A Learner and Equity-Centered Approach to Makerspaces

Dr. Carolyn Keller, UW-Platteville

Carolyn Keller is the Director of Academic Assessment at the University of Wisconsin-Platteville. She is also an associate professor in sociology. Dr. Keller works regularly consults and collaborates with faculty in the engineering programs about assessment and continuous improvement.

Dr. Jodi F. Prosise, University of Wisconsin, Platteville

Jodi Prosise is Chair of Engineering and Physics and an Associate Professor of Industrial Engineering and Mechanical Engineering. She earned her PhD in Biomedical Engineering at University of Minnesota and her Bachelor of Science in Mechanical Engineering at Iowa State University. She teaches courses in both Industrial and Mechanical Engineering at SAU, focusing in Engineering Graphics, Manufacturing, the Engineering Sciences, and Design. She was recently the PI of an NSF S-STEM grant to recruit rural students from Iowa and Illinois into STEM. Dr. Prosise mentors the collegiate chapter of SWE and organizes many outreach events encourage girls to go into STEM. She leads a study-abroad trip for engineering students to Brazil every-other-year, where students design, build, and implement assistive technologies for people with disabilities. Her research focus is to develop affordable upper limb prosthetics.

Dr. Philip J. Parker P.E., University of Wisconsin, Platteville

Philip Parker, Ph.D., P.E., is Associate Dean for New Initiatives at the University of Wisconsin-Platteville. He is co-author of the textbook ”Introduction to Infrastructure” published in 2012 by Wiley.

A Learner and Equity-Centered Approach to Makerspaces

Abstract
The growth of makerspaces is a trend that has been decades in the making. Engineers are most effective when, in addition to technical knowledge in their field, they understand the capabilities of processes such as milling, welding, and 3D printing. Makerspaces enhance engineering education by encouraging creativity and hands-on fabrication skills in students. The benefits of providing high-impact opportunities are evident to prospective students and the employers that will one day hire them. At our institution, we have a unique opportunity to expand on previous research on makerspaces as we design a new building which will include a 20,000 square foot Innovation Center.

While the benefits of makerspaces are well-documented, increasingly so are the potential shortcomings [1], [2]. It is critical to design welcoming and inclusive spaces that support all types of learners. We addressed this challenge by conducting a needs and opportunities assessment of our currently available fabrication areas. Data were collected through interviewing faculty, staff, and students; surveying student attitudes and satisfaction with existing facilities; and tracking student use. Data were used to inform an assessment plan for the future Innovation Center.

This proactive framework includes the voices and experiences of students from across the institution including those of diverse backgrounds and disciplines. The process has allowed us to improve our understanding of the role of making in the future of our university and of how regular feedback and collaboration with constituent groups helps us to create a more learner-friendly and equitable space. Furthermore, this effort to collect and analyze data in preparation for a new makerspace has been beneficial as we develop curricular and co-curricular experiences for our students that are designed to build on our strengths and provide new areas of success.

Introduction

Makerspaces are no longer novel or rare and are regularly being established on campuses and in urban spaces across the United States and beyond. A variety of research has been conducted to catalog the positive impacts of makerspaces especially as it relates to engineering education. As campuses develop makerspaces, they have used the spaces as a type of laboratory to test the impact of projects and courses related to making. We will build on this growing literature as we develop programming and policies for our Innovation Center (expected to open in the Fall semester of 2022) that will promote an open and inclusive experience for users.

New Innovation Center
Our university currently has several spaces that support making, including workshops that support our theater program, art studios, and engineering and technology shop spaces. These spaces support independent student projects, class projects, capstone design projects, student organization projects, and research projects.

These spaces are well used and professionally operated. Students receive safety training and are able to use the spaces for free. Gaps in our existing makerspaces include:

- a lack of tie-in to our entrepreneurship program;
- insufficient space to support the amount of work needed to be carried out, leading to crowded spaces;
- dispersion of existing spaces around campus;
- inadequate and outdated equipment;
- a lack of programming, including programming integrated into our classes, to provide maker experiences for all engineering students;
- alliances with business and industry that could be stronger;
- few instances of interdisciplinary work, including between different engineering disciplines and between engineering and non-engineering;
- existing spaces that are not intentionally designed architecturally to be welcoming to *all* students, including women and underrepresented minorities, first-generation students, and other students who have not had significant hands-on making experience prior to college.

Our new Innovation Center will provide services to support end-to-end design, meaning makerspace users who bring an idea to the space and will be assisted in turning that idea progressively into a design, a prototype, a final product, and a business plan (or as far along that process as they desire). Approximately 2/3 of the space will be located in our new engineering building and will connect with one of our existing shop spaces.

The new Innovation Center will span across two floors. The upper floor will contain the main entrance to the space. Visitors will be greeted at the door by a trained student worker. The upper floor has been designed to be welcoming; notably, this space will include smaller, safer, and less "intimidating" work stations: computer spaces, collaboration rooms, soldering areas, vinyl cutting, sewing, photography/videography, and 3D printing. Users located on the upper floor will have views down to the lower floor. The lower floor will contain the machine shop and include larger equipment with more of an industrial feel, including milling machines, metal lathes, bandsaws, and woodworking equipment. We will use three levels of safety training: green (safest – e.g. drills, scissors, soldering irons); yellow (medium risk – e.g. bandsaws, tablesaws); and red (high risk – e.g. metal lathes, milling machines). The upper floor will contain all green tools.

Programming goals for this new space are aimed at ensuring that *every* engineering student has an opportunity to make something with their hands. It will be open and available to all students on campus, not just engineering students. Of special note, programming and operating policies will work to promote a welcoming environment and safe space for all students.

As such, the goals for our Innovation Center include:

1. The Innovation Center will meet the needs of a diversity of users completing a variety of tasks
2. All users will feel welcome to participate
3. Programming will attract a variety of users to the space and improve the making skills of all users.
4. All students graduating from an engineering major will have made at least one item in the Innovation Center.

Benefits of Innovation Centers

The benefits of makerspaces are vast and wide-reaching with increasing evidence that supports the impact of making on student learning especially as it relates to specific fields – namely engineering and business. Experience with the entire product development and deployment process helps create tangible learning experiences that students can easily transfer to their career environments.

The benefits of makerspaces extend to professional skills. For example, Morocz, Levy et al. 2015 apply Bandura's theory related to "social persuasion" to makerspaces. They argue that makerspaces can be less artificial than laboratories and, due to the increased space and processes that are housed there, makerspaces also house more people and people with different skillsets as compared to laboratories, creating an environment with greater social interaction. Morocz et al (2015) found that influence of peers can decrease anxieties around making because makerspaces can function to level the playing field by modeling different degrees of comfort with different making processes. Further, Bandura's theory posits that the social interactions can increase students' self-efficacy. Having shared and communal making opportunities dissipates fears around making and increases student confidence in the process [1].

Engineers in many disciplines are most effective when, in addition to technical knowledge in their field, they have enhanced knowledge of the capabilities of processes such as milling, welding, and 3D printing. Makerspaces enhance engineering education by encouraging creativity and hands-on fabrication skills in students. In addition, makerspaces create opportunities for future engineers to explore business and production processes more thoroughly. While experiencing end-to-end design, makerspace users learn to communicate with a variety of people from varying disciplines who are involved with different pieces of the design process. This differs from most engineering coursework and from work processes within engineering, which are often divided to be practical and efficient, creating silos in the process. However, in engineering practice, when something goes wrong or when something new is being explored, communication with others outside one's own work group is critical for company success – consequently an advantage of makerspaces is that they provide less scaffolded, more authentic opportunities to learn critical communication skills that will be useful in students' future careers.

Benefits for Improving the STEM Pipeline

Makerspaces are found to play an important role in the recruitment and retention of future engineers[3]. Innovation Centers and makerspaces across U.S. campuses tend to be highlights of campus visits. These campus "gems" play a role in attracting prospective students by showcasing the innovative learning opportunities students might experience at an institution [4], [5]. They also are highlighted on visits by industry and government entities as evidence of universities' commitment to the workforce and local economies. The benefits of providing high-impact opportunities are evident to prospective students and the employers that will one day hire them.

Another population that can be impacted by makerspaces is the K-12 community [4]. We know that fun, accessible STEM experiences are critical in creating interest in students at a young age, especially girls. Both the frequency and quality of these experiences affects the efficacy of the pipeline. In urban areas, makerspaces have shown success in creating pathways to science for underrepresented groups as well [5]. Makerspaces can serve curricular and co-curricular functions for the K-12 population. Linkages to schools and after school programs can help bridge the way to STEM.

Teachers play a central role in creating positive impacts on K-12 students related to STEM education. Future teachers are therefore an important population who can benefit from experiences within a makerspace because they play such a pivotal role in the STEM pipeline. The ways teachers in the K-12 system approach and frame STEM fields has a significant effect on socialization of their students either toward or away from STEM fields. Modelling enthusiasm and confidence in early STEM education creates positive experiences that keep students interested, comfortable, and engaged in STEM fields later in life. A comfortable and encouraging atmosphere of an inclusive makerspace can support these efforts.

Benefits Beyond Engineering Programs

Makerspaces are not unique to engineering. Performance and visual art galleries and laboratories, educator spaces, and libraries are often locations on campus where makerspaces can be found [1], [6]. Makerspaces create intersections between multiple disciplines [7].

Makerspaces provide a wide range of opportunities to supplement engineering curriculum with highly valuable non-technical skills. Design thinking and engaged learning are learning objectives that cut across disciplines. Makerspaces are necessarily collaborative resulting in more interdisciplinary projects. Faculty and students from various disciplines bring different skills and assets to the making space and sharing and learning from one another fosters creativity in making.

Finally, the larger community can also benefit from a new makerspace. Efforts to improve town-gown relations are often entangled with innovation centers and new makerspaces [3], [7]–[9]. Some universities and colleges function quite separately from the larger community. There are often strong demarcations between campus and town boundaries. Makerspaces create opportunities to welcome community members to campus more frequently and intentionally, creating a place that builds relationships between the community and the university. They also allow for universities to support entrepreneurship and small-business endeavors.

Diversity, Inclusion and Makerspaces

The benefits of a diverse workplace are often assumed and not carefully considered. Extant literature finds that while there certainly can be benefits from diversity, it can also be a source of conflict and misunderstandings [8], [9]. Increasingly, new types of pedagogy and learning that relies on reflection and understanding one’s own identity in comparison to others can lead to increased group performance [9]. In order to benefit from diversity and inclusion, intentional planning and learning opportunities need to be considered. As we plan for a new makerspace, we must be intentional in order to reach our goals of inclusion and diversity.

In thinking about the benefits of makerspaces previously described, we argue that creating a space that welcomes and values diversity and diverse groups will have a positive and multiplicative impact for everyone. In an inclusive makerspace, engineering students have the opportunity to work through more varied and diverse problems and communicate with more varied and diverse people. An inclusive makerspace gives K-12 students, for example, the opportunity to see people who look like them in the space and those models have a positive impact on growing the supply of potential future engineers. As for other disciplines and community members, we expect that as those groups see the variety of activities and people in the space, they are able to think about inviting others to the space who they may not have originally considered.

Finally, we know that being able to work with diverse groups of people is a key to success in today's workforce. In our university's participation of the National Survey of Student Engagement, we have found that our students are below the national average in their experiences with people who are different from themselves. The Innovation Center creates an opportunity to purposefully engage diversity and inclusion with benefits for engineers but also for all of our students and the surrounding community.

Methods

In preparation for our new Innovation Center (expanded makerspace), we have collected a variety of data to determine the needs and opportunities related to creating an open, welcoming, and inclusive innovation center. In our research we used a three-prong approach to collect data for our needs and opportunities assessment. These data will serve as useful guides as we create the space and will serve as foundational instruments we can later implement to determine if our intended goals were met.

In order to understand potential faculty, staff, and student use of the makerspace, we surveyed faculty to learn how they use or encourage usage of current shop spaces within the Engineering, Mathematics and Science programs. We also surveyed graduating seniors about the culture of making and their use of shop areas during their time at the university [10]. This survey is provided in Appendix 2. In addition, we collected direct data about our current shop usage.

Next, we conducted two focus groups to get in-depth qualitative data on the needs and opportunities that engineering faculty members see in the space and on how to create an Innovation Center that more directly includes faculty and staff who work in the diversity and inclusion areas of the university. Finally, we performed a content analysis of a variety of meetings and brainstorming sessions that include input from both faculty and staff about what inclusive making looks like.

Our Institutional Review Board approved our questions and protocols. Participants received information related to informed consent.

Importantly, these findings and discussion will be reported back to the Innovation Center planning committee to help as final architectural plans, programming, and procedures for the space are developed.

Results

Fabrication Facilities Inventory of Class Use

In this survey, Engineering, Mathematics and Science faculty were asked about current and potential usage of fabrication facilities in their classes. A total of 19 faculty took the survey. Respondents were primarily in engineering, but also included faculty members in physics and chemistry.

We find that faculty members use our current facilities for a wide range of functions. While some students are required to fabricate items for courses by “making parts and samples,” “grinding a steel sample,” and “prototyping,” others use the lab as an option for student work. One faculty member reported, “Some students use the shop for their final project (i.e. making trusses or beams with wood or other materials, making piping system with PVC, as well as research i.e. concrete mold or some machine).” Some courses require all students within a course to use the shop, while others do not require the shop at all or only optionally.

Faculty members commented that with an improved Innovation Center, they could do more design and prototyping projects in their courses. Consequently, the new Innovation Center can substantially increase the number of students fabricating in courses. The respondents were asked about the current number of students that use the shop and asked to estimate the number of new users in the future Innovation Center – findings suggest a 50% increase from approximately 1,000 unique students currently to 1,500 users upon the opening of the Innovation Center.

Mechanical Engineering Student Survey

Making plays a large role in our mechanical engineering senior design course. Our current lab spaces they use include machining, woodworking, welding, and 3D printing equipment spread throughout 4 separate spaces in 2 different buildings. We surveyed students completing the senior design course to gauge their experience and interest in making. Overall, 28 students completed the survey. Most respondents spent between 6 and 10 hours each week of the semester making in lab, classrooms, and at home (Table 1). As a result, most respondents asked for longer hours for the labs to be available. If other making equipment were available, the students were interested in learning new machines for class or credit but also for their own interest. Sixty-four percent (64%) of respondents reported an interest in intermediate or advanced training beyond class or basic level requirements.

Table 1. Estimated Hours Spent Making for ME Senior Design.

Weekly Hours Spent Making in Senior Design	% Response
Up to 5 hours	21%
6-10 hours	57%

11-15 hours	7%
16-20 hours	11%
More than 30 hours	4%

Generally speaking, our surveys of faculty and students show that the new innovation center can play a large role in increasing the number of students who have opportunities to make as well as in increasing the amount of times students participate in the making process. Furthermore, students in Mechanical Engineering show strong interest and dedication to the making process. This bodes well for creating an inclusive environment. The more students and faculty who are using the space means that we would serve a more diverse population simply by increasing the number of users.

Beginning on November 7, the College Shop Supervisor began tracking usage of the College's two shop spaces using a door counter. Each count recorded by the door counter represented a single person entering or exiting; thus the sum of the counts for a day was divided by two as an indicator of the number of people using the shop. Reported here are the data collected through the end of the Fall 2020 semester, 40 days in total. Over this test period, 11,272 people visited the shop, or an average of 282 visitors per day. Given that our total on-campus undergraduate enrollment is approximately 6,500, these numbers reflect high and regular usage of labs by many students. Excluding the least busy day (Sunday – average of 19 visitors per day), the average on the other weekdays was 328 visitors per day. The average number of visitors for each day of the week is shown in Figure 1.

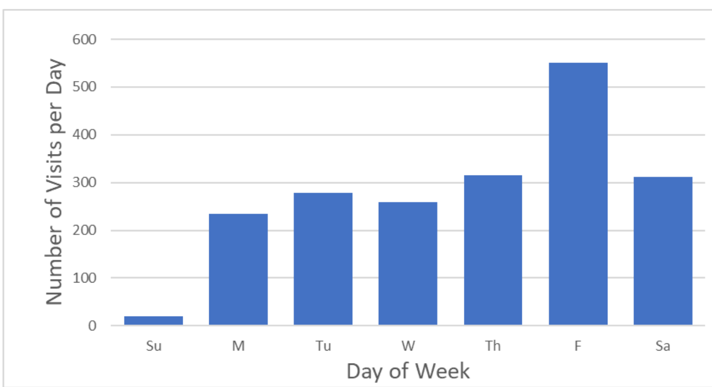

Figure 1: Average Number of Visitors to College Shops over Study Period as a Function of Day of Week

Given the nature of these areas in primarily supporting student class projects, it is not surprising that the number of visitors increased every week of the test period (excluding the week of Thanksgiving). The weekly trend is shown in Figure 2.

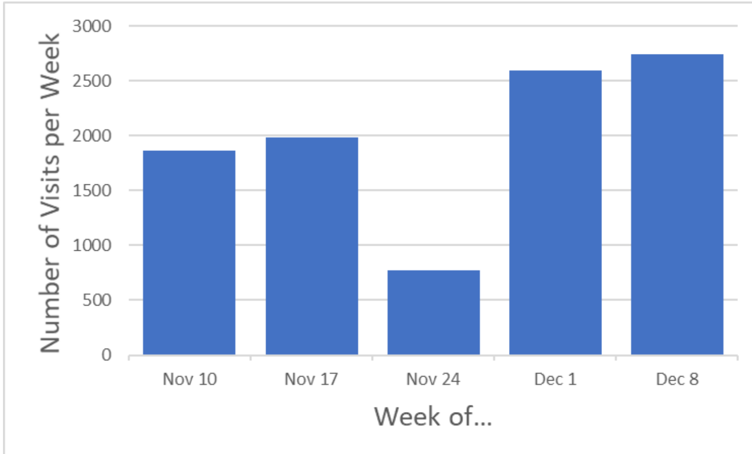

Figure 2: Average Number of Weekly Visitors to College Shops over Time

Qualitative Findings from Focus Groups and Meeting Minutes

Faculty and staff drove the conversations in focus groups and input groups (See Appendix 1). Focus groups and input groups met with two different purposes. The input meetings emphasize design features and capacity of the Innovation Center. The focus groups created an inventory of current and desired making opportunities and also of opportunities for designing inclusive spaces and programs. The findings from both sets of conversations can be grouped into a variety of outcomes.

Our respondents showed clear enthusiasm for the potential uses and opportunities that will be available when the Innovation Center opens. Furthermore, the value of making seemed to be shared by all participants. Not one negative comment about the creation and potential of the new space was made. Participants agreed that the Center will play a very important role in the education of our students and furthermore, they are excited about the possibilities the Center may play in recruiting future students.

Potential Use - Opportunities and Barriers

While the Innovation Center is framed as an exciting opportunity, making the most of the space will take careful planning. Indeed, respondents are anticipating innovative and new ways to utilize the center with their students; however, there is some concern that demand will be so high that there could be competition over the usage. Amongst faculty members especially were assumptions and expectations that specific courses would have required innovation center usage, but how that plays out was less clear. Respondents noted how our current lab staff handle these issues particularly well but with the increase of scale, governance will be important. How to schedule competing classes and make room for all interested faculty will require further discussion and planning. A similar concern was raised about how much space various projects consume. Because the nature of some design courses is longer-term making, the ability of long-term and shorter-term projects to exist concurrently is a concern.

Participants were able to name a large variety of potential users beyond classes with students. Potential users included student clubs, faculty research projects, high school student robotics clubs, student entrepreneurs, the local technical college, staff, and those affiliated with a local incubator. One faculty member mentioned a toy hackathon that the institution hosts annually as being an excellent example of something that would be a "natural fit" for the Innovation Center, but falls outside of the class/club/research categories.

While some faculty and staff raised concern about potential competition of Innovation Center usage, an alternative but related concern was also raised - underutilization. Because the new center will include equipment not currently available on our campus, not only is there a need to train students but also faculty members to increase their comfort in the space. Furthermore, some faculty respondents had not previously considered how they might incorporate the center into their classroom. Professional development that teaches faculty about current and possible usage of the space with students would be useful as would basic tool training in order to decrease barriers to entry. Participants suggest that usage policy and procedures were paramount for making sure that the space was well and equitably used.

Finally, the issue of required usage for students came up often in our discussions. Faculty and staff seemed to agree that one goal for our new innovation center would be that every engineering student has class experiences in the innovation center. In some instances, faculty members posited that this would be a retention tool for some of our students. We serve a rural student population, some of whom have grown up having extensive hands-on, applied experience with making prior to arriving on campus. Perhaps, the thought goes, requiring Innovation Center experiences would make the linkage between engineering and making more explicit and serve as a retention tool for those who view the field as being too sedentary and math driven. An alternative hypothesis was also given by participants that required usage could play a deterring role for students who might qualify as "CAD jockeys" – i.e. those students who aren't excited or interested in the hands-on aspects in engineering but excel in using computer software for example.

Brandings and Coordinating with other Makers on Campus

One point of consternation related to this project is that the Innovation Center will be located within a new building designated specifically for the college of Engineering, Mathematics and Science. Additionally, this building will be located on a far corner of campus. This reality may hinder the goal of the Innovation Center serving the entire campus community. A liberal arts faculty member incisively noted that making is not a *new* feature to the campus. To illustrate their argument, the faculty member said, "We've had a makerspace on this campus for years. It is called the Art Building." Furthermore, others noted that new making spaces are popping up on various spaces across campus. Questions around ownership of the space, determining who the makers are on campus, ensuring that various makerspaces are connected, and how we can make the center accessible must be answered thoughtfully ahead of time to insure inclusion.

One possible solution for the Innovation Center to promote inclusion involves branding all our labs and makerspaces on campus with one logo. Others noted that there isn't currently a catalog of available making capacities on campus and that the makerspaces could collaborate and be coordinated in some ways. Shuttles and easier ways to park near or travel to the center were also suggested. These ideas came from faculty members and were well-supported by others in the room.

Welcome and Design Features

Respondents were adamant that the new Innovation Center be easy to access, welcoming, and inviting. Some suggestions emphasized the importance of design features. For example, having pictures of different types of people making could lower anxiety for those who might be uncomfortable in the makerspace. Ideas about paint colors and making certain design features visible were brought up to pique interest and draw people into the space. This is important to note because many of our current lab spaces are not very welcoming because they are housed in old buildings in basements, they're not easy to find and were not designed to be visually appealing. Beyond the physical design, respondents suggested that a welcome desk be at the entry of the space and that the welcome desk have staffing during all open hours to help guide, instruct, and welcome people.

Respondents had a broad definition of what accessibility means to them. For some, it includes having the space open for longer hours for different groups to use, but for others, accessibility also relates to training people to use tools, or emphasizing ADA codes. Respondents brought attention to the need to balance competing goals. While makerspaces can allow for creativity and independent work, on the other hand, rules about safety and training must be a primary focus. Rules must be designed to ensure safety yet be flexible enough to promote creativity. The thought that the welcome desk could help play a role in directing people to safety training upon entry and also have available first-time builder activities ready to go for any new people coming to the space was one idea that participants supported and elaborated on significantly.

Discussion and Conclusion

Overall, our campus seems committed to making the new Innovation Center welcoming and inclusive. There is excitement about the opportunity and there's confidence that the center will play a big role in scaling student experiences with making. There are also many parallel discussions underway that should aid bringing in K-12 students and community members.

Making an inclusive Innovation Center will take considerable effort and energy. Our campus is committed to doing this work. An Innovation Center planning subcommittee continues to meet and will develop a mission, vision and goals for the center this academic year. In the following academic year, the focus will shift to governance and programming. This work will set the foundation upon which an inclusive and welcoming space can be built. One important outcome of these conversations is that engineering faculty and staff are engaging in the types of collaboration and coordination we envisage will flourish in the Innovation Center. Regularly seeking input from students and the broader community will signal their import to us but also help us incorporate their wants and needs into the design and programming.

A less tangible outcome from this needs and opportunities assessment is the recognition that programming and relevant policy making will need to be a regular and ongoing process that cannot end once the center is built. In fact, creating regular communication amongst faculty, staff, students, and constituents is the best way to ensure our inclusive center succeeds.

References Cited

[1] R. J. Morocz *et al.*, “University Maker Spaces: Discovery, Optimization and Measurement of Impacts,” 2015, doi: 10.18260/p.24967.

[2] E. Pines, P. Sullivan, and L. Nogales, “Broadening participation through engagement in the maker space movement.,” *ASEE Annu. Conf. Proc.*, 2015.

[3] C. Forest *et al.*, “The invention studio: A university maker space and culture,” *Adv. Eng. Educ.*, Summer 2014.

[4] J. M. Banks-Hunt, S. Adams, S. Ganter, and J. C. Bohorquez, “K-12 STEM Education: Bringing the engineering maker space, student-centered learning, curriculum, and teacher training to middle schools,” in *2016 IEEE Frontiers in Education Conference (FIE)*, 2016, pp. 1–5, doi: 10.1109/FIE.2016.7757531.

[5] T. Honma, “Community Partnership, Do-It-Yourself (DIY)/Do-It-Together (DIT) Collaboration, and STEM Learning ‘from Below’: Community Partnership, Do-It-Yourself (DIY)/Do-It-Together (DIT) Collaboration, and STEM Learning “from Below”,” *Transform. J. Incl. Scholarsh. Pedagogy*, vol. 27, no. 1, pp. 41–50, 2017, doi: 10.5325/trajincschped.27.1.0041.

[6] S. Crawford Barniskis, “STEAM: Science and Art Meet in Rural Library Makerspaces,” *IConference 2014 Proc.*, pp. 834–837, 2014.

[7] P. Rees, C. Olson, C. M. Schweik, and S. D. Brewer, “Work in Progress: Exploring the Role of Makerspaces and Flipped Learning in a Town-Gown Effort to Engage K12 Students in STEAM,” presented at the 2015 ASEE Annual Conference & Exposition, 2015, pp. 26.1751.1-26.1751.15.

[8] F. G. Stevens, V. C. Plaut, and J. Sanchez-Burks, “Unlocking the Benefits of Diversity: All-Inclusive Multiculturalism and Positive Organizational Change,” *J. Appl. Behav. Sci.*, vol. 44, no. 1, pp. 116–133, Mar. 2008, doi: 10.1177/0021886308314460.

[9] M.-É. Roberge and R. Dick, “Recognizing the benefits of diversity: When and how does diversity increase group performance?,” *Hum. Resour. Manag. Rev. - Hum. Resour. Manag. REV*, vol. 20, pp. 295–308, Dec. 2010, doi: 10.1016/j.hrmr.2009.09.002.

[10] “MIT Maker Survey » MIT Project Manus,” *MIT Project Manus*. [Online]. Available: https://project-manus.mit.edu/mit-maker-survey. [Accessed: 02-Feb-2020].

Appendix 1

Focus Group Methodology

Three separate hour-long focus groups were held with faculty and staff to gauge their opinions about current and future making processes on campus. All focus group protocols were approved by our Internal Review Board and all participants completed an informed consent form. A semi-structured interview was used. The interview schedule is below. Generally, respondents were probed for issues of clarity but also to provide examples of the claims they were making. Participation was voluntary. All faculty and staff were solicited via email invitation. A convenience sample was used of available and interested faculty and staff. A total of 13 participants were included in the focus groups.

Additionally, comments and observations came from an input group of the new Makerspace sub-committee. Participants were informed that information from the process was being used as part of this study. Nine people participated in those meetings.

Interview Schedule:

Lab/Makerspace uses and intentions

1. How do you currently use labs with students? How may that change with the new SQH innovation center?
2. What are the current strengths of our labs? What opportunities for improvement do you see with the new Innovation Center?
3. Which students are most likely to use a lab? Which students are least likely to use a lab? What are opportunities to increase students' lab or makerspace experiences?

Inclusive Space

1. What examples do you have where our labs have been used inclusively? (We mean this broadly encompassing different majors/programs as well as different student demographics etc). How can we extend these types of experiences to others?
2. Which groups on campus may be less comfortable in a lab or innovation center? Why? How can we create a space and learning activities to make the space more inclusive?

Appendix 2

Default Question Block

CONSENT FORM FOR PARTICIPATION OF HUMAN PARTICIPANTS IN RESEARCH
UNIVERSITY OF WISCONSIN - PLATTEVILLE

1. Purpose:
The purpose of this research is to determine techniques and strategies to create a more welcoming and inclusive makerspace on campus.

2. Procedure:
Focus groups and surveys will be conducted to understand opportunities in which a new makerspace could be more impactful related to student learning and inclusivity.. Additional information about participants will also be collected but will not be released or distributed in any way that could identity you.

3. Time required:
Your participation will be voluntary. You may stop taking the survey or participating in a focus group conversation at any time.

4. Risks:
It is not anticipated that this study will present any risk to you other than the inconvenience of the time taken to participate.

Benefits:
Data about how students learn and creating a welcoming environment is of value to universities, instructors, and students. Your participation in this study will provide us with a better understanding of how specific pedagogical practices might be utilized to better help students.

5. Your rights as a participant:
Your participation in this study is entirely voluntary and will not affect your employment or grades. No data or summarized results will not be released in any way that could identify you. If you want to withdraw from the study at any time, you may do so without penalty or repercussions. The information collected from you up to that point would be destroyed if you so desire. You may not participate in this study in you are under 18 years of age.

You have the right to a complete explanation ("debriefing") of what this experiment entails. If you have questions afterward, please contact:

Carolyn Keller
Department of Social Sciences
University of Wisconsin-Platteville
(608) 342-1981
kellerca@uwplatt.edu

Also, once the study is completed, you may request a summary of the results.

6. If you have any concerns about your treatment as a participant in this study, please call or write:

Yuanyuan Hu
Chair (through May 2020), UW-Platteville IRB
(608) 342-1929
huy@uwplatt.edu

WHICH YEAR ARE YOU?

- ○ Undergraduate: Year 1
- ○ Undergraduate: Year 2
- ○ Undergraduate: Year 3
- ○ Undergraduate: Year 4 or later

DO YOU IDENTIFY AS ANY OF THE FOLLOWING?

- ☐ Engineer
- ☐ Scientist
- ☐ Leader
- ☐ Creator
- ☐ Maker
- ☐ Designer

- ☐ Software Developer
- ☐ Artist
- ☐ Innovator
- ☐ Technologist
- ☐ Entrepreneur
- ☐ Inventor
- ☐ Other
- ☐ None of the above

HAVE YOU OR DO YOU INTEND TO TAKE ANY CLASSES, INCLUDING ALL CLASSES, AT UWP WHERE YOU ARE EXPECTED TO "MAKE" SOMETHING AS A PROTOTYPE OR FOR A FINAL PROJECT?

- ○ I have taken one or more such classes or am taking one now
- ○ I intend to take such a class
- ○ I would like to, but I don't think I will be able to
- ○ No

DURING A TYPICAL WEEK IN THE LAST ACADEMIC YEAR, HOW MANY HOURS DID YOU SPEND BUILDING, MAKING, OR CREATING?

- ○ None
- ○ Up to 5 hours
- ○ 6-10 hours
- ○ 11-15 hours
- ○ 16-20 hours
- ○ 21-25 hours
- ○ 26-30 hours
- ○ More than 30 hours

APPROXIMATELY HOW MUCH OF YOUR OWN MONEY DO YOU SPEND EACH ACADEMIC YEAR ON THE RESOURCES, RAW MATERIALS, TOOLS, ETC. FOR THINGS YOU MAKE AT UWP?

- $0
- $1-50
- $51-100
- $101-150
- $151-200
- $201-250
- $251-500
- $501-750
- $751-1000
- $1001-1500
- $1501-2000
- Over $2000 a year

IN THE LAST YEAR, HAVE YOU BUILT, MADE, OR CREATED IN ANY OF THESE AREAS? PLEASE CHECK ALL THAT APPLY.

- [ ] Software, code, programming, etc
- [ ] Electronics, Arduino, etc
- [ ] 3D printing, rapid fabrication and prototyping, etc
- [ ] Hardware, machining, etc
- [ ] Art, painting, graphic design, etc
- [ ] Culinary arts, creative cooking, etc
- [ ] UI/UX, web design, etc
- [ ] Product design, etc
- [ ] Woodworking, carpentry, etc
- [ ] Paper-craft, origami, etc
- [ ] Cinematography, animation, photography, etc
- [ ] Clothing, knitting, sewing, etc
- [ ] Metalwork, smithing, foundry, etc
- [ ] Jewelry, soldering, enameling, stone setting, lost wax casting, etc
- [ ] Sculpting, ceramics, glass blowing, etc
- [ ] Architecture, drafting, etc
- [ ] Cosplay, soctuming, etc
- [ ] None of these
- [ ] Other

WHERE DO YOU MAKE?

IF YOU ANSWERED THAT YOU MAKE AT HOME, WHAT DO YOU MAKE THERE?:

THINKING ABOUT YOUR OWN SCHEDULE DURING THE SCHOOL YEAR, WOULD YOU USE MAKER SPACES DURING ANY OF THESE TIMES IF THEY WERE OPEN?

- ○ I would use maker spaces if they had some weekend hours
- ○ I would use maker spaces if they were open from 7-10pm on weekdays
- ○ I would use maker spaces between 4-7pm on weekdays
- ○ I would prefer maker spaces to be open 24 hours per day
- ○ I would use maker spaces if they were open from 10pm-1am
- ○ 8am-4pm is usually sufficient for my needs
- ○ ________ Other, please specify

IF YOU COULD DESIGN YOUR OWN MAKER SPACE, WHICH TOOLS, TECHNOLOGIES, AND EQUIPMENT WOULD BE ESSENTIAL, NICE TO HAVE, OR EXCLUDED?

- ☐ 3D printers
- ☐ Metal cutting tools
- ☐ Woodshop tools
- ☐ Laser cutting tools
- ☐ Sanders/grinders
- ☐ Computers with design software
- ☐ Electric fab
- ☐ Waterjet
- ☐ Sheet and tube metal working
- ☐ Foam cutting tools

- [ ] Welding tools
- [ ] Paint booth
- [ ] Bike repair tools
- [ ] Light and photo equipment
- [ ] Plastics fab
- [ ] Silicone/plaster molding
- [ ] Textiles and vinyl
- [ ] Metrology equipment
- [ ] Composites
- [ ] Wet lab
- [ ] Jewelry making tools
- [ ] Glass making and shaping tools
- [ ] ____________ Other
- [ ] Forge
- [ ] Foundry

WHICH AMENITIES AND OTHER SPACES WOULD YOUR IDEAL MAKER SPACE INCLUDE?

- [ ] White boards
- [ ] Space for group work
- [ ] Personal project storage
- [ ] Class project storage
- [ ] Lounge space
- [ ] Vending machines
- [ ] Space for remote conferencing
- [ ] ____________ Other

LEARNING TO USE BOTH SIMPLE AND COMPLEX TOOLS AND TECHNOLOGIES REQUIRES TRAINING AND PRACTICE. WHICH OF THE FOLLOWING POSSIBLE TRAINING OPTIONS APPEAL TO YOU THE MOST?

- ○ Basic training
- ○ Intermediate training
- ○ Class for credit

- ○ Comprehensive training
- ○ [   ] Other

Would you be interested in participating in a Focus Group on this subject on Thursday, December 19 from 12:15-1 PM?

- ○ Yes
- ○ No
- ○ Maybe

If so, please supply your email address.

[   ]