Help! I Need Somebody – Not Just Anybody: Impact of Student Technician Staffing at an Academic Makerspace

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Introduction

There are many options for staffing an academic makerspace. At Sears think[box] we have elected to use a model that has a large complement of paid student technicians working under the guidance and mentorship of professional staff. We review the advantages to the user community, and aspects of the personal and professional transformation of the student techs.

Sears think[box] operates as an open-access innovation center and makerspace located at Case Western Reserve University operating with a mission of:

- Supporting people in learning, refining, and utilizing skills to achieve their desired goals in innovation, entrepreneurship, and making;
- Cultivating and welcoming a diverse community;
- Creating a culture which encourages persistence and values resilience.

Think[box] occupies a single 7-story building of 50,000 sq. ft. that is physically adjacent and connected to the traditional campus. The makerspace and fabrication studio area, inclusive of metal and wood fabrication, welding, 3D printing, laser cutting, and other capabilities, inhabits half of the total area, and is distributed across four adjacent floors. We provide a combination of extensive facilities and broad technical expertise to assist users in learning how to create the designs, parts, and devices they desire.

In addition to the campus community, users include members of the public. Regardless of affiliation status, users are not charged either membership or usage fees; the only fees charged are for selected materials and consumables (some are provided at no cost). Our facility receives over 7,000 visits a month, with roughly 2,000 unique visitors. Our facility serves a highly diverse set of users with varied and disparate goals. The campus community and its partner institutions make up three-quarters of our users, and the community makes up the balance.

One of the ways we realize our mission is through our staffing structure. In this paper we will examine how the role of our staffing choices, hiring process, and training procedures contribute to the fulfillment of our mission and their impacts on the students that work at think[box]. Our staffing model has evolved over our ten-year history as think[box] grew from a single 3,000 sq. ft. lab in an academic building to its current location and as the floors were sequentially renovated and put into service. Aspects of the staffing were initially opportunistic and have been refined based on observations and feedback. Over time there has been an increasing awareness of the scholarly literature related to operations research as it pertains to staffing and scheduling, and we have sought to leverage that learning.

Staffing Criteria and Goals

The core of our makerspace staff is a team of full-time degreed professionals. The five professional staff operating the makerspace and fabrication studio are intentionally of diverse backgrounds, inclusive of mechanical engineering, trades, industrial design, fine arts, and art education. Their experience includes significant time in different industries, different teaching environments as well as community advocacy. The common element amongst these staff is a commitment to the mission and desire to work with people. The rest of the makerspace staff is made up of a team of paid student technicians. The student technicians are the frontline staff, engaging most directly with users.

Each term (fall, spring, and summer) 30 student technicians are employed who are split evenly between two main teams - prototyping and fabrication - who serve distinct constellations of equipment. Typically, student techs work between 10 and 20 hours per week in two teams of 3 at a time. This approach is costly – our budget for student technicians exceeds $125K annually. Furthermore, recruiting and training of student techs is time intensive. However, there is evidence that this model benefits the organization in many ways and has benefits relative to other staffing models. There are two independent sets of benefits – the user experience is improved and the student techs realize professional growth and transformation.

The framework below can be useful in describing aspects of the think[box] student tech system. The characteristics of teaching assistants in college classes and laboratory courses has been widely studied. In a recent research article, Wheeler et al. [1] review prior studies and identify the following factors as important (in addition to prior experience in teaching):

- There is a risk of overconfidence of teaching effectiveness (insensitivity), but also a risk with a lack of confidence (hesitancy to engage).
- Pedagogical content knowledge (depth of knowledge in the skill(s) and content being taught),
- Self-reflection (coupled with a growth mindset),

They also address the systematic factors:

- Regular constructive and critical feedback from mentor(s) is a factor with large impact on TA mediated outcomes.
- Modeling effective desired behavior by supervisors and others is impactful as well.
- Establishing a culture of TA training that clearly conveys the importance of TAs (as independent agents affecting solutions to users' challenges).

In their own work, Wheeler et al. established that "no differences existed between undergraduate teaching assistants and graduate teaching assistants."

In simpler, less academic, language Duerno [2] describes a related set of characteristics that benefit one serving in the role of education assistant,

- Compassion: showing empathy and caring for the learner as an individual.
- Flexibility: tolerance for interruption and deviation, and the ability to adapt and respond quickly.
- Patience: the ability to control oneself when confronted with challenges from learners as well as supervisors and co-workers
- Communication: strength both in terms of taking the initiative to clearly express information when needed, and in terms of active listening.
- Organization: a focus on being prepared, reliable, and consistent.

Student techs in academic makerspaces have qualitatively different sets of responsibilities. They are not responsible for a specific course nor do they have grading responsibilities. Yet they do support a wide range of courses from different schools with students with very different backgrounds. They must successfully engage with a broader range of individuals aspiring to highly personalized goals. Additionally, they deal with the operation and maintenance of high capital cost machinery - some of which is capable of inflicting serious physical harm.

A. *Recruiting for Empathetic Student Techs with Interpersonal Skills and Growth Mindset*

Student techs are drawn from the undergraduate populations of four schools at Case Western Reserve University (engineering, arts & sciences, nursing, and management) and the Cleveland Institute of Art. Typically, the student techs arrive with limited or narrow sets of technical skills relevant to think[box]'s equipment. We do not select for technical expertise, but rely on in-house training and intrinsic motivation to fill this gap.

The first review of all applications, which is blind (i.e., names, gender, and demographic information are removed) is an in-house developed questionnaire of 8-10 short answer questions designed to gauge the applicant's experience coupled with their social skills. Questions include, for example, "Tell us about a time when you found yourself in an unfamiliar situation. How did you adapt? What was the eventual outcome?" These questions give the applicant a chance to relate their experiences as well as give us insight into how they approach different situations with a variety of different types of people, and situations that anticipate those that they will encounter several times each shift. After a committee review of all the essay answers, we invite a subset of applicants to face-to-face interviews with think[box] staff. We ask standard interview questions, but also ask them to prepare a paper craft project to show and discuss at the interview. We find that this paper project is a great chance to gauge the craftsmanship and attention to detail that the applicants possess. In addition, this facet of the interview provides an opportunity to observe making-relevant communication. Typically, the applicants outnumber the available positions by a factor of roughly three.

It is often difficult to make the final decisions about hires, mostly due to how excited these students are about the prospect of working in our space. We find that students want to join the team for several reasons; among them are the desire to gain new skills in a controlled environment, the excitement of belonging to a group of like-minded people, and the extra access to the facility and equipment that is afforded to our student technician team. Managing hiring risk has been reduced by requiring reapplication of all current student techs each term - their applications are pooled with new applicants and all compete on equal footing. Experience indicates that on the order of one in five, or 20%, returning applicants are replaced each term. The result is a set of highly-motivated talented individuals with strong empathy and good communication skills. They are particularly well-suited to engage other college students. Interacting with other populations and deeper technical skills are elements of training.

B. *Training for Depth of Knowledge and Skill*

All techs must attend the dedicated intensive training prior to the start of the semester. This training period covers technical skills, administrative skills including the various computer systems that we use to help us run our space, and customer service skills. We find it important to give the students a chance to role play, not just in the context of uncomfortable customer service situations, but also give them a chance to mock-train each other to develop their style and confidence in communicating safe and effective use of our facilities.

Some of us have previously considered the training week as a necessary evil in terms of time and effort spent to provide the same training year in and year out. However, we all have come to realize training week is iterative in nature and provides us with more opportunities to find better ways to communicate ideas and concepts to inexperienced students. This translates into what we spend the majority of the academic year doing for our users and we recognize it as a highly effective means for self-improvement and personal growth by staff.

For technical training, and operational efficiency, student workers split into two separate teams: the PRO team and the FAB team. The PRO team manages what are nominally termed prototyping tools that are highly dependent on digital representation of information and which carry low risk of physical injury. The fabrication equipment of the FAB team is much more dependent on eye-to-hand coordination and

operator skill, and carries significantly higher injury risk. The domains of tools for each team are broad, but sufficiently thematic that students are able to become sufficiently skilled during an intensive training session at the start of the term coupled with through-semester meetings and augmented training. Students are assigned training projects to help expand their knowledge and comfort with equipment. For example, on the fabrication team each student is required to make an end table that utilizes several types of machinery. Other projects are more open-ended, providing design experience in addition to skills development. These types of projects are constructed to reinforce previous taught skills and at the same time incorporate new challenges.

Furthermore, the culture of think[box] is to answer questions without judgment. Returning techs and professional staff are always available and are regularly consulted as needed. While informal, cultivating these types of intra-team communication is very effective in maximizing the use of the more experienced individuals as they are naturally selected to intercede on the challenging, rather than routine situations or problems.

C. *Student Techs Bring Skills*

All student employee populations are inherently high-turnover – since they graduate. At think[box] the re-application and interview process accentuates this. While the burden of training is high there are benefits. Firstly, it ensures we remain aware of shifts in the expectations and backgrounds of the user base. As we are now concluding the end of our first decade we have had the opportunity to see evolutionary changes. The onset and ebbing of the pandemic have provided us with the experience of responding to sudden and dramatic changes [3]. The culture of constant adjustment has served us well.

Secondly, the transient nature of the workforce can bring new students with diverse backgrounds and skills that can be leveraged for specific projects. We are fortunate to have students with deep technical expertise in fields that the professional staff and faculty are not versed in. By way of example, we took advantage of a Computer Science major to assist with the development of a complex post-processor file, i.e., a program used to translate Computer-Aided Machining design data into G-Code, the instructions that run a CNC machine. Another Computer Science student was able to revamp and redesign the system used to label the jobs currently running on our Ultimaker 3D printers. This led to clearer understanding by our staff and users and took advantage of existing, but underutilized, system data. Having a new set of eyes on our operations every academic year gives us the chance to hear feedback from the new students and improve our processes. Our habits are regularly challenged.

Thirdly, the advantage of having student techs as a point of first contact is difficult to overstate. Fig. 1, shows the results of helpfulness and safety having high rates of satisfaction, showcasing elements of the student techs' depth of technical knowledge. Welcome and ease of use correlate with empathy, accessibility, and patience.

From direct observation, we find that having a student tech work with an inexperienced user can be a better combination than having that user get a final answer from a professional full-time staff member. The student tech and user inhabiting the problem-space together gives them the opportunity to find solutions, test them, and iterate to a satisfactory result in a way that appears to instill powerful lessons for both.

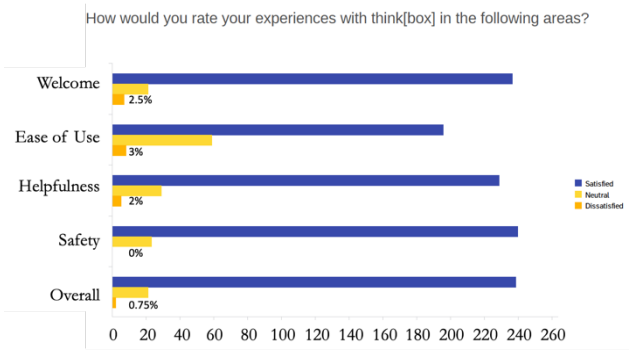

Fig. 1 User Survey 2020-2021 Academic Year.

D. *Impact on Student Techs: Personal and Professional Transformation*

Examining the impact on the student techs themselves was initiated due to anecdotal remarks of alumni as well as current students. For example, in a presentation to a committee of CWRU Board of Trustees a senior student tech observed that he had been initially unsure he had the knowledge and the skills to help someone solve their problem. And, similarly, was uncomfortable with the responsibility of bringing a "broken" half-million-dollar machine back online. However, he was comfortable taking the risk due to the supportive environment and having been through the training program. His initial successes, he related, were readily transferred to new situations with both people and machines – and led to personal growth. This observation brought to mind the frequently quoted statement of Desse [4] that "[t]here is no more important topic in the whole psychology of learning than transfer of learning."

Motivated by such anecdotes, we prepared a survey for alumni student techs to gather systematic data as their insights about how their time working at think[box] has affected them. We employed a short set of five questions:

1. Was your experience as a student tech at TBX important to you personally and/or professionally? Please explain.
2. Compare your experience working at think[box], in terms of personal and professional development, to other experiences you have had.
3. Do you feel that your experience as a student tech at TBX affected your career progression to date relative to your peers? If so, please elaborate.
4. What technical and other skills did employment at think[box] help you to develop?
5. What other aspects of your experience at think[box] were important to you?

Within the results, we were able to identify a few themes.

Student tech experience:

- tends to jumpstart professional development. We

characterize this as increased people skills and more professional communication, an increased ability to network and form productive relationships, valuable experiences working in a diverse and cross-disciplinary team, and more comfort in leadership roles.

- can accelerate their career progression following college. Those surveyed attribute this to a proven track record with working on complex technical problems; enhanced time management experience; being held to a high standard of craftsmanship and quality control; and the fact that integrity, accountability, and responsibility are pillars of the student technician experience.
- leads to very substantial advancements in technical skills that, generally, outpace that of their peers in the workplace. These skills are obviously gained in the everyday activities of staffing our space, but our respondents also cite the after-hours access to do independent work as a key aspect to their development. In a sense, being able to use the space in the same way that our normal users do, but with the know-how and confidence that they have gained as employees supercharges this time and allows them to grow their skills even faster.
- establishes a sense of belonging and community. Students voiced the culture of trust, independence and curiosity allowed them to grow and learn together. The team atmosphere fostered strong friendships and developed networks for future opportunities.

We are excited to see our theories about the experience they are receiving validated in the survey results and will continue to expand our efforts to enhance their collegiate experience. Our goal is to pursue more research development around this model so we can share our processes as a resource to other makerspaces. Think[box] will continue to evolve and iterate as an organization, it is integral to our mission and values.

Summary

At Sears think[box] we strive to remain on the cusp of emerging technologies and techniques in the world of design and fabrication. We have invested considerable resources into the equipment that we make available to a wide array of users to facilitate our University's commitment to serving the community adjacent to campus. While proud of the array of capabilities that we can provide, we continually evaluate our efficacy and push ourselves to remain at the forefront of both technology and operations. We fully embrace the idea that the essence of all academic makerspaces is people-to-people interactions. Excellence in staffing is essential to realizing the value of the investments in state-of-the-art equipment. Our evolution as a space is running in parallel with the evolution of our staffing model. We value the commitment of our student technicians and take our role in their growth and development seriously. As we learn and test our hypotheses, we create an environment that allows our student technicians deliver high-quality and high-impact assistance to our users, which they are developing as young professionals. They are approachable, accessible, and cultivate our welcoming environment for users from all walks of life.

References

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