IMPACT REPORT VOLUME 2

MAKERSPACE INITIATIVE


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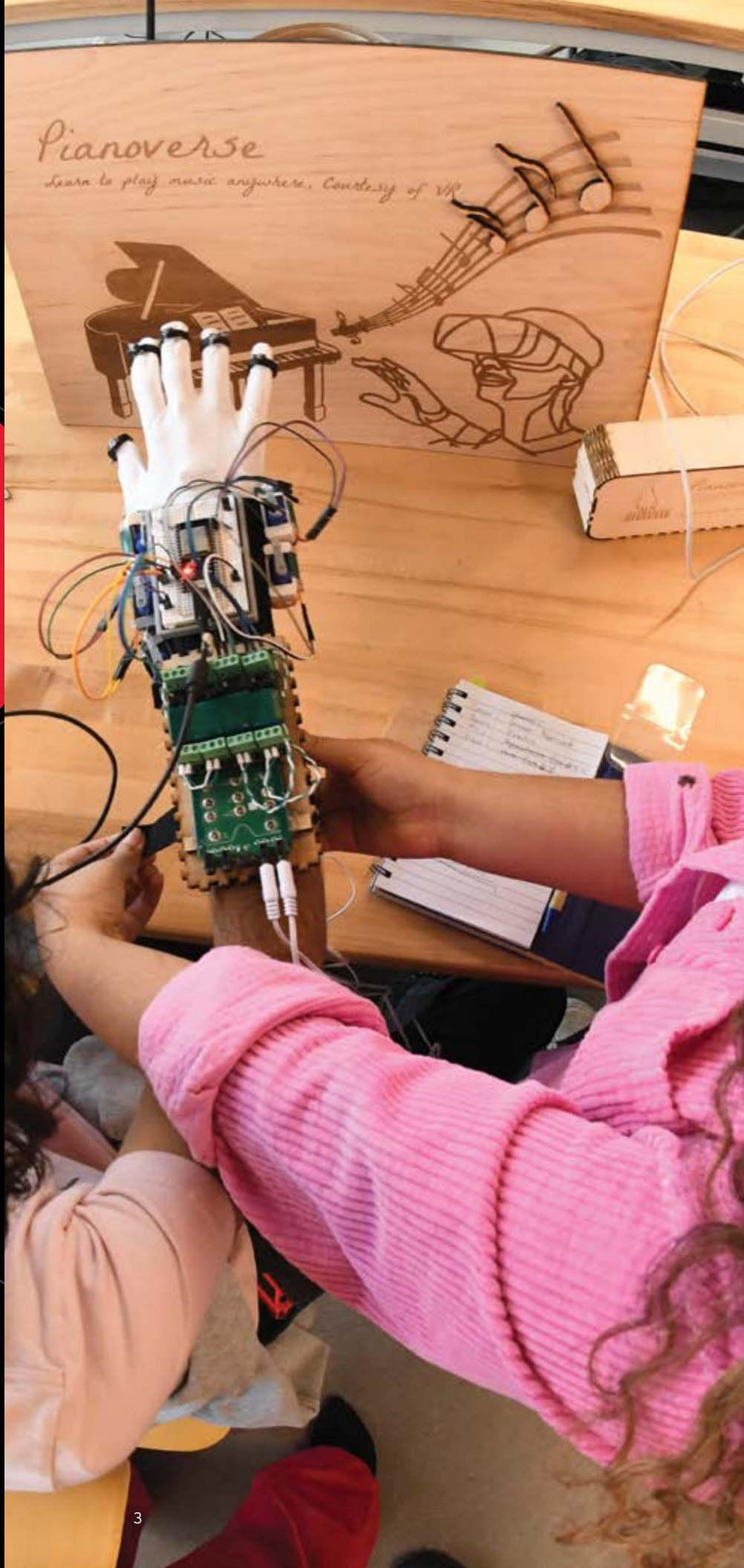
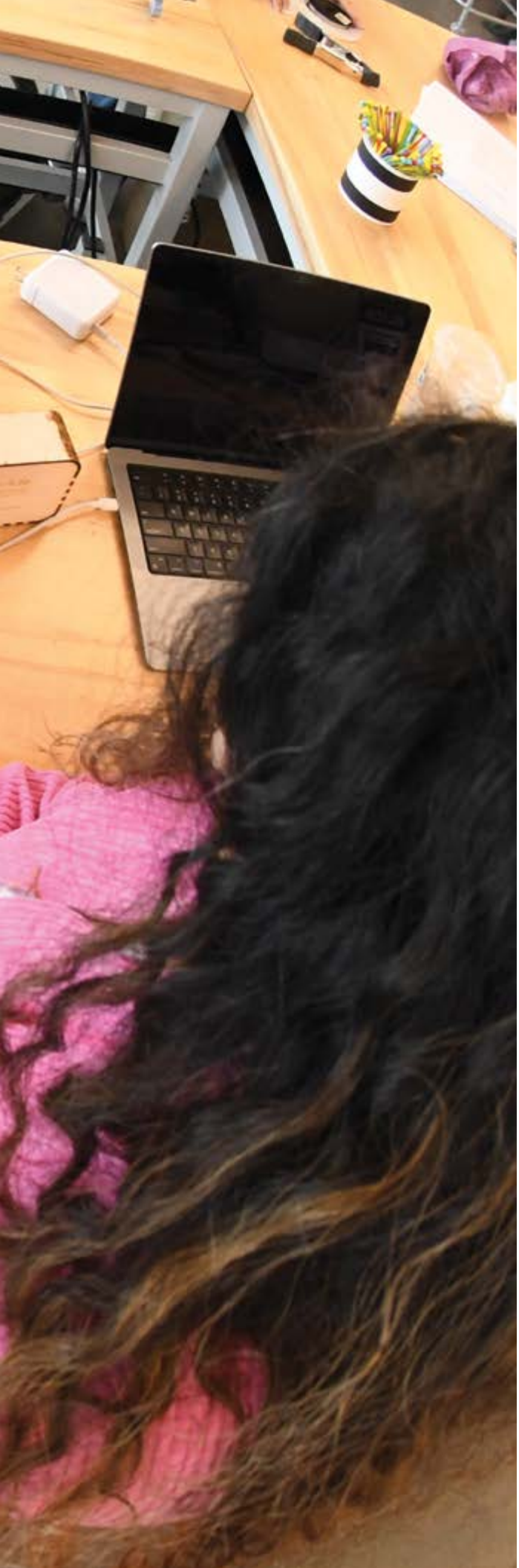




The MakerSpace Initiative (MSI)
A Collaborative Force of UMD Makerspaces and Instructional Fabrication Labs

The MSI is an association of makerspaces and other instructional fabrication labs at the University of Maryland College Park (UMD) working collectively to bring tools and tech to students, staff, and faculty while maintaining the highest standards for safety. Members each focus on different functional goals but all provide experiential learning opportunities to enhance the university experience. These hands-on learning opportunities can reinforce concepts taught in an academic classroom or may be completely extracurricular. Eight organizations founded the MSI in 2018, with the help of a donation and strategic guidance from Emeritus Professor Bill Pugh.

The 2021 Makerspace Impact Report (Volume 1) has a more detailed narrative of the history of makerspaces on campus, motivation for the creation of the MSI, the founding principles and first year goals for the organization. Volume 1 covered inception through June 2020, a time period ending just a few months into the global COVID-19 shutdown. While our initial goals remained important, the new dynamics of the pandemic required an adjustment to operations and recognition of new opportunities to provide an impact to the larger community. Many MSI spaces shut down entirely and their staff took on new responsibilities. For those spaces that didn't close, the unanticipated quiet of a nearly-empty campus provided an opportunity to focus on improvements to internal operations. Several of our members also worked through the summer of 2020 helping the local community by producing masks, face shields, and other personal protective equipment (PPE) needed by hospital staff, first responders, and local food distribution networks.

Publication of the Volume 2 Impact Report was postponed as MSI members adjusted to the pandemic. Volume 2 covers June 2020 through May 2023. This longer time frame allows us to document the challenges faced and overcome on the journey back to normal operations.

Evolution of
MEMBERSHIP

The Makerspace Landscape at the University of Maryland Continues to Evolve

As the makerspace landscape at the University of Maryland undergoes continuous transformation, notable changes have taken place since the last report.

Reorganization of Library Makerspaces

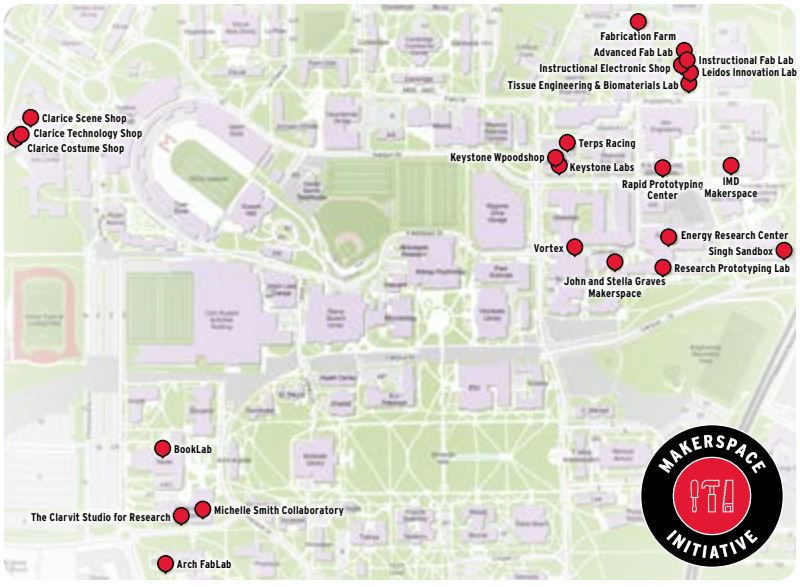
During 2021, the John and Stella Graves Makerspace in McKeldin Library merged with the STEM Library Makerspace. The newly combined makerspace relocates all of the Libraries' resources and expertise in making and fabrication in a single location.

Opening of New Makerspaces

Several makerspaces have opened since the last report. In the Fall of 2022, the IDEA Factory opened which included two new maker-centric spaces; ALEx Garage and the Rapid Prototyping Center both managed by Terrapin Works. The Clarvit Studio for Research in Art and Design in the College of Arts and Humanities (ARHU) opened in Fall of 2022. Another space opened in the AV Williams building, associated with the new Immersive Media Design (IMD) degree program.

Current MSI Members

The MSI comprises spaces across campus aligned with the maker movement, a cultural trend of empowering people to create. Many MSI members run makerspaces where shared equipment is available to campus community members. Several other MSI shops, such as the Clarice, don't fit the traditional definition of a makerspace, but contribute a great deal of expertise.



Architecture, Planning & Preservation FabLab
School of Architecture Planning & Preservation
Architecture, ARC 0110

BookLab
College of Arts & Humanities
English, Tawes 3248

Clarvit Studio for Research in Art and Design
Department of Art
Parren J. Mitchell Art-Sociology Building 3311

Immersive Media Design (IMD) Virtual Production Studios
College of Arts and Humanities & College of Computer, Mathematical, and Natural Sciences | Many Locations

Keystone Program Fabrication Labs
A. James Clark School of Engineering
J.M. Patterson, Rooms 1116 & 1120

Singh Sandbox
College of Computer, Mathematical & Natural Sciences
Institute for Advanced Computer Studies, Iribe 1231

Terrapin Works
A. James Clark School of Engineering
Engineering, Many Locations

The Clarice Scene Shop
College of Arts & Humanities
The Clarice Smith Performing Arts Center, PAC 1702

Michelle Smith Collaboratory for Visual Culture
Department of Art History & Archaeology
Parren J. Mitchell Art-Sociology Building, 1211B

The John and Stella Graves Makerspace
University of Maryland
STEM Library, William E. Kirwan Hall, Room 1403

Vortex
College of Computer Mathematical & Natural Sciences
Physics, Physics Welding Shop

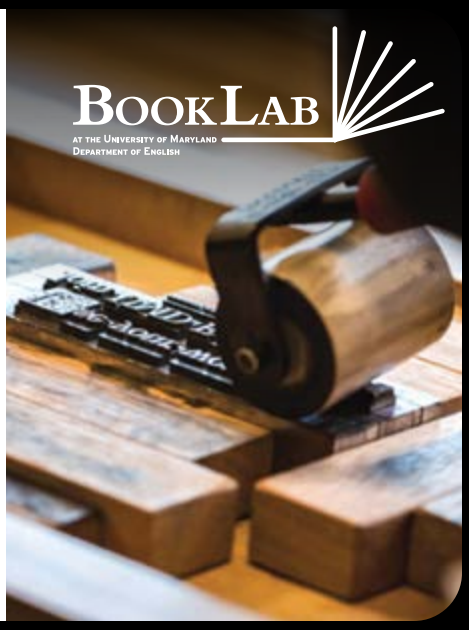
For a complete list of MSIs makerspaces, locations, and contacts, please refer to page 49

Architecture, Planning & Preservation FabLab

The Fabrication Lab (FabLab) enables students and faculty to construct digital and physical three-dimensional scale models of urban sites, landscapes, buildings, and building components. The Fablab consists of two shop spaces; one is principally devoted to fabrication of model components in a range of materials (woods, plastics, and composites like MDF) using both traditionally analog and digital CNC shop equipment; the second utilizes rapid prototyping equipment including 3D printers and laser cutters complementing the full scope of industry standard fabrication capabilities.

BookLab

BookLab in the Department of English offers a space combining elements of the traditional book arts with new platforms for digital expression. Far from believing that books are "dead," BookLab aims to have students and others explore this moment of media transition in creative and active ways—from movable type letterpress to 3-D printing, from page to screen and everything that happens in between. To that end, Booklab maintains a printing studio with traditional presses and hand-set type. It also offers materials for bookmaking and bookbinding, a library of rare and unusual books, 3D printing, wearable and embeddable sensors, and more. BookLab supports classes throughout English, ARHU, and elsewhere on campus.



Clarvit Studio for Research in Art and Design

Thanks to a generous contribution from Nancy ('78) and Chuck Clarvit the Dept. of Art opened a new fabrication studio in the fall of 2022. The Clarvit Studio for Research in Art and Design supports all art majors in developing artwork utilizing a wide range of digital tools. It houses three labs with dedicated workstations for 3D scanning and modeling, photo and video editing, and audio production along with laser cutting, 3D printing, and large format photo printing. A checkout system allows students short term access to projectors, portable audio equipment, depth sensing cameras, video and still cameras, and other tools for creating, documenting, and displaying their work.

Immersive Media Design (IMD) Virtual Production Studios

A new virtual production facilities opened in the AV Williams building as part of the recently-created Immersive Media Design (IMD) undergraduate degree program. IMD welcomed its first cohort in Fall 2021. As a limited enrollment program, students declared for one of two degree programs. Either a B.S. with a focus on computer science or B.A. with a focus on arts. Co-taught by faculty in the College of Arts and Humanities and the College of Computer, Mathematical, and Natural Sciences, the program uses new digital tools and technologies to explore how immersive media can be used in the visual and performing arts, medical applications, education, entrepreneurship, and more. Early in the IMD planning process, it was decided that IMD would work with MSI to define their makerspace needs specific to the programs. This led to the decision that IMD would make substantial use of the makerspace tools already in place at the nearby Singh Sandbox makerspace. Taking advantage of existing infrastructure allows IMD to focus most of its equipment investment and space allocation on studios and tools dedicated to XR development, projection design, motion capture, sound design, and immersive production.

Keystone Program Fabrication Labs

Located in the J.M. Patterson building, the Keystone Fabrication Labs house ENES100: Introduction to Engineering Design Course for first year engineering students. Nearly 1000 students take ENES100 yearly using these spaces to design and fabricate autonomous roving vehicles nicknamed Over Terrain Vehicles (OTVs), as part of a semester-long design project. These spaces feature commodity FDM 3D printers, laser cutters, and a variety of tools. In collaboration with Terrapin Works, Keystone also provides staff support to the engineering woodshop, which recently underwent a full scale renovation. The woodshop is open to all members of the campus community to work on both artistic and functional woodworking projects is now providing state of the art suite of woodworking tools.

Singh Sandbox

Sandbox is a 5,400 square foot maker space in Iribe Center dedicated to introducing a wide range of maker technologies and providing a welcoming and inviting setting in which to master them. Sandbox strives to provide an open and accessible maker experience for all. Student volunteers serve as mentors to makers learning and using tools and technologies. These volunteers allow us to support walk-in hours each weekday afternoon. Sandbox has individual studios for electronics, crafting & sewing, digital media creation, woodworking, CNC machining, and rapid prototyping using 3D printing and laser cutting. Access to Sandbox is freely available to anyone with a UMD ID.

Terrapin Works

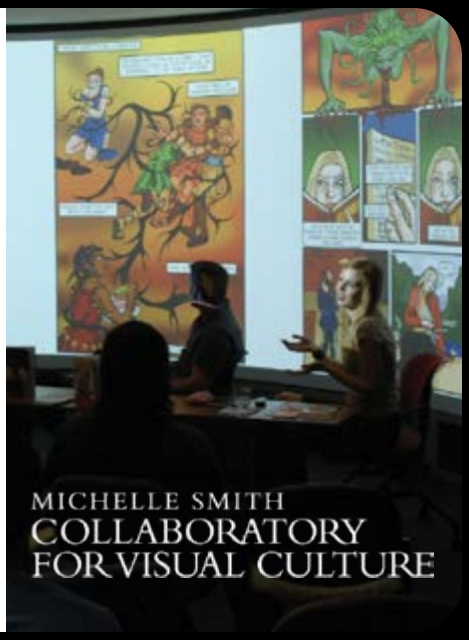
Terrapin Works is a collection of instructional shops and makerspaces providing rapid prototyping, advanced manufacturing, and digital design resources as a service to the campus and surrounding community. These resources range from 75+ consumer, research and industrial grade 3D printers, to high-end subtractive production systems capable of creating complex parts in a variety of materials. Research, production, and design services are offered as well as access to equipment spanning 18 major manufacturing processes in our 17 locations and 28,000 square feet of lab space across campus.

The Clarice Scene Shop

The Clarice Smith Performing Arts Center (The Clarice) houses workshops dedicated to crafting costume, scenic, and technological elements for the School of Theater, Dance, & Performance Studies (TDPS) and the School of Music (SOM). These workshops also assist artists and events organized by the Artistic Programming (AP) department including the NextNOW Festival, National Orchestral Institute + Festival, Clarice Presents, and other programs held in The Clarice venues. The Scene Shop collaborates with the Costume Shop and Technology Shop, sharing resources to fulfill production requirements such as scenery, properties, lighting, video/projections, and audio production. Together, these production spaces support and engage hundreds of students, faculty, and staff throughout the academic year. The Scene Shop, a founding member of the MSI, prioritizes production support and student training at The Clarice and while it does not offer a community workshop space, it often provides expertise and equipment for MSI projects.

Michelle Smith Collaboratory for Visual Culture

The Michelle Smith Collaboratory for Visual Culture is a digital art history/digital humanities facility situated within the Department of Art History and Archaeology. As the name implies, the Collaboratory is especially interested in collaborative projects that invite in the strengths of different participants and field perspectives. We work not only within the Department of Art History and Archaeology, but with others throughout the College of Arts and Humanities, the University community, and communities beyond the UMD campus. Occupying the space of the former Art History and Archaeology Slide Library, which was transformed to foster digital work in 2010, the Collaboratory is a place where students, faculty, and staff can come together to learn new processes, methods, and tools, and foster a spirit of shared curiosity, to bring their ideas to fruition.



The John and Stella Graves Makerspace

In 2021 The John and Stella Graves Makerspace relocated to and merged resources with the STEM Library Makerspace. This combined makerspace kept the name, The John and Stella Graves Makerspace. Located in the STEM Library, it aims to provide students, faculty and staff with hands-on experience and access to emerging technologies. It currently provides training on 3D printing and laser cutting. The hope is to empower the UMD community to create, innovate, problem solve, and learn through activities in a multitude of disciplines.

Vortex

The Vortex is dedicated to expanding the knowledge and ability of undergraduates beyond their classroom and lab experiences. Reopening the space to UMD was focused on maintaining that vision. Vortex encourages learning, investigation, and collaboration through practical projects in electronics, fabrication, coding, and more. The focus is on skills that are useful to a physics major in their career, but are not taught in any courses at UMD. While built around UMD physics, the same skills are useful in a range of fields and all are welcome. It is located in the former physics welding shop (building 111), tucked away in the courtyard between the physics and chemistry buildings. All interested students are trained in proper usage of equipment, shop safety, and managerial duties. The Vortex is open to students 12–4 PM weekdays during the academic year. All acting managers are trained to support and teach other students.

Progress on
GOALS

Enhancing Our Understanding of User Interests in Campus Makerspaces

One of MSI's startup goals was to create and deploy systems for tracking metrics about campus makers. One such system asks each visitor to sign in and identify the tools they plan to use when visiting a campus makerspace. This has allowed the MSI to collect a great deal of helpful information allowing member spaces to make data-driven decisions regarding the allocation of resources.

In collaboration with the Clark School's Engineering Information Technology unit, the MSI is continuously improving the software solution that collects this data. The current version is being piloted in six MSI member makerspaces.

It is currently collecting:

- The name of the individual.
- What tools and equipment they expect to use during their visit.
- Their college or school and degree program.

The system also allows some basic tracking of the safety and usage training completed by each maker. Feedback from the pilot program is continuously reviewed and integrated into the next major version of the system.

The next release includes:

- Additional support for lab managers.
- Automatic collection of user information through UID card swipe.
    - Increased quality of information collected and improved tracking of student information even if one's ID card is lost and replaced.
    - This integration will improve the quality of information collected and reduce barriers of entry into the spaces.
- Integration of reporting features which will simplify and standardize reporting of metrics.
- Integration with MSI makerspace training modules written in ELMS/Canvas to automate tracking of maker training certification.
- Additional features which allow makerspace managers to quickly identify the names and training certifications of all makers currently using a makerspace.
- A sign-out feature which will allow us to track the duration of visits to improve analysis of engagement.

Increase Visibility of MSI Makerspaces Through On-Campus Awareness and Outreach

During MSI's startup years one of our foremost goals was to increase on-campus awareness of the MSI and its members. This work continued through the campus shutdown but was supplemented by our efforts to connect with makerspaces at other educational institutions.

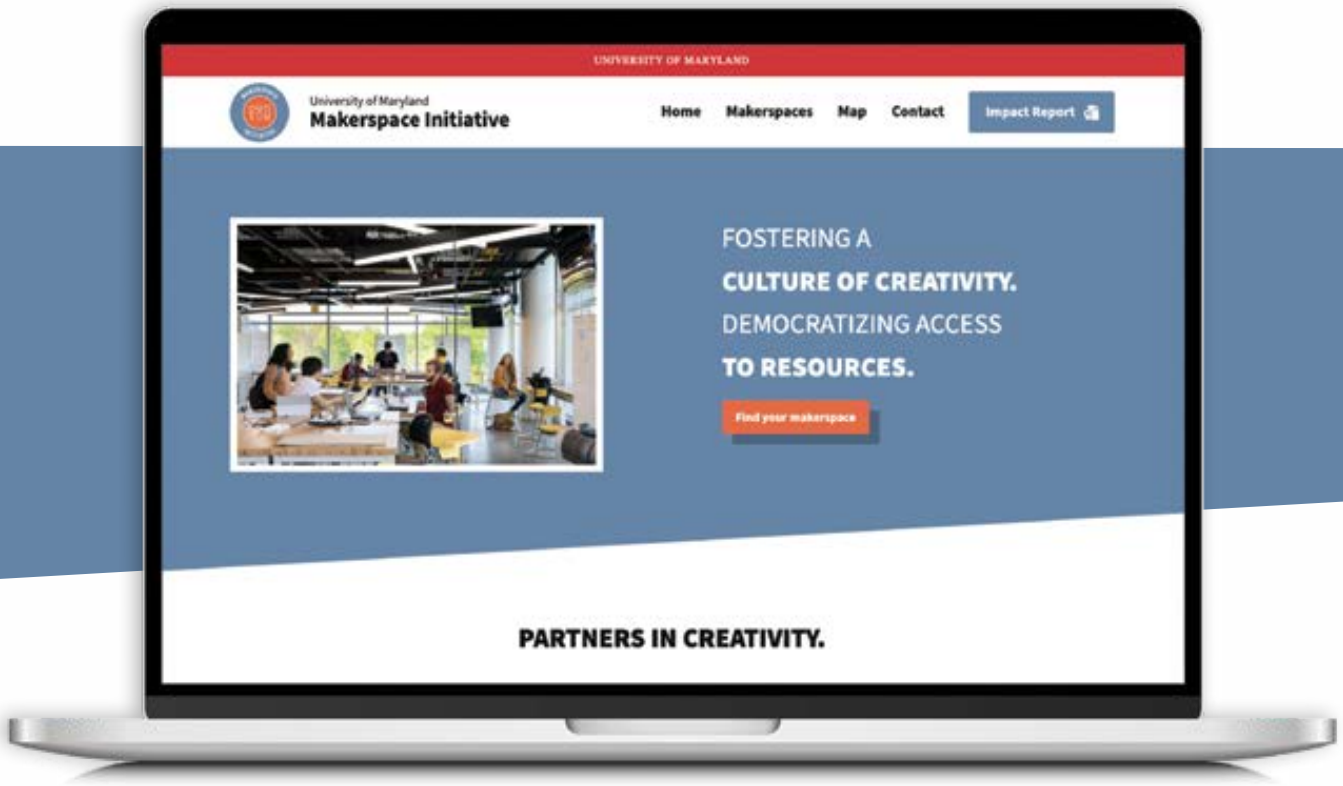
Since the goals of these related efforts are very different, MSI will use the term outreach to describe our efforts to connect with makerspaces at other educational institutions and we continue to use the term awareness to describe how MSI has promoted the benefits of makerspaces to members of the UMD community.

Awareness

MSI Website | make.umd.edu

The MSI launched the website in 2020 to provide a single place for the UMD community to find information about campus makerspaces. Improvements were made during the Fall 2020 semester with the addition of an interactive map of campus makerspaces.

The MSI includes the url in all promotional efforts and encourages individual members to do the same. For example, the MSI table at the First and Second Look Fairs hands out items engraved with this url. The website continues to inform the UMD community and assist them in locating makerspaces but more work is needed to increase traffic to the site and encourage visitors to explore. Currently in development are the addition of an event calendar and a searchable database of tools. With these utilities, users could see what is going in MSI spaces when, and find the right spot for their project.



Continued Participation in First & Second Look Fair

MSI has participated in every First and Second Look Fair since 2019. These events are consistently the most successful method for bringing new students into UMD makerspace seeking new members.

Due to the pandemic lock-down, the First Look Fair in September 2020 and the Second Look Fair in February 2021 were held online. During the online fairs, participants were able to interact with a participating lab manager who explained what limited services and activities were available during lock-down and detailed our plans for restarting operations when campus reopened.

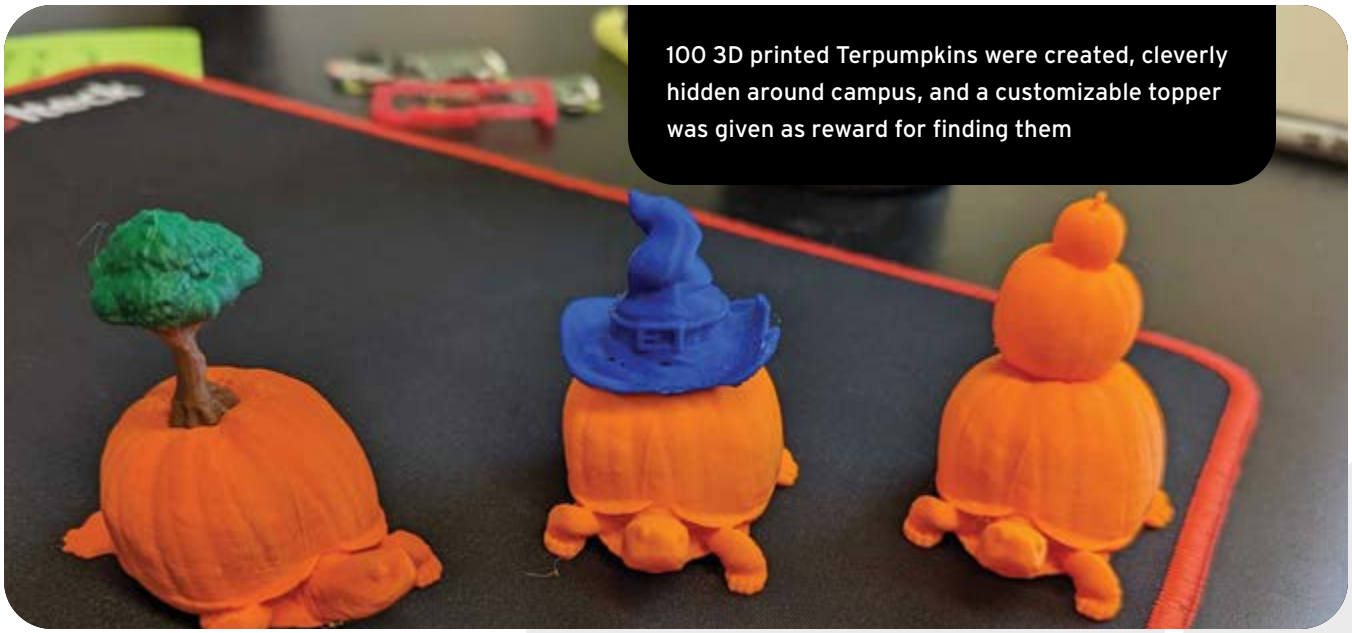
Student involvement promotional events typically feature a table on the lawn of McKeldin Mall or in the Stamp Student Union

During in-person events, several makerspaces have representatives present to interact with students and answer questions. Projects made in MSI makerspaces are displayed to pique student interest and provide concrete examples of the possibilities of each space. Always a crowd pleaser, a range of takeaway items are typically available, from pencils engraved with the MSI web url to 3D printed models of the iconic testudo statue.

Connecting with Students using Terplink to promote MSI events | terplink.umd.edu

The Terplink website, managed by the Student Organizations Resource Center (SORC), acts as a hub for student-run organizations to advertise their meetings and events. MSI, as a campus organization, uses Terplink to promote makerspace events, finding it to be a highly effective tool. Terrapin Works used Terplink to promote a series of workshop events on woodworking, laser cutting, soldering, and CAD in 2022 and 2023. Next year, MSI plans to build on these initial successes, rolling out new events, particularly those involving collaborations among multiple MSI members.

Terpumpkin | Terrapin Works piloted a scavenger hunt advertising campaign



100 3D printed Terpumpkins were created, cleverly hidden around campus, and a customizable topper was given as reward for finding them

Terrapin Works' Terpumpkin scavenger hunt achieved remarkable success, with over 30% of the Terpumpkins redeemed for a topper and all hidden Terpumpkins found within two weeks. This triumph has inspired MSI to expand the scavenger hunt, inviting more members to participate across additional locations.

Outreach

Fostering Excellence Beyond Campus

Other colleges and universities often express interest in touring UMD makerspaces or collaborating with MSI makerspaces. These connections allow MSI members to share operational strategies such as safety and training information, and receive similarly useful information in return. On another level these efforts contribute to the overall UMD goals of fostering a culture of excellence and innovative leadership.

During the pandemic, the MSI focused on reaching out to other makerspace leaders in the wider academic community. MSI offered our support to other schools beginning to build or expand their campus makerspaces. While this change was initially a reaction to Covid restrictions, the value of off-campus promotional efforts has proved beneficial, and MSI plans on continuing indefinitely.

UMD's Outreach Impact

Although, quantifying the impact of outreach efforts can be difficult, one tangible result was the selection of UMD by magazines *Newsweek and Make:* as one of the top maker schools in the world. While the list is unranked, UMD is one of only two schools selected in Maryland and one of only three schools selected in the Washington DC Metropolitan area.

Several of the outreach efforts that helped UMD attain such recognition are as follows.

University System of Maryland at Southern Maryland

MSI member Terrapin Works has been of critical aid in getting the MATRIX & SMART labs, located on the University System of Maryland at Southern Maryland (USMSM) campus, off the ground. Among other support, Terrapin Works was included in the oversight of the MATRIX & SMART labs procurement process for rapid prototyping equipment. This collaboration resulted in the free installation of two additional 3D printers each valued at $20,000.

Terrapin Works staff also assisted in the hiring process for the MATRIX manager and stood in for several product owner training sessions.

> **Terrapin Works… [has] been a key and unique resource for our new MATRIX Lab at [University System of Maryland at Southern Maryland].** As a brand new facility and research capability, we are working from the ground up in establishing positions, capabilities and processes. Knowing that we had a resource like [Terrapin Works Staff] available to us was not only informative but reassuring – somebody else has done this! [They] understood our challenges, the unique and demanding environment we are working in, and most importantly, how to be successful. [Terrapin Works] worked with us in establishing the requirements for research lab manager positions, participated in interviews and addressed what candidates were bringing to the position. After we set up our operation, [Terrapin Works] assisted with how [they] and other UMD labs work, what processes work and which don't, for both users and administrators, and how to scale our operation. [Terrapin Works] informed us what resources were available to help and what outcomes they would move us toward. The focus on safety and user experience and outcomes was key in the successful implementation and acceptance of the new processes…the experience of Terrapin Works [has] been invaluable to us as we stand up a new presence here at the MATRIX Lab."
>
> ***Matt Scassero***
> *Director of Research, Innovation, and Outreach at USMSM*

United States Institute for Theater Technology

The Clarice Scene Shop participated as part of a team of theater and performance professionals in conjunction with the United States Institute for Theater Technology to help create international guidelines and suggestions for best practices of how to continue to keep the performing arts active and functioning within the existing parameters of the COVID environment based on the information at the time.

> **I'm extremely proud of and grateful for the hard work of my colleagues.** They have spent many hours poring over documents from the CDC, OSHA, IATSE, Event Safety Alliance, SAG/AFTRA, and many others, working to distill the guidance these offer into annotated 'quick read' guides. It is our hope that these can prove helpful as our industry continues to learn how to respond to the coronavirus pandemic."
>
> ***Rich Dionne***
> *Technical Production Commissioner*

Salisbury University (SU)

SU met with MSI members in 2021 to discuss ideas for their newly-funded makerspace in the Rommel Center for Entrepreneurship. As a result, the Sandbox created a sample course in ELMS Canvas that SU used to jump-start the creation of their own training materials.

Bowie State University (BSU)

BSU recently opened their Entrepreneurship Innovation Center (EIC). EIC staff initially toured several MSI makerspaces to gather ideas. Since then, the relationship has expanded. MSI staff assisted EIC in drafting several initial training modules and safety procedures, while MSI members have visited the EIC to assist with organization in the space.

Universities at Shady Grove (USG)

In the Spring of 2018 a contingent of administrators from the Universities at Shady Grove came to College Park to tour Terrapin Works' facilities in A. James Clark Hall. Specifically the Leidos Innovation Labs. During this tour basic operations and considerations that went into those operations were discussed in detail. Plans to build a similar facility at USG were placed on hold due to the COVID outbreak in early 2020, but the USG was able to start work again in late 2020. Representatives from Terrapin Works collaborated with key USG stakeholders on the acquisition of equipment and provided general guidance on a broad range of topics from safety plans to recommendations on specific models of equipment. Recent Terrapin Works graduates were contracted as consultants to oversee the final logistics and commissioning of the new lab spaces in the Biomedical Sciences and Engineering Building.

Conference Participation

MSI members participate in two well-established makerspace conferences: the Student Shop Managers Consortium (SSMC) and the International Symposium on Academic Makerspaces (ISAM), where leaders in the academic makerspace community commune to share and develop best practices.

The International Symposium on Academic Makerspaces (ISAM)

The International Symposium on Academic Makerspaces (ISAM) is an annual conference for academic makerspaces hosted each year by the Higher Education Makerspace Initiative (HEMI), a consortium of 8 universities. Due to COVID-19 restrictions, ISAM was postponed and then canceled in 2020 and held virtually in 2021. The Fall 2022 conference was held on the Georgia Tech campus in Atlanta, GA. MSI members from Sandbox and Terrapin Works attended the conference, and presented a poster on the method used to determine needed equipment capacity for 3D printing operations.

Student Shop Manager Consortium (SSMC)

Several MSI members are active participants in the Student Shop Manager Consortium (SSMC). This organization hosts the preeminent conference on the safe operation and development of academic shops. It also has ancillary missions to provide an online platform for discussion, support, and development of educational shops in a wide array of formats, and to promote awareness, respect, and legitimacy of proficiency in shop skills. SSMC is a national organization with over 300 members from various academic disciplines and institutional enrollments.

As part of SSMC, the MSI members have participated in various Lunch-and-Learn events to discuss topics such as sustainable materials, video tutorials, signage, and mental health. Terrapin Works staff members participated in planning and organizing these monthly events.

MSI representatives from Terrapin Works and The Singh Sandbox attended the annual SSMC conferences in 2020 and 2021 which were presented in a virtual format. MSI representatives from the Clarice Scene Shop, Sandbox, and Terrapin Works resumed attending the SSMC's in-person conferences in 2022.

Standardize and Improve Training Materials and Safety Practices Across Campus Makerspaces

At the outset, MSI established a working group focused on drafting Standard Operating Procedures (SOPs) and other training materials for member makerspaces. Which coincided with another working group tasked with coordinating with UMDs Department of Environmental Safety, Sustainability and Risk (ESSR) to draft new safety guidelines for campus makerspaces. **These two groups have effectively merged together since inception. Their accomplishments include the following:**

Resources for Supporting Collaboration

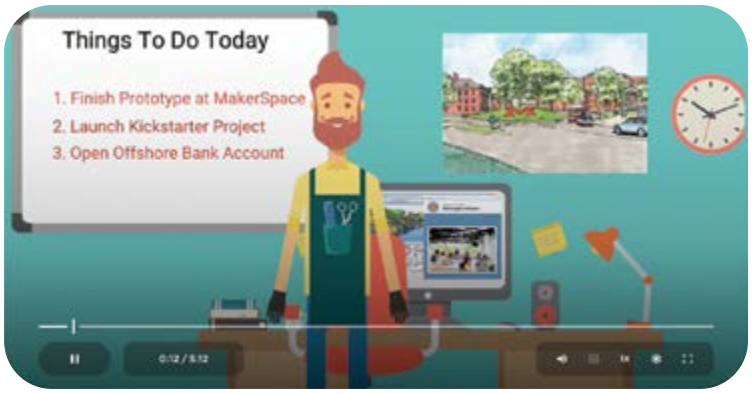
In its first year, MSI members worked together to establish standards and best practices for internal communications, document sharing, and platforms for training materials and procedure guides. This work has resulted in a portfolio of technologies currently in use:

- **Google Suite** for file sharing and collaboration.
- **Slack channel** for inter-group communication on a day-to-day basis.
- **Dozuki application** for documenting staff work instructions such as equipment maintenance tasks. Terrapin Works took advantage of the COVID-19 related slowdown to focus on developing more than 4,000 procedure-steps in Dozuki helping to ensure everyday job functions are done correctly and consistently. Many of these procedures are applicable to other USM makerspaces and are available to them free of charge.
- **ELMS / Canvas Learning Management System** for maker training materials, including templates and best practices for defining training and testing steps. This tool set is planned to include micro-credentialing (badging) capabilities when they become available.
- **LabSwipe / Pinpoint Software** for tracking usage of individual makerspaces. LabSwipe is the system currently used by makerspace visitors who swipe their UMD ID to log in to a space. Pinpoint is an upgrade to this system currently under development which includes several new features integration with ELMS / Canvas, improved reporting features, and other useful management tools.

Creation of a Safety Training Video

The SOP committee created an animated safety video intended to standardize basic safety rules across makerspaces. This video is a resource available to all makerspaces and covers basic rules on personal protective equipment (PPE), appropriate clothing when working on a makerspace, and common safety rules.

This safety video has been used for more than two years by several of our makerspaces including the Keystone labs where 1,200-1,500 students use this training resource each year in their course ENES100: Introduction to Engineering Design. This is a significant accomplishment towards our goal of providing a uniform safety briefing campus-wide.



Self-Directed Training Using ELMS/Canvas Learning Management System

MSI members tested and refined several methods to deliver training, ultimately selecting UMD Canvas Enterprise Learning Management System (ELMS). The SOP committee used the ELMS system to create a group of new training modules for commonly-used tools, initially focusing on basic equipment and later expanding to encompass more specialized machinery like 3D printers and laser cutters. These self-paced modules ensure consistent training standards across the campus makerspace community, offering advanced students the opportunity to complete much of their training remotely before visiting a makerspace. Leveraging the familiarity of ELMS, the training materials are presented in a format that is accessible to current students. It also lays a solid foundation for MSI to develop a system enabling makerspaces to share information regarding student training achievements.

Refining Campus Safety Rules & policies

The MSI works closely with ESSR to refine campus safety rules for machine shops and makerspaces, as well as to assist MSI makerspaces in maintaining safety policies. Operating a makerspace safely and ensuring compliance with regulations can be challenging. MSI serves as a resource for makerspaces and machine shops on campus, helping them identify and resolve safety issues.

As one of its startup goals, MSI pledged to aid UMD makerspaces in this challenge, and continues to prioritize this effort. Many individual makerspaces may struggle to find staff fluent in fabrication technologies, safety regulations, and the practices of various governing agencies. MSI's shared knowledge and experience with campus safety regulations accelerate staff learning.

MSI also serves as a source of experience for new makerspace managers trying to understand the complex collection of existing campus safety rules established by ESSR. These rules cover hazards such as radiation, biohazards, confined spaces, and working at heights. MSI acts as a translator between ESSR and makerspace managers, simplifying the process of opening and running a new makerspace with the anticipated completion of a makerspace-specific safety guide. By having the most experienced MSI members lead our efforts to increase safety we not only allow our other members to save time and money implementing a safety program, but we also demonstrate to ESSR and the Fire Marshall that MSI members view a commitment to safety as paramount.

Collaborative **SAFETY IMPACT**

Knowledge Sharing:

- Members share specialized safety knowledge
- Collective expertise enhances safety practices

Regulatory Guidance:

- MSI provides guidance on safety regulations
- Collaboration ensures adherence to safety standards

Unified Safety Approach:

- Working as a group reduces the burden on individual spaces
- MSI fosters a collective commitment to safety excellence

The MSI safety committee has a valuable perspective on safety in makerspaces, informed by: members' experiences; relationships with professional and educational makerspaces; from around the world; and continuing collaboration with regulatory bodies such as ESSR. MSI members have been instrumental in the efforts by ESSR to rewrite safety rules for makerspaces and machine shops.

Lessons Learned and **CHALLENGES**

Beyond Campus Amenities: Makerspaces' Crucial Contributions Amidst the Pandemic

Before the onset of the COVID-19 pandemic, makerspaces were viewed as auxiliary campus amenities that would cease operations in any emergency necessitating a campus shutdown. During the pandemic, the MSI learned that makerspaces were capable of contributing more than originally anticipated.

A Micro-Manufacturing Resource

Campus learned a lot during the pandemic, and the MSI took away some unique lessons with respect to makerspaces. As the COVID-19 pandemic transitioned from a crisis to a long-term concern in the summer of 2020, ad-hoc partnerships formed between the few MSI makerspaces still open and healthcare providers and first responders.

These efforts demonstrated the value of makerspaces to our local community and were recognized by local media outlets and government officials. Many of these partnerships and resulting products were discussed in the first edition of this report. Masks, face shields, and other PPE filled a useful gap in the global supply chain but as supplies of these items became available MSI COVID-19 response pivoted to other efforts. Foremost of these is the capability of makerspaces to act as micro manufacturing facilities in times of local, national, or global crisis. During a global shortage of personal protective equipment (PPE) University of Maryland makerspaces including Terrapin Works, The Clarice, and Singh Sandbox redirected use of their equipment to fabricate PPE for local hospitals, first responders, and various departments on campus.

Terrapin Works staff 3D print protective gear and other equipment for front-line workers fighting the pandemic

FABRICATED PPE FOR CAMPUS, HOSPITALS & FIRST RESPONDERS

3000
MASK STRAP RELIEF BANDS

100
HANDS-FREE DOOR OPENERS

50
DESK SHIELDS

2000
FACE SHIELDS

1500
FACE MASKS

In addition to PPE, MSI members fabricated phone mounts for instructors remotely teaching, and critical parts for oxygen masks needed by DC Fire and EMS. Their efforts garnered recognition from local news outlets and political leaders. Administrators should keep in mind this utility of makerspaces during times of crisis, and consider designating makerspace staff as essential employees.

Sustainability / Funding

Sustainability and ongoing funding was brought up in the first edition of this report. It continues as a concern after the Covid-19 shutdown and campus reopening. During the shutdown, MSI members mostly paused their efforts to lobby for funding sources. Recurring funding is needed for new equipment, consumables, and staffing. Raising campus awareness of maker activities should assist in increased funding opportunities for all our member spaces. These funding opportunities could be from external donations and sources or lobbying for additional internal resources.

Staffing Models and Staff Training

Makerspace training and staffing models are often built on the assumption that a significant number of student workers will return from semester to semester; new student workers learn from experienced ones. Several MSI spaces have noted difficulties returning to pre-covid staffing levels. While there are numerous reasons for this, one common cause identified was the loss of trained student workers. Students graduated, found new opportunities, or changed their priorities; this resulted in the loss of critical institutional knowledge and an important recruiting pipeline. Also significant is that experienced workers serve as a powerful recruiting force, attracting potential new workers by word-of-mouth. MSI intends to work on new approaches to staffing and improvements to staff training to recover from this problem and lessen the impact of skilled-student loss in the future.

MSI Makerspaces **IMPACT**

MSI Makerspaces Make a Positive Impact on the University of Maryland

The impact of the MSI makerspaces varies from day-to-day and from makerspace to makerspace, but the sum of the contributions become significant week by week and month by month.

This positive impact manifests in several way, including:

- **Enriching** student life
- **Adding value** to our academic programs
- **Facilitating** the needs of researchers
- **Administering** resources and facilities to support student organizations and competitions
- **Providing** alternative approaches to campus infrastructure improvements

This section provides insights into key metrics and showcases selected projects and activities of MSI makerspaces, illustrating their impact through personal stories.

Increased Usage of Makerspaces

One key measure of impact is the number of community members using makerspaces each day. Without measurement, it's impossible to understand and assess the effectiveness of our efforts to increase usage. Data collection and analysis was an important first-edition goal and continues to drive our project planning priorities.

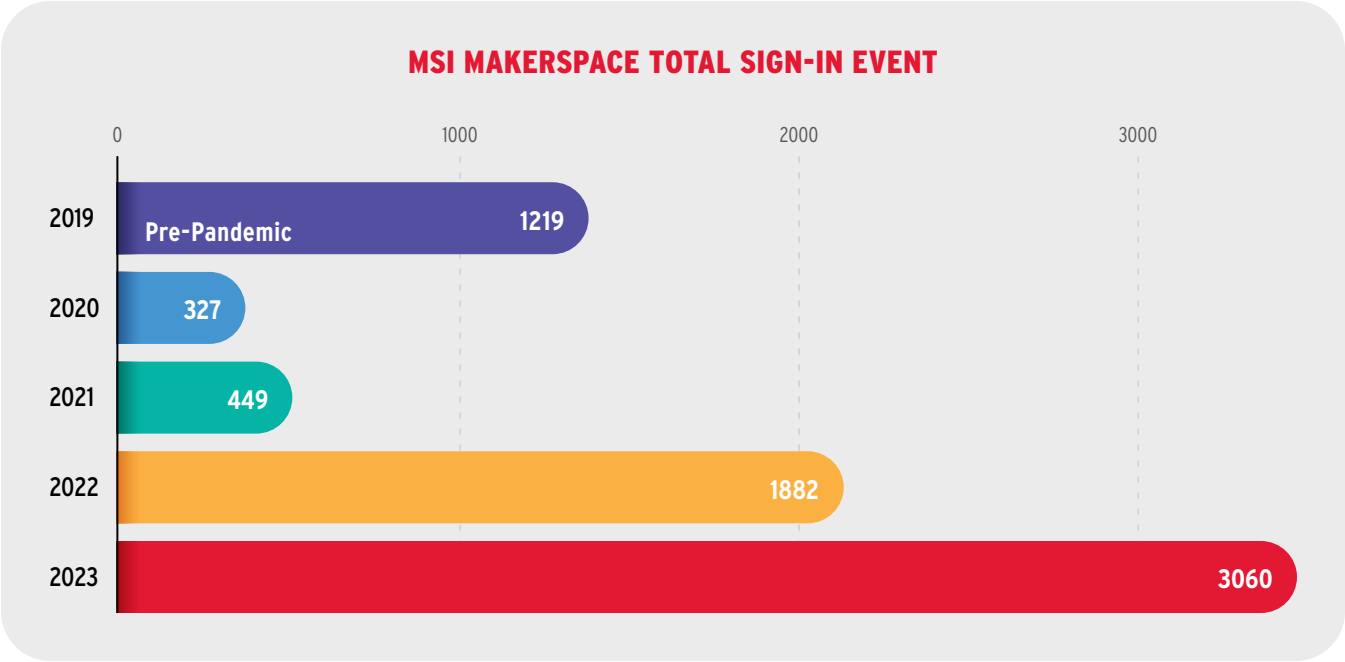
Most Popular **TOOLS**

- → Woodworking
- → Electronics
- → Laser Cutting
- → 3D Printing

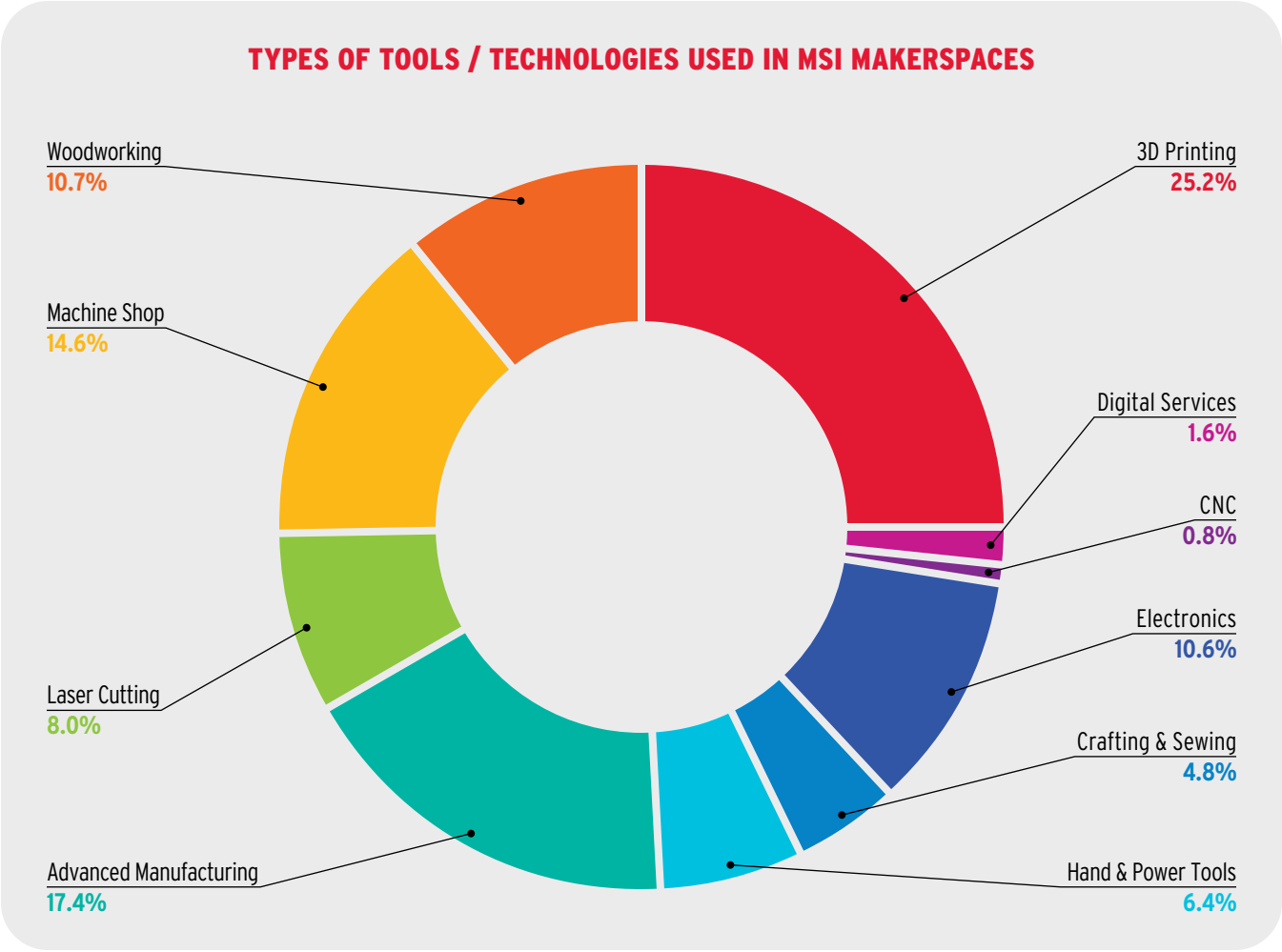
In 2019, the first year of MSI operations, we recorded 1,219 total maker visits. Following challenges posed by the Covid shutdowns in 2020 and 2021, visits saw a remarkable recovery in 2022, surging by **50% to reach 1,882 visits.** The momentum continued into 2023, with **more than 3,000 visits recorded**, showcasing the sustained growth and resilience of MSI.

MAKER VISITS IN 2022 & 2023

4882+ VISITS **300% GROWTH**



The most popular tools used in UMD makerspaces were Woodworking, Electronics, Laser Cutting, and 3D Printing according to data gathered between January 2020 and May 2023.



Impact of Makerspaces on Students and Student Organizations

Student Competition Groups

The MSI supports various competition teams across campus, these include: Terrapin Rocket, Concrete Canoe, Steel Bridge, Seds: Space-based projects, Gamera: solar powered rotorcraft, and Terra Formers.

Student competitions provide a platform for students to apply and refine their newly acquired knowledge through practical demonstrations in a competitive environment. The competitive setting motivates students to delve deeper into their curriculum, leveraging their knowledge to gain a competitive edge for their team and bring recognition to the university on a national level.

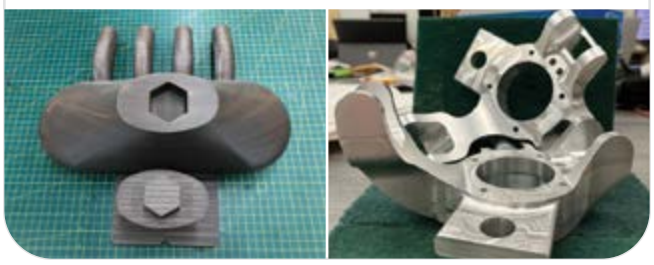
Terps Racing Electric Vehicle Team

The team was able to make use of the Singh Sandbox to prototype and produce several key components for their race car. Among these were battery packs\assemblies made using Delrin, polycarbonate, and Nomex.

Terps Racing Internal Combustion Team

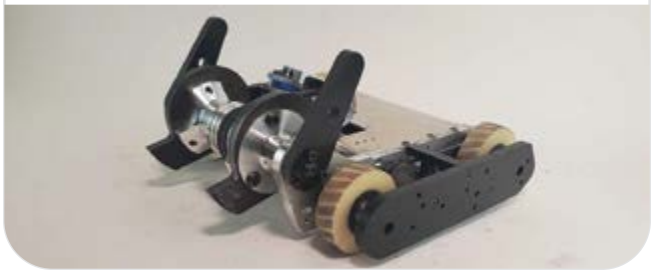
Team members take advantage of the training and equipment provided by Terrapin Works to manufacture components for their race car build. They have utilized additive manufacturing to create a mold for their intake manifold, wrapping it in carbon fiber to achieve a strong geometry.

Utilizing the Okuma Genos M460 CNC mill, the team fabricate large metal parts for their vehicle.



Leatherbacks Robotics Team

Inspired by the sensational Battlebots show, Maryland students have created their own chapter of battlebots. The team has participated in local and national competitions in various weight classes as well as hosted internal and local competitions. Their most popular, 1lb category, competition challenges their members to use 3D printing at Terrapin Works to create small yet destructive bots.



Robotics @ Maryland Team (R@M)

Team members utilize 3D printing and the waterjet in Terrapin Works to create a vast array of robots. Their latest include a miniature spot robot clone and autonomous submarine from aluminum parts made on the Protomax waterjet.

Support for Student-Centric Organizations

Student Organizations contribute enormously to the texture of university life. Some student organizations exist primarily to provide a much-needed opportunity for students to blow off steam while others are more serious, providing students with real-world experience in journalism, engineering, software development, business management, and other important skills.

Just as there are a variety of organizational goals, so too are there a wide variety ways in which MSI supports these organizations. Support could be a one-time event such as hosting a team-building workshop or assisting the organization with their hackathon or competition. Or the support could be more of an ongoing commitment such as providing a meeting space that also has tools available so the group can move directly from idea to prototype. More involved and complex support could include creating and hosting workshops & activity programming, loaning equipment and trained staff, facilitating guest lectures, and offering dedicated lab space to support the mission of the organization.

This support is offered after discussing the specific needs of the organization and how the MSI is best able to meet those needs. For many organizations these resources make a huge difference in their ability to achieve their goals and maintain members interest. These partnerships have resulted in relationships that have spanned the last several years and impacted thousands of students.

The following are examples of organizations and units that have taken substantial advantage of MSI resources.

Maker Workshops

The Keystone woodshop, supported by Terrapin Works aims to take away the technological mystery and complications of engineering and allow students and faculty hands-on design and prototyping experience without worrying about cost and complications of precision machining.

To expand the woodshop's reach beyond the school of engineering, the Keystone woodshop has worked with various on-campus organizations for collaborative workshops. Typically, the standard workshop is a one-day 3-hour cutting board workshop, as held for VSL, TAD, Office of Graduate Affairs, and EIT Faculty, however each organization is free to create a workshop based on their needs and desires. WIE and EWB have both designed hand tool workshops to suit the needs of their club's projects. Chi Epsilon has partnered with the woodshop to create keys for their initiates. The Center for Young Children built child-safe model robots to give to child attendants.

Feedback from clubs has been consistently positive, emphasizing the friendly staff, interactive projects, and desire to return. **A HIGH NET PROMOTER SCORE** reflects the positive feedback from workshop attendees and other student users, with the majority of respondents likely to recommend the shop's services to others. Notably, organizations like VSL and Chi Epsilon have returned for multiple workshops, indicating long-term satisfaction. Additionally, Terps After Dark has been a regular user, hosting numerous cutting board workshops.

Cutting Boards

The Keystone woodshop hosts making events where students, faculty and staff make impressive cutting boards.

Collaborative Workshops PARTNERSHIPS

- Veteran Student Life (VSL)
- Women in Engineering (WIE)
- Terps After Dark (TAD)
- Engineers Without Borders (EWB)
- Engineering World Health (EWH)
- Chi Epsilon
- The Center for Young Children
- The Alumni Association

FEEDBACK ANALYSIS

170 RESPONDENTS OUT OF 190 likely to recommend the shop

89% **HIGH NET PROMOTER SCORE**

Build a Buddy Workshops

The Build a Buddy Workshop is a hands-on make and take activity designed for participants of all ages. It is customizable to the comfort level of participants, but provides an engaging platform to teach some basic hand and power tools, as well as assembly, joinery, and fastener basics. Participants design and create their own personal buddy, the perfect companion for reading, cooking, studying, commuting, or whatever!

Terps After Dark Workshop

Students showing off projects made during the first Terps After Dark woodworking Workshop.

Hand Tool Workshop

Members of EWB's local project practicing the safe and proper use of power tools during a hand tool workshop.

Terrapin Works hosts numerous workshops each semester in addition to supporting the Keystone Woodshop. These workshops cover a variety of technical subjects, and are intended for UMD community members. Each workshop aims to be educational, fulfilling, and accessible for attendees of all backgrounds. Workshops are either hosted in coordination with a specific organization or for the general student population.

Going forward Terrapin Works will be expanding its workshops by collaborating with other campus makerspaces in an effort to attract more students who might feel intimidated by engineering-focused workshops.

Workshop Topic **EXAMPLES**

- → Woodshop
- → Electronics
- → 3D Printing
- → CAD Software
- → Laser Cutting

Electronics Workshops

Arduino is a type of microcontroller board, and a common starting point for simple electronic projects benefiting from microcontroller control. The hardware and software are accessible to people with little to no prior experience in electronics or coding, and the capabilities are versatile enough to sponsor a variety of new hobbies or endeavors. Terrapin Works staff led by the Instructional Electronics Shop provides workshops for up to 50 participants.

Introduction to 3D Printing

3D printing is a broad term that covers a wide range of technologies. The most easily accessible, and what most people think of when they hear the term, is Fused Filament Fabrication (FFF). Terrapin Works staff from the Fabrication Farm specializes in FFF and hosts workshops introducing students to the technology and the skills associated with it.

Student Projects

Student projects represent the largest impact from MSI makerspaces. These spaces aren't just about providing tools to build or repair projects; they're a place for students to get creative, explore ideas and collaborate – makerspaces improve campus life. Although, each student project may seem to have a modest impact, the collective impact is great.

Pearson the Dog Model by Isaac Rattey

In 2022, Terrapin Works student Lab Coordinator Isaac Rattey prepared to say goodbye to his guide dog in training Pearson, who was about to head off to school and then his new home. To help Isaac remember him, Pearson was 3D scanned, sitting still for 30+ minutes. The model was then printed in full color, and Isaac got a tiny memento of his good boy. In 2023, Pearson hit early retirement, and happily went to live with Isaac in his new home of Durham, NC.

Richie Figure by Richie Lempicki

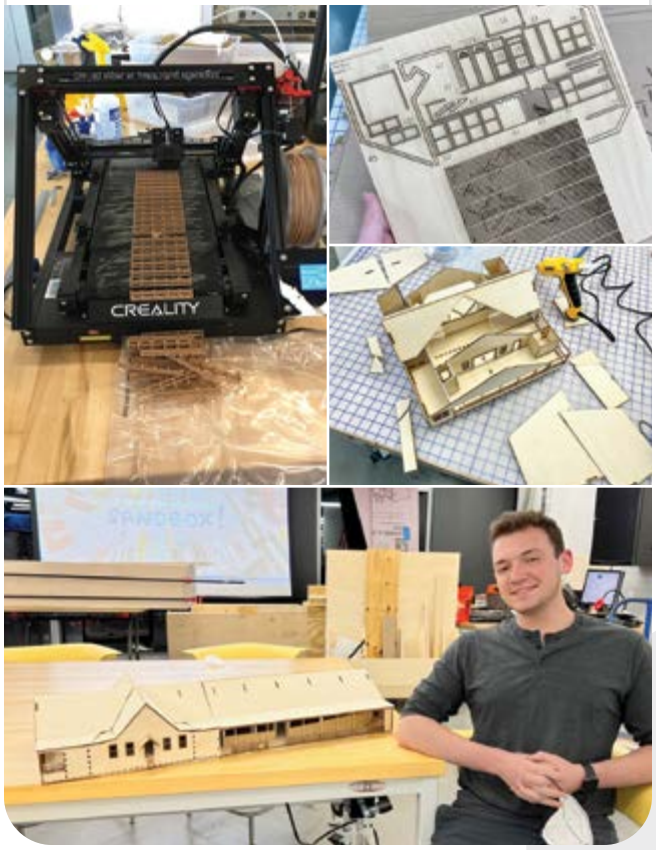
Undergraduate and Terrapin Works staffer, Richie Lempicki, trained in advanced 3D scanning, replicated full-body scans using sophisticated 3D printers.

Micro Drone by Kali Belsky

Undergraduate and Terrapin Works staffer, Kali Belsky, expands her drone racing passion by crafting custom carbon fiber frames for quadcopters using the Datron CNC mill and Water Jet.

Theater Model by Dylan Speiser

Sandbox maker, Dylan Speiser used the ULS laser cutter and Creality CR-30 3D printer to craft model parts for a scale replica of the theater where he worked for years.



Cat Sculpture by Alex Wang

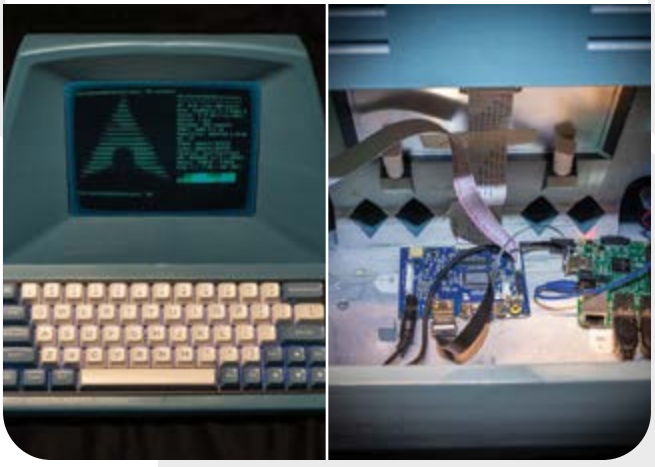
After completing the self-directed training module for the Glowforge laser cutter, Alex Wang, a Sandbox maker produced this stylized cat sculpture.

A Plant Stand by AJ Accad

A plant stand made of stained poplar.

Retro Terminal Project by David Green

Inspired by a Lear Siegler ADM3a terminal at a vintage computer festival, student David Green, unfamiliar with dumb terminals, built a functioning scale model using a Raspberry Pi single-board computer running a terminal simulator program.



Cajon Wood Drum by AJ Accad

Peruvian wooden drum called a cajon made of plywood, maple and jatoba, built in Woodshop.

Cocktail Tool Set & Sofa Table by Josh Cocker

Josh Cocker, a former student and faculty member, skillfully crafted a cocktail tool set and cutting board from padouk, walnut, and maple using the Woodshop. Additionally, he fashioned a walnut and maple sofa table.

Crotales Upgrades

A percussion student's crotales, a percussion instrument consisting of a set of twelve very small, thick cymbals tuned to the chromatic scale, needed new standoffs. The Clarice Scene Shop helped with the fabrication and assembly of components.

Custom Computer Case by Chinmay Sevak

Undergraduate and Terrapin Works staffer, Chinmay Sevak utilized the Protomax waterjet at the Instructional Fabrication Lab to cut a series of hexagon patterns on the aluminum case, designing a custom case for his computer build.

Impact of Makerspaces on Research

Campus makerspaces provide support to a variety of research projects across campus, serving as a valuable resource for researchers.

Bat Houses

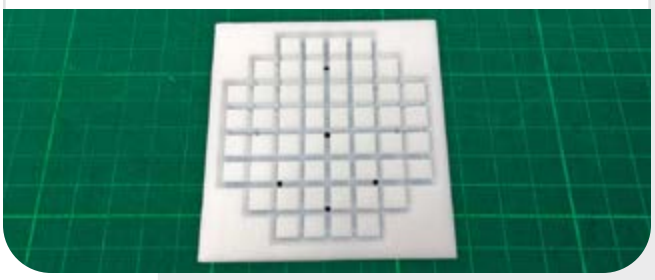
The Clarice Scene Shop worked with several other campus departments to complete a research project started by a student in the College of Agriculture & Natural Resources. This project was funded by a grant with the intention of studying bat and bird migration in the local area. The student graduated before completing work on the project so a group made up of The Clarice Scene Shop, The Smith Family Landscaping Endowment, Area Maintenance, Environmental Science & Technology, and Arboretum & Landscape Services came together to complete the installation of the boxes.

Stress Analysis

Stress analysis is usually performed to better understand how a part will behave under a specific condition. This type of analysis generates a digital heat map of stress concentration on the CAD part. Using the HP 580 3D printer, researchers were able to manufacture their part and overlay the heatmap on the surface of the physical part. By testing the part, researchers demonstrated it failed along the expected stress concentration.

Antenna Array

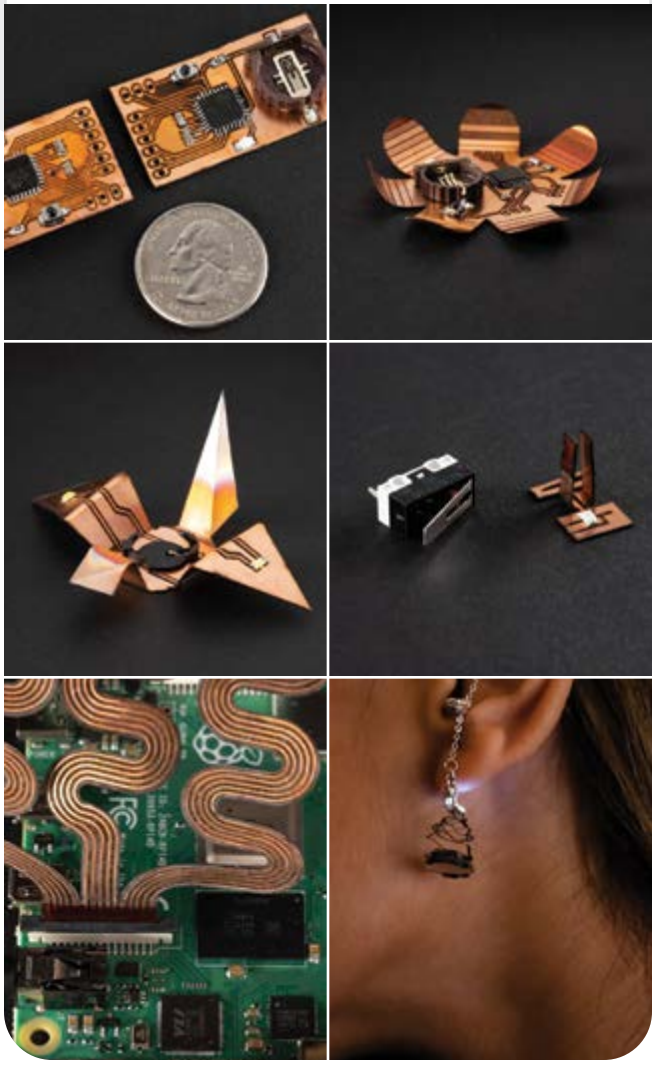
The Terrapin Works Instructional Fabrication Lab staff utilized the Datron CNC milling machine to fabricate a mold for an antenna array. Using a block of Delrin acetal plastic, they programmed the machine to cut the specified geometry.



SmArtLab Flexible Circuits

The Singh Sandbox worked with researchers from The Small Artifacts Lab (SMART Lab) in Iribe Center to develop an innovative method of creating flexible circuits using a fiber laser to cut traces from a sandwich of copper foil and Kapton tape. Over the course of several weeks this technique was refined to include kirigami folding of the circuits as well as using the laser to solder SMT components to the fabricated circuits.

The Small Artifacts Lab named this technique Fibercuit and developed a software application to design and create the circuits. This application has a user interface intended to simplify the creation of circuit boards.



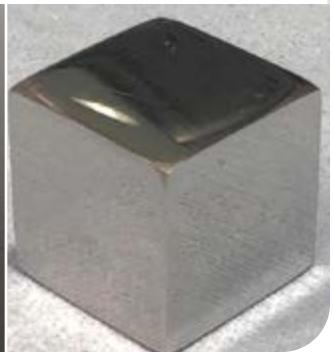
Timpani Spider

A professor of Music asked The Clarice Scene Shop for assistance developing a new mechanism to improve existing timpani tensioning methods. Existing timpani use a spider under the drum to secure the tensioning rods attached to the drum head. Apparently the manufacturer doesn't provide this capability and it is believed this new modification will improve consistency of sound quality. By developing this modification in-house, testing and revision cycles are compressed.

The "spider" under the timpani holds the bottom end of tensioning rods for the drum head. Some timpani have the spider secured, but some have it "floating". One of the professors from the music department asked if we could help create something to freeze a floating spider in place to allow for consistent tensioning when the drum head is replaced, instead of trying to tension something that is moving, which leads to inconsistent sound across the drum head. Apparently the manufacturer doesn't have such a thing, so this was a first test in an experiment for a solution. They'll try it out, and we can modify based on what they learn.

Virtual Foundry Prints

Terrapin Works staff test out a new material development in the 3D printing, metal filled 3D filament. The filament can be printed in a normal FDM 3D printer. After printing, the plastic is debinded in an oven, and the metal is sintered, resulting in a pure metal part.



Autonomous Bicycle

Autonomous bicycle. Autocycle hopes to increase the utility of bike-sharing systems by developing an effective self-driving bike that could autonomously deliver itself to a rider and return itself to storage.

Lathrop Labs

Lathrop Labs worked with Sandbox to print flight-grade hardware for their heavy-lift drone as a part of the Provost Grand Challenge Teams project for water/steam waste and the NSF-PFI award for AVAILD (Aerial Vehicle using Artificial Intelligence for Landmine Detection). This was achieved by adapting Sandbox's suite of Ultimaker 3d printers for printing NylonX, a carbon fiber reinforced nylon polymer. The parts designed and printed are actively being used on our sensor platform and play a vital role in the drone's landing gear and in ensuring proper alignment of our magnetic gradiometer.

> When looking for manufacturing options, Sandbox stood out as the only resource that offered the suite of tools we needed in the time frame we needed it. Having this manufacturing resource as an option greatly aided our ability to manufacture our parts in a timely and iterative fashion.
>
> **We'd absolutely choose to work with Sandbox on future research projects."**
>
> ***Dan Lathrop***
> *Principal Investigator*

Impact of Makerspaces on Academic Programs

Some MSI makerspaces are tightly integrated with academic programs of a particular department or course, while others operate mostly independent of any academic program. There is overlap between these roles with independent makerspaces sometimes supporting an academic program and academic spaces sometimes offering community access.

As the COVID-19 pandemic transitioned from a crisis to a long-term concern in the summer of 2020, ad-hoc partnerships formed between the few MSI makerspaces still open and healthcare providers and first responders. These efforts demonstrated the value of makerspaces to our local community and were recognized by local media outlets and government officials. Many of these partnerships and resulting products were discussed in the first edition of this report. Masks, face shields, and other PPE filled a useful gap in the global supply chain but as supplies of these items became available MSI COVID-19 response pivoted to other efforts.

Just as all universities learned a great deal about the practical aspects of remote instruction during covid, MSI makerspaces learned a great deal about converting our unique instructional methods to remote learning.

The Clarice shops had to be very flexible as the School of Theater, Dance and Performance Studies (TDPS) and School of Music (SOM) varied their needs as the health protocols and situational reactions and requirements changed during the pandemic. They were able to quickly pivot from in-person performances to live streamed events. Among their priorities was the preservation of student thesis performances, necessitating adherence to intellectual property laws in recording these shows.

With the return of students to virtual classes, The Clarice shops focused more on producing theater as these shows were instrumental for graduate students theses. Scenery, lighting design, costumes, video projections, and other work were back on the schedule even as the ability to hold public performances was a question mark. While some shows were canceled, others were performed on stage but were streamed to a remote audience.

Theater, Dance and Performance Studies (TDPS)

Actors each performing remotely are brought together on screen thanks to technology.

Production Streaming INNOVATIONS

The Clarice Technology Shop developed new innovations in the streaming of productions, creating a virtual performance with multiple actors appearing together on screen even though each was performing from their home or dorm room.

MSI makerspaces worked together to create new ELMS/Canvas training modules focused on remote learning to address the pandemic. These simple modules built on existing technologies to quickly deliver training by wrapping online training resources with the familiar ELMS/Canvas learning management system.

Support for CMNS 730

The Singh Sandbox Makerspace provided tools and technical assistance for students in the Lab and Competition modules of the CMNS 730 course. This graduate-level, research-oriented course covers broad areas of interactive technology and human-computer interaction (HCI) topics, e.g., ubiquitous computing, wearables, virtual/augmented reality, haptics, tangible UIs, accessibility, and Interactive fabrication.

The Course Consists of FOUR MODULES

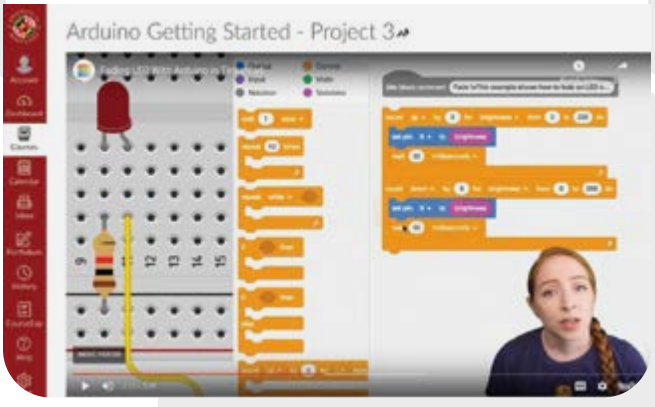
1. **Lectures:** Explore key research topics in technical HC
2. **Labs:** Equip students with skills for rapid, interactive physical prototyping
3. **Mini Competition:** Student dyads design and build a rope climbing robot using lab skills
4. **Semester-Long Project:** Teams of 3-4 build working prototypes to solve HCI challenges

Environmental & Occupational Hygiene Course

The Clarice Scene Shop worked in conjunction with ESSR and University of Maryland School of Public Health course MIEH 780 Environmental and Occupational Hygiene. The students monitored noise exposure within the shop environment, and made assessments and recommendations based on their research.

Arduino / Electronics Workshops for Intro to Engineering

The Keystone Program found incoming freshman consistently had trouble with electronics and Arduino programming. In collaboration with Keystone faculty, Terrapin Works developed workshops specifically designed to bridge those gaps. Terrapin Works staff led by the Instructional Electronics Shop provide introductory Arduino workshops regularly throughout each semester to ensure those who need the extra help can get it.



Calico Robot Dance

DANCE X DANCE or DANCE2 is an interactive dance performance and an interactive installation inspired by Square Dancing and online crowd-sourcing. DANCE2 performance is a duet between the dancer and Calico, a wearable robot that uses sensors and actuators to move on and around the dancer's body. The motion and light effects of the wearable robot directly contribute to the performed dance moves. DANCE2 is also the interaction between the dancer and the dance audience through Calico. With smartphones, the audience will collectively instruct Calico's movement on the dancer's body via real time voting. The dancer, the wearable robot, and the audience will thus complete the art performance in a collective manner.

"We recognize that one grand challenge that new technology and traditional art forms both face is that they can be exclusionary and inaccessible to the general audience.

The perception of both the arts and technology is that one must have specific knowledge, be it technical or cultural, in order to engage with or appreciate them. In the performing arts, codified spaces (i.e., theaters) and the long-standing expectations of an audience in these spaces can feel intimidating or alienating to some community members; when new technologies are developed, the uncertainty of them can conjure concerns about safety, privacy, and other adverse effects on society. DANCE2 aims to explore if wearable robotics, through a live and interactive dance performance, can help bridge gaps and promote understanding between the community, art, and technology. Additionally, we hope to spark conversations about the ethical implications of wearable technology and the influence of the digital collective on the individual. The work is supported by the Arts for All Initiative of UMD."

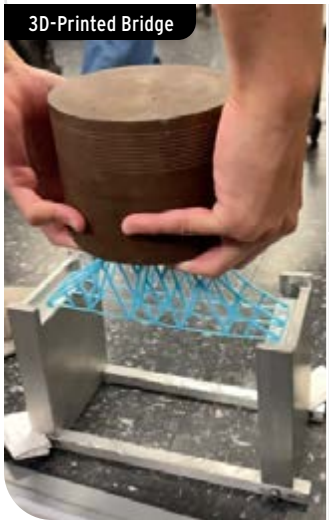
Huaishu Peng
Asst Professor, CMNS – Computer Science

Props for a Thesis Dance Piece

The Advance Fabrication Lab was able to use their epilog laser cutter to engrave a tan of leather. This leader was wrapped on a wooden staff used in a Thesis dance.

Additive Manufacturing Coarse

Terrapin Works plays a fundamental role in the Department of Mechanical Engineering's dual undergraduate-graduate level course, ENME 416/744 handling nearly every project from the coarse including the Midterm 3D-Printed Bridge Design Challenges and the Northrup Grumman Final Project. Countless guest lectures given by Terrapin Works staff members have been recorded and are available as additional content for students interested in learning more about the 3D printing capabilities offered on campus.



3D-Printed Bridge

Northrup Grumman

> **It is simply a fact that nothing in this Testimonial will do justice to how significant an impact Terrapin Works facilities and staff have had on my education, outreach, and research activities.** Thus, I wholeheartedly support Terrapin Works and believe it remains a unique and truly indispensable asset to my course, my lab, the College, and the University.
>
> **Ryan D. Sochol, Ph.D.**
> *Associate Professor,*
> *Department of Mechanical Engineering*

Pulleys for As You Like It

Student staff at the Instructional Fabrication Lab fabricated 10 pulleys in three weeks using water jet, CNC milling, and manual drilling. These pulleys were then used by the Clarice Scene Shop to automate scenery in the TDPS production of *As You Like It*. Allowing students to manufacture these pulleys enables them to apply their knowledge of manufacturing and machining processes to create a functional part, giving them hands-on practice with skills essential for their professional careers.

Car for Hookman

Motor Transportation Services helped The Clarice Scene Shop by making the vehicle safe for the theatrical production "Hookman" by removing all of the hazardous components that cannot be within the lab space, like the gas tank.

3D Scanned Face Form

Terrapin Works worked with The Clarice Costume Shop to create a face form of a cast member's face using a 3D scan. This scan was 3D printed as a proof of concept test to replace the tedious traditional lifecasting process using layers of alginate. These face forms are used in theatrical productions to facilitate mask making and prosthetic make up. Through this process it was determined that scanning someone's face successfully produces a 'face cast' but is cost prohibitive for theatre use.

To Continue THE EXPERIMENT

Next steps would be to manipulate the printing process to build a more open scaffolding resulting in less filament being used, thereby reducing the cost of the overall product.

While the initial process is quicker, computer work and printing time balance out the time commitment.

Impact of Makerspaces on Supporting Diversity, Equity, and Inclusion

UMD Makerspaces are essential to promoting diversity, equity, and inclusion by creating accessible, hands-on learning opportunities for underrepresented communities in STEM and beyond.

Through partnerships with Project Lead the Way (PLTW), Women in Engineering, and TerpsEXCEED, students from diverse backgrounds gain skills, confidence, and connections. From inspiring high school students with aerodynamics workshops to equipping women in engineering with essential technical training, makerspaces foster growth through an inclusive approach, paving the way for students of all abilities and backgrounds to excel.

> **On behalf of the Centers for Minorities in Science and Engineering, we'd like to thank Terrapin Works for their collaboration for hosting the PLTW workshops.**
>
> Terrapin Works played a crucial role in helping execute the event. We were able to accommodate 150 high school students in running a workshop for building and launching pneumatic rockets."
>
> ***Rosemary Parker***
> *Director, Center for Minorities in Science and Engineering*

The Women in Engineering Program is thankful for its partnership with Terrapin Works. We promote this program primarily to our Flexus and Virtus Living and Learning communities, as well as all students who identify as women in the Clark School.

The value provided to our program through these workshops is tremendous. Based on feedback we have received from our women students, many of them transition into college with lower confidence in their technical knowledge, experience, and abilities than their male counterparts. Each semester, TW and WIE regularly check in to identify which topics, dates, and times would be most beneficial to our students. Once the schedule is confirmed, WIE promotes the workshops each week through our website, our weekly FYI newsletter, and social media pages. We have seen that Arduino, Python, and CAD are the topics most requested, attended, and beneficial to our students. Our women students report higher confidence in their ENES 100 course due to the supplemental instruction they receive through these workshops."

Tabatha Rodriguez
Assistant Director – Retention, Women in Engineering Program

TerpEXCEED

The Clarice Scene Shop collaborated with The Clarice Production Management office and TerpsEXCEED to offer a valuable work experience to Zach McKay, a member of TerpsEXCEED's inaugural class.

Inclusive EDUCATION

TerpsEXCEED is an inclusive post-secondary education program at the University of Maryland, College Park that provides Maryland students with intellectual disabilities the opportunity to participate in a college experience for two years, culminating in a certificate.

TerpsEXCEED Mission: For students with Intellectual Disability, create access to UMD courses to develop a course of study aligned with individual career goals; on-going career development that includes work experiences on and off campus; participation in campus social clubs and community organizations; use of all campus facilities; ability to earn a credential recognized by UMD; and inclusion in housing and residential life.

Impact of Makerspaces on Campus Infrastructure and Services

Transforming Campus Equipment and Solutions

One of the most unique impacts makerspaces have on campus is the ability to extend the lifetime of obsolete equipment or create custom solutions to unique problems.

While these solutions may appear mundane at first glance, their impact can be significant, as they enhance efficiency and cultivate a culture of creativity and problem-solving within the campus community.

Collaborative effort yields stunning turtle shell table. The Department of Residential Facilities and Student Affairs reached out about a custom-made conference table for Patty Perillo, Ph.D. '02, Vice President for Student Affairs. The Clarice Prop Shop and Scene Shop took charge of the project.

The Prop Shop, drawing on their furniture-building expertise, handled the preparation of the maple lumber, including planing, sanding, and joinery to meet size and design requirements. Concurrently, the Scene Shop pushed the boundaries of their CNC machine to accommodate deeper carving depths and intricate designs on both sides of the material. Collaboration was key in addressing the table's larger dimensions than the CNC's platform.

Extensive experimentation was conducted to determine the optimal approach for carving the maple slabs with the CNC, assembling them, and developing programming for the carving process. After numerous iterations, the maple slabs were successfully carved, assembled into a single large tabletop resembling a turtle shell, and mounted onto a pre-fabricated custom base, topped with glass.

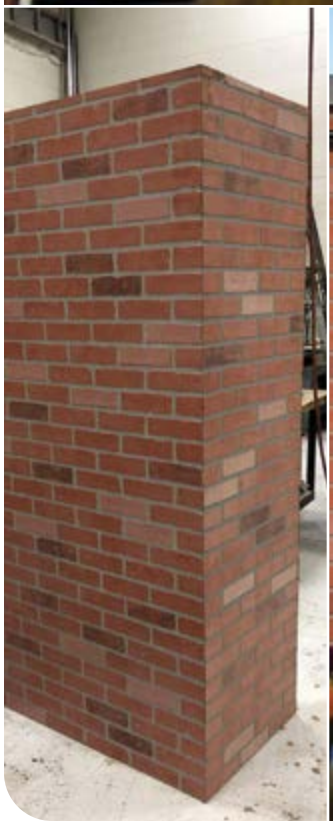
Terp Table

The Clarice Scene Shop crafted a beautiful conference table for Patty Perillo, Ph.D. '02, Vice President for Student Affairs. The table entailed intricate carvings to replicate the turtle shell scutes pattern requiring research and experimentation due to its intricate and deep carvings.

> **"My new table is not only a piece of artwork, as the craftsmanship is extraordinary,** but I can feel the love and joy you all put into this project – I can feel it when I sit arouand the table!"
>
> ***Patty Perillo Ph.D. '02***
> *Vice President for Student Affairs*

Brick Facade

University House reached out to the Clarice Scene Shop to create a brick facade for University House's Mote event. The Scene Shop constructed a lightweight, portable prop that could be stored at University House for future use.



"I just wanted to again say THANK YOU for the brick facade that you constructed for the Mote event for University House.

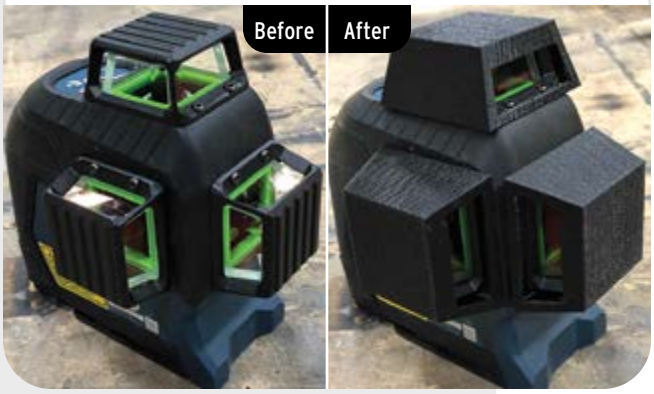
It was a huge hit with the unveiling, and a photo even made it onto *Maryland Today!* We had VP's looking at it up close, analyzing (with favor) how it was made. And the Motes were over the moon with the event in general; the facade added a great flair of theatricality to the occasion.

Thank you so much for being a great campus partner and for your willingness to extend a helping hand – it is getting harder and harder to find these qualities on campus these days. I made sure to give you all full credit and praise, so your contribution is well known. Also, the facade has continued to be useful for other events, and we already have plans for its incorporation into our holiday decor!"

Stephen Oetken '95 History, '12 MHP
Assistant to the President & University House Manager

Shields for Laser Level

The Scene Shop occasionally uses lasers as part of their layout and installation processes. One team member designed and made removable caps to restrict laser direction from 360° to 90° when necessary, to shield other workers from eye exposure to the lasers.



TerpZone Safety Upgrades

The Clarice Scene Shop helped TerpZone establish safety protocols for their maintenance and repair operations to better align with campus safety regulations.

Disc Golf

The Clarice Scene Shop is launching an innovative project to install prototypes of lawn disc golf across The Clarice's grounds. Supported by a generous endowment from the Smith Family Foundation, this initiative aims to enhance the use of the building's outdoor areas. It introduces seasonal recreational activities and opens doors for future endeavors.

Athletics Department Flag Pattern

The Clarice Scene Shop helped Athletics Production by doing some CNC work fabricating Maryland flag patterns for use in video and media work.

NextNOW Fest

The Clarice's annual NextNOW Fest is a student creativity and experiential event held each fall as a cooperative endeavor partnering the Division of Student Affairs, academic departments, and organizations across campus and throughout the College Park community.

Skate park for NextNOW Festival

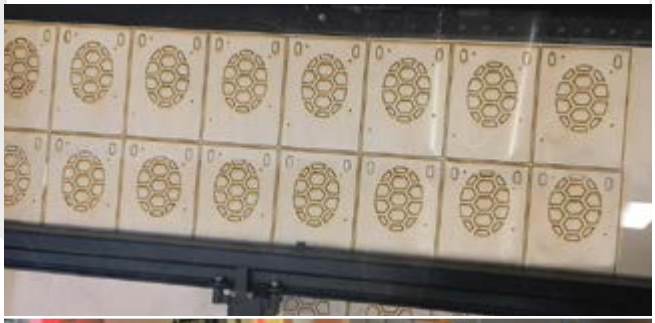
Co-sponsored by University Recreation & Wellness with student groups Skateboarding Clubat UMD and WeSkate UMD as partners, The Clarice Scene Shop helped turn the Kogod Theater into a skate park during the NextNOW Fest.

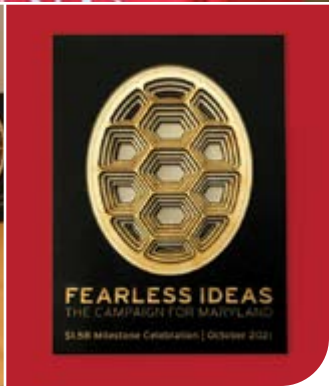
Promotions and Campus Awards

Sandbox and Terrapin Works joined forces to craft custom promotional items that left a lasting impression. From laser-engraved pencils promoting the MSI web page to commemorative plaques for the UMD Board of Visitors meeting and the Jagdeep Singh Family Makerspace dedication event in May 2021, as well as a range of promotional items for the AFL Tour by US Secretary of State Antony Blinken in August 2021. The collaboration resulted in high-quality, impactful pieces that showcased the spirit and innovation of the University of Maryland.

Plaques

Laser-cut awards made from 8 layers of baltic birch plywood for the UMD Board of Visitors meeting and the Jagdeep SIngh Family Makerspace dedication event courtesy of Sandbox and Terrapin Works.





Pencils

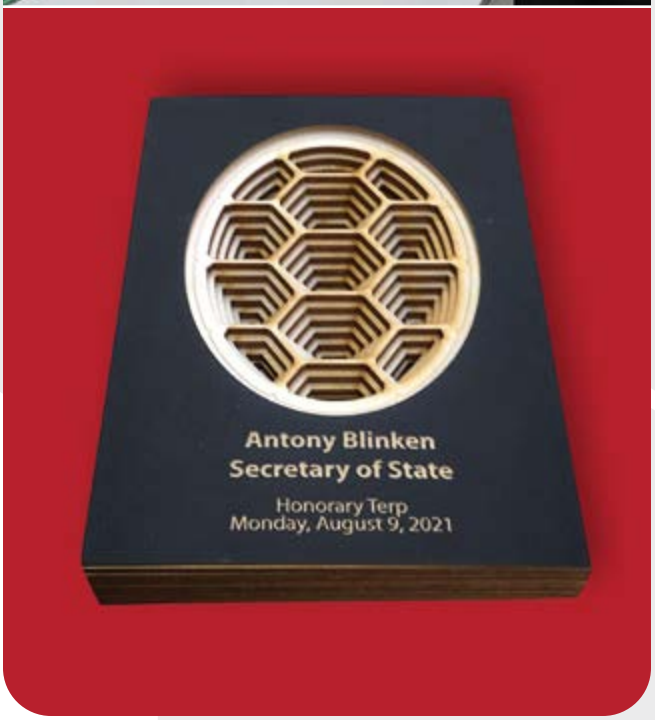
Laser-engraved pencils promoting the Makerspace Initiative's website, make.umd.edu.

Commencement Batons and Box

Terrapin Works was asked to duplicate the Commencement Batons used in the Clark School's Graduation Ceremony, and create a box to store them.

Desk Ornaments

To commemorate a speech and tour by US Secretary of State Antony Blinken, Terrapin Works 3D-Printed desk ornament featuring the Department of State's seal which was presented to him along with a Testudo statue.



Makerspace improvements

Student volunteers at the Sandbox makerspace used the fabrication capabilities of their makerspace to improve the space by building custom tool holders and creating unique and informative signage.

Tool Wall

Sandbox student managers designed and constructed a modular tool storage system for the woodworking studio. Having tools displayed on this wall helps makers find and return tools to the correct location.

Modular Display Panels

Sandbox student managers designed and constructed modular display panels to show off projects made by other Sandbox makers. Having many example projects on hand helps others understand how to make use of a tool or technique.

Arduino Sensor Demonstration

Display board demonstrates the use of an ultrasonic distance sensor on an Arduino microcontroller. The QR code links to a more detailed explanation of the sensor, including the code used for this demonstration.

Signage

Signage created in Sandbox helps makers quickly learn about individual tools and the training required to use them.

Impact of Makerspaces in College Park Community and Beyond

The Clarice Costume Shop has made significant contributions to the local community through their creative talents and generosity. They embarked on a heartwarming initiative spreading joy and warmth in the community through their thoughtful creations for two important causes; Columbia Community Care in Columbia, MD, and Terps Toy Drive benefiting the City of College Park Youth and Family Services.

BookLab's public work focuses on social justice, amplifying the voices of historically marginalized communities through their unique and impactful printed materials.

Sewn Bears Donation

The Clarice Costume Shop created and donated sewn bears to Columbia Community Care in Columbia Maryland and College Park Youth and Family Services, Terps Toy Drive.

Crocheted Hats Donation

The Clarice Costume Shop created and donated crocheted hats to Columbia Community Care in Columbia Maryland and College Park Youth and Family Services, Terps Toy Drive.

Justice Book Press

A set of vintage Linotype slugs spelling the word JUSTICE that BookLab uses in its letterpress printing projects. Much of BookLab's public-facing work centers on social justice and giving voice (with ink on paper) to historically marginalized communities.

Advanced Fabrication Lab
A. James Clark Hall, Room 2123
Contact: Evan Hutzell, ehutzell@umd.edu

Arch FabLab
Architecture Building, Room 110
Contact: Marty Koelsch, martyk@umd.edu

BookLab
Tawes Hall, Room 3248
Contact: Matthew Kirschenbaum, booklab@umd.edu

Clarice Costume Shop
The Clarice Smith Performing Arts Center, Room 3749
Contact: Jennifer Daszczyszak, jendas@umd.edu

Clarice Scene Shop
The Clarice Smith Performing Arts Center, Room 1702
Contact: Reuven Goren, rgoren@umd.edu

Clarice Technology Shop
The Clarice Smith Performing Arts Center, Room 1737
Contact: Jeff Reckeweg, reckeweg@umd.edu

Energy Research Center
Engineering Lab Bldg
Contact: Cathy Stephens, csteph5@umd.edu

Fabrication Farm
Technology Advancement Bldg, Room 1103
Contact: Evan Hutzell, ehutzell@umd.edu

IMD Makerspace
AV Williams, ROOM 3258
Contact: Ian McDermott, imcdermo@umd.edu

Instructional Electronic Shop
A. James Clark Hall, Room 1115
Contact: Rick Blanton, terrapinworks@umd.edu

Instructional Fabrication Lab
A. James Clark Hall, Room 1119
Contact: David Kreisberg, dkriesbe@umd.edu

Keystone Labs
J.M. Patterson Bldg, Rooms 1116 & 1120
Contact: Josh Cocker, jcocker@umd.edu

Keystone Woodshop
J.M. Patterson Bldg, Room 1212
Contact: Ted Baker, tedbaker@umd.edu

Leidos Innovation Lab
A. James Clark Hall, Rooms 1106 - 1122
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Michelle Smith Collaboratory for Visual Culture
Parren J. Mitchell Art/Sociology Building, Room 4213A
Contact: Quint Gregory, quint@umd.edu

Rapid Prototyping Center
E. A. Fernandez IDEA Factory , Room 1107
Contact: Evan Hutzell, ehutzell@umd.edu

Research Prototyping Lab
Glenn L. Martin Hall, Room 126
Contact: David Kriesberg, dkriesbe@umd.edu

Singh Sandbox
Iribe Center for Computer Science & Engineering, Room 1231
Contact: Gordon Crago, sandboxumd@gmail.com

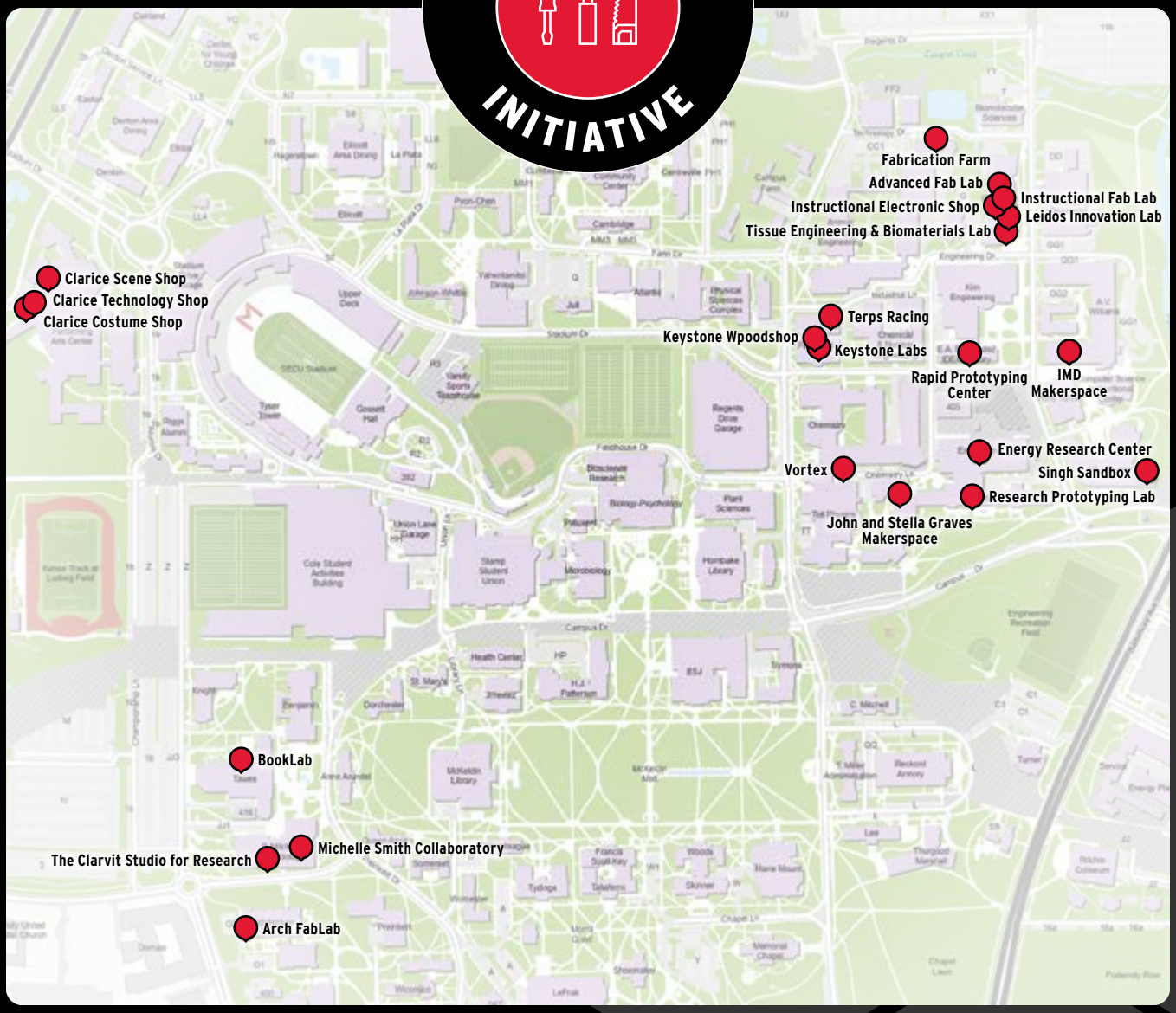
Terps Racing
J.M. Patterson Bldg, Room 1229
Contact: David Kriesberg, dkriesbe@umd.edu

The Clarvit Studio for Research
Parren J. Mitchell Art/Sociology Building, Room 3311
Contact: Tommy Bobo, tbobo@umd.edu

The John and Stella Graves Makerspace
William E. Kirwan Hall, Room 1403
Contact: Maggie Bentley, stemmakerspace@umd.edu

Tissue Engineering and Biomaterials Lab
A. James Clark Hall, Room 4102A
Contact: John Fisher, jpfisher@umd.edu

Vortex
Physics Welding Shop
Contact: Angel Torres, torang12@umd.edu



Visit Our Interactive Makerspaces Map

On behalf of MSI, we extend heartfelt thanks to all our supporters, colleagues, and supervisors. Your incredible support is what keeps us going as we chase our wildest ideas to make the world a bit brighter.

A huge thank you also goes out to all the MSI members who contributed to this report. It was truly a team effort, but we'd like to give a special shout-out to Rick Blanton, Reuven Goren, Gordon Crago, David Kriesberg, and Evan Hutzell. Their efforts to weave together all the contributions created a truly cohesive tapestry. And finally, a special thanks to Anastasia Vullis for her creative vision, bringing it all to life through her remarkable design.