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A Sea of Makerspaces:

Finding a Niche for a STEM Library Makerspace at an R1 Institution

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INTRODUCTION

Though still developing and shifting as a concept, makerspaces are widespread, even in higher education institutions where the adoption and implementation of ideas can sometimes be slower. The spread of makerspaces in academic institutions often results in a proliferation of these spaces across campuses, sometimes with specialized offerings or missions supporting particular academic departments. In this environment of abundant offerings, it's important for library-based makerspaces to solidify a niche to effectively reach users they hope to support. We have found ourselves confronting this need and have begun to identify areas where we—and many other library makerspaces—are uniquely suited to contribute. In the process of searching for our makerspace's unique role, we have also begun to explore solutions to another common library makerspace issue: the growth of a space without a corresponding increase in staffing. Through refining our makerspace's goals and purpose, we are designing a sustainable model of offerings that meets the needs of our campus community. As we look toward the STEM Library Makerspace's future and its niche, we find ourselves incorporating elements already very familiar to us as library workers: our roles as educators, our dedication to access, our support of interdisciplinary learning and collaboration, and an approach that involves users more directly in the evolution of the makerspace and the progression of their own skills.

INSTITUTIONAL CONTEXT

The University of Maryland, College Park (UMD), the state's flagship institution, is an R1, doctoral degree-granting university, situated in the heart of a research-rich region around Washington, DC, and Baltimore, MD. The University Libraries are the largest university library system in the Washington, DC-Baltimore area, serving more than 37,500 students and 4,200 faculty. Over the 1,250-acre campus, the system boasts eight libraries, six of which are on the main College Park campus.

This robust culture of research is a wellspring for makerspaces on campus. While the total number of makerspaces has fluctuated over the years, there are approximately twenty locations identified on the UMD Makerspace Map as of 2021.[1] Despite the large size of our campus, space is both scarce and sacred, as in many academic institutions. The space scarcity often means that departments are territorial of the spaces they do have, so it's notable that of those twenty spaces identified, only six are open to the campus community and only four are open to the greater College Park community. The majority of the spaces are only open to members or students and faculty in a particular department.

Within this makerspace-rich environment, the University Libraries are constantly evolving and developing their own makerspace offerings. The Libraries' makerspaces have fluctuated throughout the years, expanding, contracting, and changing missions. The John & Stella Graves Makerspace was opened in September of 2014, marking our inaugural exploration into what academic library makerspaces might look like at UMD. The purpose of the space was to provide a central area on campus that was devoted to instruction in and support of maker technologies for the entire campus community, including students, faculty, and staff. As such, the space embodied the Libraries' vision of democratization of services, stewardship of our collections, empathy, bravery, and transformation. This makerspace explored how technologies—specifically maker technologies—can support those goals.

In the beginning, the Graves Makerspace was located in the main library on campus, McKeldin Library, often referred to as the heart of campus. This location was a central meeting spot, one that would allow Libraries staff to create connections across campus that spanned all disciplines. The goal was to break down the barrier that other campus makerspaces had erected: namely, that only faculty and students of a specific department could use their spaces. By establishing this makerspace as non-department-specific, and by opening its doors to all faculty, staff, and students, the University Libraries ensured that all those that entered the space would get access and training on maker technologies.

The STEM Makerspace was originally a smaller branch of the Graves Makerspace located in UMD's STEM Library. In September of 2014, the STEM Library (at the time known as the Engineering and Physical Sciences Library) received one 3D printer, which it kept at the front reference desk. Staff trained themselves and within a month started printing for patrons. The Library was able to produce two or three prints per week, and news spread by word of mouth and through simple advertising bookmarks. By November of 2015, with the success of the Graves Makerspace, a second 3D printer was purchased for the STEM Library, and both machines were connected to a single, dedicated PC. By 2017, it was clear that a much bigger space would be needed, and in October of that year, a large room was dedicated as the STEM Library Makerspace.

Later, in 2021, it was announced that the Graves Makerspace in McKeldin Library would be moved and merged with the STEM Library Makerspace and some of the technology would be distributed to other library branches. The STEM Library also acquired an Augmented Reality Sandbox (which will be discussed more in-depth later in the chapter) and is pursuing the acquisition of an Anatomage Table. The STEM Makerspace is now the only UMD Libraries makerspace, leading the Libraries' exploration into and support of emerging maker technologies. This array of changes is forcing us to rethink our role in the makerspace community, and in order to do so, we have focused our approach in two key areas: technology and programming/outreach.

PART I: THE TECHNOLOGY

Foundational Equipment

Similar to other makerspaces in academic libraries across the country, the STEM Library Makerspace has a foundation of technology that is used especially heavily. While the technology has changed over the years, we currently feature an Artillery Sidewinder (https://artillery3d.com/), which we use with a wider range of filament, including flexible filament, and two Prusa i3 MK3Ss (https://www.prusa3d.com/), which are easy to use, reliable, and upgradeable. In the future, we hope to expand our 3D printing capacity to include multi-material printing or printing with more than one filament at a time. The printers are used for a variety of projects from research to simple printing.

In addition to our 3D printers, we acquired a Glowforge laser cutter, another common fabrication tool for prototyping. It's relatively fast and can be used on a wide range of materials, including wood, acrylic, cardboard, cloth, and so on. The Glowforge has proved especially good at entry-level laser cutting, which allows our students to grasp the basics before moving on to more advanced equipment. When we first acquired the Glowforge, we assumed that we would be making mostly custom housing for electronics or engraving printed circuit boards. While we have done some of this, it has seen broader use as both Libraries employees and makerspace patrons have used it for the fabrication of games, puzzles, and art projects that have been utilized in classrooms. In the future, we hope to expand our laser cutting to a wider range of materials, and we anticipate designing laser cutting lessons, which we hope to use for both individual laser cutting training and possibly for integrating into classroom instruction.

The Emerging Technology

One piece of technology we obtained more recently has generated excitement and moved us closer to finding our niche more than any other: the Augmented Reality Sandbox. The

ARSandbox is a literal box of sand about thirty inches square, mounted on a movable cart. An arm holding a projector and an Xbox Kinect extends over the sandbox. As a person shifts the sand in the box, the Xbox reads the height of the sand, and a software program, developed by a research team at the University of California, Davis, renders the height of the sand into a 2D topographic map.[2] This map is then projected onto the sand. The ARSandbox is an excellent tool for teaching students how to read topographic maps, interpret changes in topography, and can be utilized to teach a variety of concepts from urban planning to how climate change might affect local communities.

Additionally, with the merging of the Graves Makerspace and the STEM Library Makerspace came an influx of new technology. Some of the more exciting acquisitions are our new VR and AR headsets. As of January 2022, students can check out either of two Oculus Quest 2s or a Microsoft Hololens 2. Previous iterations of our VR offerings focused on using VR devices in partnership with and within the John and Stella Graves Makerspace at events such as Study Breaks during finals, and Game Nights during the semester. Interest was high and users wanted to interact with this technology (then the Oculus Rift S), but on their own terms and in their own spaces. Unfortunately, the computing power required to run a VR experience wasn't readily available to average users, which meant they were often limited to using the tech at the Makerspace during the aforementioned events. The Graves Makerspace experimented with loanable kits, which included powerful gaming laptops and even a desktop. While these solutions worked, they were cumbersome and not ideal for any but the most motivated users. Both the Quest 2s and Hololens 2 are fully self-sufficient with no expensive accessories required, offering better ways for us to meet the needs and desires of our users. It is our hope that, as we incorporate these headsets into our offerings, students will find them better suited to their VR experimentation and research.

Unique Possibilities

Some important aspects of the Makerspace and its technology that make it unique in the university's makerspace ecosystem have to do with the instruction and access we offer. We are the only space on campus that provides a free print-on-request service as well as widely available direct training on 3D printing. While other spaces do offer some form of training, there are normally stipulations about who is eligible and how users can be trained. Most spaces on campus offer training through online courses and certification tests, while we teach in-person lessons with the actual equipment, after which a user is certified to use the machinery.

We also recognize that the creative muse strikes outside of STEM Library hours; in an effort to expand users' making capability, we developed loanable kits stocked with different tools for different types of projects. The kits were built in partnership with the Clarke School of Engineering, which purchased the tools, made recommendations on the contents, and built the carrying cases. They are employed for assignments in engineering classes but are also often used by interested individuals without assignments. Students can check out these toolkits for three days, allowing them to make on their own time. The kits include

- electronics—soldering iron, multimeter, helping hands, wiring, breadboard;
- fastening—screwdrivers, C-clamps, hot-glue gun, tape measure, combination square;
- woodworking—hammer, mini hacksaw, scribing compass, torpedo level, files; and
- general engineering—screwdrivers, files, mini pliers, ratchet set, hot glue gun, and more.

Soon users will be able to borrow VR headset kits as well. While other spaces on campus may loan tools here and there, we are the only makerspace with an established and organized system of circulating equipment to maximize users' access. This is an area where libraries are uniquely situated to succeed, as we can draw upon our extensive experience with existing infrastructure for item circulation.

The success and popularity of the VR headsets and ARSandbox have also expanded our vision of what a makerspace can be. We envision using AR and VR in the creation of class-specific assignments that encourage students to explore and build these technologies. Bringing small groups into the makerspace for class projects, assigning projects outside of class time, and encouraging students to design their own homework assignments around AR and VR makerspace technologies are all possible directions. These technologies have gotten attention from faculty and students across the campus interested in determining if the tools can be incorporated into the classroom or instruction sessions, so we anticipate interest. In other words, we are looking to create and foster more large-scale instruction opportunities for our makerspace. This collaboration will create opportunities for us to build out the makerspace more, making room for more expensive technologies that more people can have access to, while also being mindful of our limited time and staffing: teaching to a larger group, such as a full class, will be far more efficient than scheduling individual training sessions and instructing one user at a time.

PART II: PROGRAMMING AND OUTREACH

Past Efforts

We have approached programming and outreach for the libraries' makerspaces in a number of different ways. Throughout, we find our niche in developing programming that highlights learning through play and the joy of creation. In the beginning, we featured makerspace products in several display cases located prominently throughout the library to garner interest and expand awareness. Makerspaces are visual and tactile by their very nature. Encouraging patrons to look at and play with objects became fundamental to our efforts to expand awareness of our makerspaces. These display cases, in addition to smaller, 3D-printed giveaways for orientations and local festivals, became a keystone to our marketing approach. For example, the Graves Makerspace had a gumball dispenser that was filled with 3D-printed terrapin statues (UMD's mascot) that were popular during open house events.

Putting together programming and outreach has been a fun exercise in making for both libraries staff and patrons. The STEM Makerspace used our laser cutter to create a series of puzzles for an escape room. This started as a project with a university-wide escape room program, and the series was play-tested right before the COVID-19 lockdown. In an effort to keep the escape room alive, the physical pieces were put aside and staff worked on developing a virtual escape room using tools such as Qualtrics survey software and MIT's Scratch programming language. However, since the actual pieces were made and play-tested, we anticipate using them, or the concept of an escape room, in the future.

A series of competitions we held featuring the ARSandbox combined a variety of library services and makerspace technology into one fun, interactive project for students. There were three scheduled competitions, though the last one was canceled due to the COVID-19 lockdown. During a two-week period, a 2D topographic map was featured next to the ARSandbox. Students were given brief instructions on how to read the map and then challenged to recreate the map, either in its entirety or a section, in the sandbox. Students were also encouraged to use 3D-printed items, such as shovels, dams, and bridges, in their rendition when it made sense to do so. When they completed their rendition, they snapped a photo and tagged us on Instagram. A winner was chosen after each entry was judged on aesthetics and the faithfulness of the replication. The winner was given a gift card and featured on our Instagram account, which was brand new at the time.

This competition was effective at drawing more students into the STEM Library Makerspace and helped us determine if and how the ARSandbox could be used for classroom assignments. While the new maps are certainly made objects, we are also interested in the coding potential of the Sandbox. By allowing students and researchers access to the Sandbox and the open code provided by UC Davis, we hope that they will be able to create more coding products that are valuable to them for both research and instruction purposes.

The most effective partner in our effort to reach interested community members has been the University of Maryland's Makerspace Initiative (MSI), an organizing body that aims to work with all makerspaces on campus to coordinate effort, inform the community, and encourage access to the resources available on campus. They are a group dedicated to "fostering a culture of creativity" and "democratizing access to resources."[3] Through its coordinating effort, the MSI is helping the STEM Makerspace place ourselves squarely in context with other makerspaces on campus. It gives us an opportunity to see what other makerspaces are doing, what limitations they have, and how to fit ourselves into a unique niche in the campus makerspace world. They also conduct massive media campaigns, putting out a Makerspace Annual Report[4] and connecting with two campus publications including *Maryland Today*,[5] our campus communications newsletter, positioning us to communicate our offerings effectively. For example, during our ARSandbox competitions, the Makerspace Initiative assisted with marketing that pulled in instructors who were interested in using the technology for classroom instruction.

Future Potential

By considering our programming and outreach successes so far, we can develop an effective approach for our role in the future. Marketing of the Libraries makerspaces has always been interdisciplinary and collaborative in nature. In the beginning, this was due to the central location of the Graves Makerspace in McKeldin Library as well as the Libraries' overall interdisciplinary ethos and commitment to serve the whole community. However, as we expanded physically into other areas (such as to the STEM Library) and as more makerspaces popped up all over campus, it became more essential to market and program across many disciplines. We have seen great benefits to our participation with the Makerspace Initiative group on campus and to working collaboratively with other makerspaces, campus departments, library units, and more. Not only does a focus on partnerships support the Libraries' mission and philosophy as a whole, but it also decreases the pressure on our staff members by allowing them to divide the work with others, contributing to a sustainable model for us moving forward.

Analyzing our past marketing has also helped us understand where we can decrease and redirect our efforts. The ARSandbox competitions, in particular, provided us with an opportunity to reexamine our outreach approach. The theoretical purpose for having a social media presence is to increase awareness and usage of the STEM Library's services among our students and faculty. However, the popularity of social media platforms is a constantly moving target. The STEM library has had a Facebook account since 2008 and Twitter account since 2009. The Instagram account, which we opened in 2020, is the most recent addition to our social media presence. To date, we have gathered 140 followers and posted thirty-four times with an average of three or four likes per post and a maximum of only eight likes. Though our Twitter account is more established with 1,214 tweets and 440 followers, and though it draws more interaction than our Instagram, these counts are still small when compared to a student body of roughly 40,000.[6] There may be potential to reach students and draw attention with a more dedicated investment and a greater allotment of time, but this is beyond what we can achieve within our current limits. In assessing our previous efforts and our current capacity, we understand that it may be more effective for us to focus less energy on social media engagement and redirect it toward outreach that produces better results, such as designing programming that resonates with the campus community.

We also see future instruction potential developing from our programming and outreach efforts. As an example, our ARSandbox competitions were designed on a series of geographic principles—specifically, those relating to reading and interpreting topographic maps that can be used in classroom assignments and lectures. Instruction sessions can be built on how to read topographic maps, how to interpret scale, and how to build models based on 2D renditions of an object. Through partnership with classroom faculty, future programming could combine the fun and engagement of the competitions with a solid foundation of instruction integrated into coursework, once again taking advantage of the broad access we provide as a library open to the entire campus community.

REFLECTION AND CONCLUSION

A series of changes, as well as our own successes, are pushing us to rethink what it means to be an academic library makerspace. When the STEM Library Makerspace first expanded in 2017, we drafted a mission statement that declared that the Makerspace would "build creativity, innovation, intellectual curiosity, problem-solving skills, and hands-on experience to complement multidisciplinary curricular activities and support active learning with emerging technology and empower the success of the students, faculty and staff of the University of Maryland community." The space would "enhance intellectual curiosity and student success" and "reflect the academic needs of the UMD community."

This mission statement was a good start in identifying our role on campus, and it aligned our Makerspace with makerspaces that were popping up in academic libraries across the country as well as research and literature being produced on the topic. For example, Burke defined academic library makerspaces as places where "participants, or makers, can create digital and physical items in common working spaces using shared equipment and resources. The essential makerspace elements of makers, tools, space, and shared expertise are also often joined by a spirit of individual exploration and discovery through creative activities."[7] This definition grounds our makerspace; we are a shared space, with shared equipment. We offer both digital and physical items for creating, and we encourage individual exploration and discovery.

While we still hold to our drafted mission statement, and while we still look similar to Burke's definition of a makerspace, we realized our STEM Makerspace needed to further develop and differentiate our special purpose in the sea of makerspaces on campus to allow us to survive and thrive. It should be noted that the University of Maryland Libraries is not alone in recognizing the need to find a niche among many campus makerspaces. Indiana University Libraries at Bloomington also recognized the proliferation of makerspaces across campus.[8] Recent research in academic makerspaces across the country point to more AR and VR technologies emerging as maker technologies; in keeping with this trend, the University of Southern California was able to integrate VR technologies into research, resulting in a productive collaboration with students.[9] In addition, the Binghamton University Libraries were able to incorporate some VR headset use into a nursing course and plan further curriculum integrations.[10] Ultimately, these technologies suggest new and expanded uses of the makerspaces in the curriculum and for instruction, both in active learning activities within traditional classrooms as well as project-based assignments within the makerspace itself.[11] Our own findings are in line with these examples; our work so far has highlighted the potential for our involvement with classroom-based learning and curricular instruction, an approach libraries are already very familiar with in terms of information literacy and research assistance. The interdisciplinary and unrestricted qualities of our Makerspace also help make it ideal for a broad range of instruction possibilities not limited to a specific subject or academic department.

Still, the future isn't without speed bumps. As is the case in many academic libraries, the UMD Libraries are currently facing constrained budgets due to both downsizing of the Libraries and COVID-19. While the Makerspace is likely to remain in the STEM Library, there is concern about both funding and staffing consistency. There is no defined budget for the maintenance or acquisition of new technology for the Makerspace from year to year. Both the limited amount of time staff spends in the Makerspace and the turnover of those staff pose problems for future work especially in maintaining instruction modules. Currently, one of the authors (JDW) dedicates approximately 40 percent of his time to

Makerspace work. He supervises two students who work a combined total of twenty hours a week in the Makerspace. In the past, another author (SES) spent a large portion of her graduate assistantship (a max of twenty hours per week) on Makerspace work. It is unclear how much time the new graduate assistant will be able to dedicate to this work, and each time a graduate assistant leaves, they moreover take a large body of knowledge about Makerspace technology with them. This also highlights a sustainability challenge: continuity of institutional knowledge.

We recognize the very real limits we face in available staff time and the challenges of running a successful makerspace serving the entire campus community. We believe instruction, especially on a larger scale than individual training, is key to both establishing our unique niche and developing a sustainable service model we can maintain with the resources we have. The case of the Augmented Reality Sandbox pushed us to further develop this concept. This successful project taught us the value of scalable projects that are available to students on their own time and assignments that do not require makerspace staffing. At the same time, the experience turned our focus toward integrating makerspace technologies into classroom work and collaborating with teaching faculty. Makerspace staff can train the teacher, who incorporates the skills required into their lesson plans and assignments and passes the knowledge along to the students, resulting in more scalable student instruction. By training faculty or other instructors likely to remain at the institution, we will be able to train just one individual on a technology, either through in-person sessions or online tutorials. They can then use these materials and this knowledge to train individual students or student groups with minimal Libraries staff time. Encouraging user involvement and seeking out partnerships can also help us sustain and even grow our services with limited staffing. A strong collaborative spirit will benefit us in numerous ways, and our commitment to interdisciplinary learning helps us form connections throughout the campus community.

Finally, we are beginning to understand that our Makerspace has a place in UMD's makerspace ecosystem as an entry point and that we do not have to meet every single user need on our own. Since we are open to the entire campus and provide the greatest access to our equipment both in the Makerspace and by loaning items, we serve as a low-barrier way for students to explore, discover interests, and generate ideas. If students then require more advanced equipment or more dedicated assistance, we can direct them to the space or lab that was less accessible to them as novices but that will now fit their needs. Reaching students in need and connecting them with the appropriate resources is an essential practice in libraries and is an excellent way for us to contribute to the campus makerspace community in a way that makes sense for us. The central role of the Libraries on campus uniquely situates us to facilitate these connections and collaborative, interdisciplinary dialogue in a way that department-specific makerspaces cannot.

As these answers emerge, we encounter new questions, especially when it comes to instruction and curricular integration. Without a dedicated makerspace staff member, can a makerspace in an academic library have an effective instruction or outreach component or be effective and utilized to a significant degree? With so much student labor turnover and the constant loss of technological knowledge regarding the tools that come with staffing changes, how can academic library makerspaces be effective at reaching the students who are most in need of their spaces and tools? Without a predefined, constant budget, is it likely that the technology within academic makerspaces will be effective for research and instruction at an R1 institution? These questions about basic logistics beg even greater theoretical questions, such as: Is there a place within R1 academic libraries for makerspaces? We believe there is, and we hope to answer some of these questions as we move our Makerspace forward. We believe elements integral to libraries can help us succeed in clarifying our niche and building a sustainable service model—namely, an interdisciplinary approach, a dedication to access and collaboration, and the willingness to involve users in the growth and change of the space. We have already drawn upon these ideas in our past efforts, but recognizing them and the ways in which we as Libraries employees are especially prepared to adopt these methods will help us move forward into the future. In partnership with the Makerspace Initiative, we will also explore our role as an entry point to campus makerspaces. In a sea of makerspaces, we are constantly evolving to find a better habitat in which the STEM Library Makerspace can thrive.

NOTES

1. "Makerspace Map," Makerspace Initiative, accessed December 3, 2021, https://makerspace.umd.edu/map/.
2. Oliver Kreylo, "Oliver Kreylos' Research and Development Homepage," Augmented Reality Sandbox, 2021, 1999, https://web.cs.ucdavis.edu/~okreylos/ResDev/SARndbox/.
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9. Curtis Fletcher, "A Case for Scholarly Making in the Library: Makerspaces, Innovation Labs, and the Evolution of Scholarly Communications," *College & Undergraduate Libraries* 27, no. 2–4 (October 1, 2020): 339–53, https://doi.org/10.1080/10691316.2021.1899881.
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