given access to technologies typically out of reach for the average undergraduate. This makerspace would be a product of the makers' movement that has emerged in the last decade across campuses as a solution to the twin problems of keeping students engaged and giving students valuable knowledge and skills for the workplace.[1,2] As an interdisciplinary team ourselves, the idea of a makerspace that appeals to all disciplines was born—the first on our campus. Hoping to build on this idea, we began planning using human-centered design thinking methodologies.

Focused on systematically identifying and addressing problems, design thinking has been used everywhere from Silicon Valley to hospice clinics.[3] The model used was created by faculty at the Stanford University d.school and consists of five steps: empathizing, defining, ideation, prototyping, and testing. Empathizing is about immersion in and exploration of the user experience, while define seeks to aggregate these findings to identify the problems the user faces. Ideate is about brainstorming to solve the problems, while prototyping involves refining and going forward with the select few ideas that seem most promising. Prototyping and testing is the main iterative process loop of this system—prototypes are created, tested, and refined further in a different version.[4]

The d.school's method is centered on the idea that, to solve a person's problem effectively, decision makers need to understand the user and the user experience. We let this guide every step of the way—focusing not only on our own experiences but the experiences of our friends and peers, both at our institution and elsewhere. As students and "users" of our respective colleges, we have crucial insight that, when combined with faculty members passionate about improving the student experience, can bring effective change to our schools.

This paper is targeted towards students and/or faculty potentially interested in the makerspace movement and for those in the beginning stages of planning or implementation of a space. Our primary aim is to help students navigate through the process of creating a space similar to ours, emphasizing resources (people, financial, and otherwise) needed. Our secondary aim is to provide faculty with student perspective on the creation of a makerspace, including the type of guidance needed (and not needed) from a collaboration between students and faculty.

Team-Building (Empathize)

It cannot be emphasized enough the importance of a diverse team of both faculty and students when working on a student-centered project like this one. Our student group consisted of two biomedical engineering majors (one with an interest in bio-technology, another in entrepreneurship), a political science and public health major with an interest in technology start-ups, and an interdisciplinary social sciences major interested in healthcare delivery innovation. We fit well with each other; each brought a different set of skills and traits that meshed well together. The faculty team was diverse as well: a professor in the School of Engineering interested in hands-on learning, a professor in the School of Business leading the entrepreneurship movement on campus, a psychology professor who directs a science-focused honors program, and the entrepreneur-in-residence and director of a student business incubator. We were able to cover much more ground because we were each familiar with what different sides of campus had to offer in terms of faculty and resources.

In discussions across our campus, students and faculty members generally communicated a lack of integration between different areas of campus and the unrealized potential of the whole being greater than the sum of its parts. In informal discussions amongst our team and with friends, the same themes began to appear: a lack of effective collaboration, a need for the university culture to move more towards self-directed learning, and a shortage of experiential learning activities. We found that the best way for faculty and administration to understand student needs is for students to discuss amongst themselves in order to elicit more honest responses as opposed to faculty surveying or asking students directly.

Defining the User Problem and Establishing a Plan (Define and Ideate)

As we began wrapping up our discussions with students on campus, we started meeting more frequently to discuss our findings from student talks. Students wanted to have the opportunity to explore their creative interests, especially those outside of their disciplines. We found in conversations with the team that breaking down siloes could be done from the student perspective, creating a place that could serve as a central hub for innovative learning experiences on campus in different departments (research positions, course offerings, and design resources). With these themes identified, we looked to our mentors for guidance. This back and forth negotiation between students' desires and administrative restrictions was key to the way we defined the user problem.

After identifying this problem, we made plans for a space that would be student-driven, serving a dual function as a makers' studio and a student hub for innovation. The next step was to scrounge together as many resources as possible with hopes to move forward with a prototype as soon as possible. As interest among peers grew, we began to build our team to include those students who were from different backgrounds and levels of technological expertise. This was a major step in making the space a reality, as finding students willing to volunteer to staff the space in the early stages could potentially have been difficult. Casual networking among friends was our simple answer to this problem. A facility still needed to be found, so we quickly put together a sustainability plan and moved towards pitching to our first choice, the leadership of the main undergraduate library on campus. Along with one of our faculty mentors, two of us on the student team had a brief meeting with the leadership. They expressed hesitation when they assumed we were looking for financial assistance or additional help or accommodations, but we quickly reassured him that we were simply looking for a "home" for the space and we needed no additional assistance besides moving furniture. Budgets do not have much room for bold projects without proven results; we made sure to avoid that appearance, instead opting to emphasize the student-centered nature of our request and the lack of resources needed. We secured the space and were given approval.

The creation of a prototype was strongly informed by our conversations with students about a hypothetical space. We gauged student interest in different technologies that could reasonably "fit" in the space through surveys online and in person. We found that the tool students were most interested in was the 3d printer, a tool very much representative of the new tech makers' movement. 3d printing technology has the benefit of being very visible and particularly easy to deal with for new users. This would be our centerpiece for the space and would, along with the second choice (intuitive electronic creation kits like Arduino), compose our Version 1.

In order to communicate our sustainability plan, we developed an order system was created using PayPal and Podio, a project management tool, with simple algorithms created to measure overhead (maintenance of the printers and the filament) and net profit from student payment. Students would be urged to make a request for a print through the order form on Podio, using their own models or those created by the makerspace staff or online artists. The staff member quickly makes the necessary adjustments for size and print detail, providing the student with a quote that can be confirmed and paid or declined.

With the outline for the space and the space's business plan completed, we created a detailed budget and with the help of our mentors we secured two donations of $15,000 from departments on campus, more than twice the amount needed for our Version 1.

The Launch of the Space (Prototype and Test)

Over the course of a month during the holidays, we built our team to around 14 students, creating a grassroots organization of sorts that had the expertise to market the makerspace's services as well as provide assistance with the technology. At the same time, we built a network of supporters including makers and entrepreneurs from the Birmingham community and faculty and staff from different schools on campus. We decided to soft launch our Version 1 sooner than initially planned with less refinement, keeping in mind the inevitability of a stumble or two during implementation. This would later pay off, as we learned (fittingly, through experience) that the use of the space defied our expectations, and time was better spent implementing and improving rather than trying to predict and anticipate barriers before launch.

At the start of the spring semester in January, we set up the 3D printers (3 medium-sized and 2 smaller-sized, all reasonably priced and open-source) and the associated computers (each with 3D scanners) in the library and started the makerspace in a location in the library visible from the outside. We started in a quieter manner to give off a more welcoming and less "official" impression to passersby. We wanted students to understand that this effort was one for the students and by the students and that this was really a space that we, as a student body, could simply call our own.

During the first semester, we had a consistent flow of interested bystanders from different classifications, occupations, interests, and majors (Figures 1 and 2). Picking the 3D printers was a good choice for an unexpected reason: it is easier to see the technology's use in comparison to smaller technologies (circuits, sewing machines) or computers. Students will stop by on their way into the library to post the 3D printing process on their Snapchat stories—it is free publicity, so we do not have any complaints. These observational details, although not quantifiable most of the time, are important to understand where we can improve. The importance of the space's equipment being seen cannot be understated for word-of-mouth advertising and this is something we would never have realized prior to testing of Version 1.

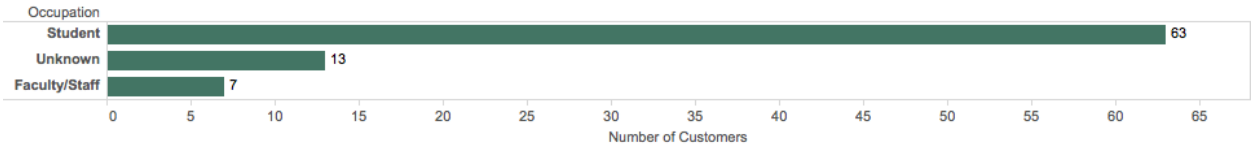

Figure 1. Users of the makerspace in the first four months, by occupation (n=83)

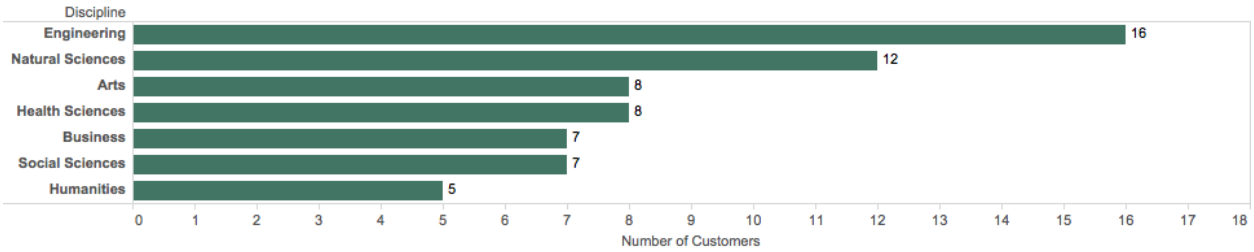

Figure 2. Student users of the makerspace in the first four months, by academic discipline (n=63)

Orders for the 3D printers were higher than expected for such a low-profile opening, especially when considering that most students do not use the library as often at the beginning of the semester (Figure 3). There was a spike in prints in the first week as we offered free material to any students interested in trying it out, but these students have since come back to print more.

Profit has been relatively low as we have been focused on generating interest rather than making a return solely from printing (Figure 4). Profit is not a primary concern at this point as we are far away from approaching our budget's end and our team of volunteers is large enough that they can work a manageable amount of hours a week without experiencing burnout.

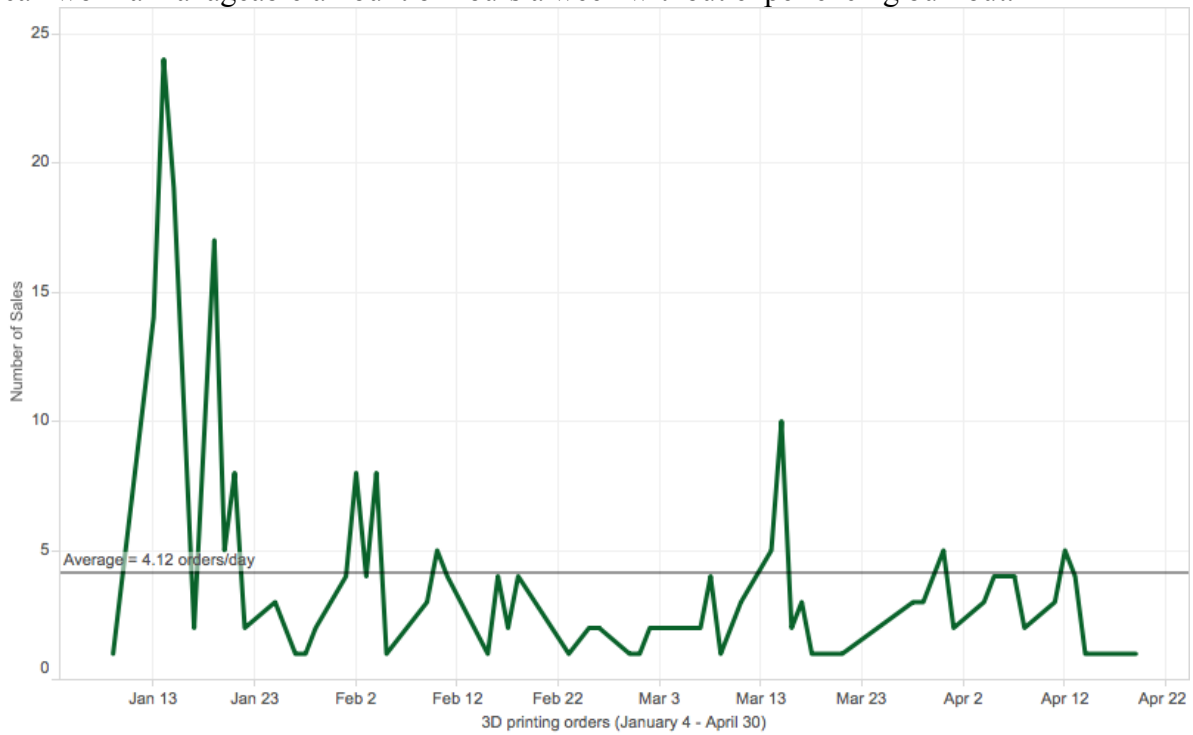

Figure 3. Number of 3D printing orders in the makerspace, by day from January 4th to April 30th (n=237)

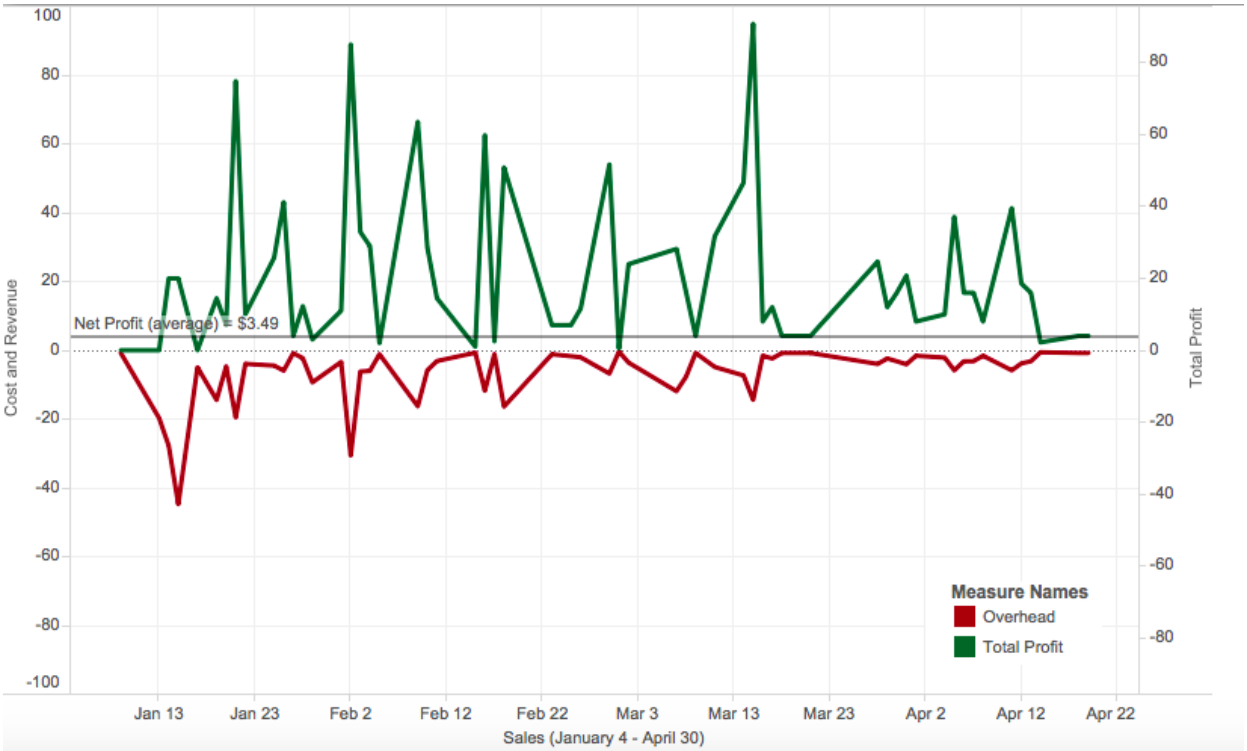

Figure 4. Makerspace total profit and overhead, by day from January 4th to April 30th

Future Directions

The circuit kits are currently in the process of being formally introduced into the space and will add a new attraction to the space. For long-term goals, we hope to expand the space further into the library and encourage increased revenue production to pay student volunteers. We hope to build the university's confidence in our work and create partnerships with departments across the campus. In fact, other universities have experimented with different funding models including using tuition from Capstone Design courses and requiring student fees for use of the space.[5] Design thinking is an iterative process; as time passes, we hope to get the opportunity to build a bigger and better space for the students. This has been an experiment in student engagement, and we are proud to be a part of it.

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