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### MakerMap

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# Worcester Polytechnic Institute IQP Final Report

MakerMap

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# 1 Abstract

This report describes our efforts to enhance the student maker experience on the Worcester Polytechnic Institute campus. Throughout our research, we discovered a need for interdepartmental communication around availability of testing equipment and resources that expanded our user base to include on-campus researchers. As an outcome of our research, we developed and launched a sustainable website accessible to the WPI community to increase ease of access to the tools and resources available for research and making.

## 2 Acknowledgements

First and foremost, we would like to thank our advisers, Curtis, Adam, and Donna, for the tremendous time and energy they dedicated to our project and for their invaluable guidance. They brought positivity and enthusiasm to each of our weekly meetings, and we learned so much more about entrepreneurship, market research, and project management than we had expected.

We are grateful to Cooper Bennet for his generous contributions to the software development of MakerMap.

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We are very thankful to Kristopher Sullivan from the Provost's Office for his continued support throughout our project.

We would also like to thank all the faculty members we interviewed for the time and insight they volunteered to help our project. We thank the department heads who agreed to distribute our student survey to their department aliases, as well as the club leaders who distributed our survey to their membership. We thank all the students who participated in the survey and helped us gather important data.

We thank the IT department for their vital assistance in ensuring that MakerMap can serve the WPI community effectively.

Finally, we appreciate all the other faculty and students who in some way supported our project.

### 3 Executive Summary

The MakerMap Team set out to enhance making on campus by developing a web app that creates an inclusive maker community at WPI. We focused on creating a visual database where users can find tools and like-minded members of the community to encourage making across campus. To accomplish this, we took the following steps:

- Initial Research
- Surveying - ID2050
- Interviewing Staff and Faculty
- Student Surveying
- Data Analysis
- Website Development

Worcester Polytechnic Institute is a place for thinkers and doers. Navigating the expansive geography of resources and opportunities can be overwhelming for new students and even a challenge for veteran employees. Communication is key across this sprawling territory and while current departmental discourse may be functioning well, there are great opportunities for interdisciplinary engagement whether between co-operating faculty and staff or broadcasting to the general student population. Other Institutions have identified similar challenges and have developed platforms to enable greater transparency that have led to financial and time efficiencies.

To address this challenge here at WPI, we began by empathizing with our stakeholders to better understand the needs of all parties. This included students, student teams, clubs, lab managers, professors, individual departments, and members of the management team such as the finance, marketing, and environmental health and safety departments. We conducted interviews with faculty and staff members to collect qualitative data and distributed a student survey to get quantitative data. We also designed and implemented an AWS based website back-end that allowed for easy and fast development.

From the interview and survey responses, we distilled a list of key areas for communication improvement. These include finding resources, connecting people, training, community engagement, and finances. We then used these key areas to create a shortlist of important website features, including a map, tool database, event manager, user profiles, and an about page. This feature list, while not covering every potential use case, ensures that all of the stakeholders we needed to buy into the project would be getting something meaningful from it.

While our initial intentions were to present a fully featured release of our MakerMap tool during the 2019/2020 school year, unfortunately due to the COVID-19 crisis, we pivoted our deliverable to launching early next year. We are also setting up infrastructure to continue active development and maintenance of this project for the years to come.

## 4 Authorship

Each member of the team contributed approximately equally to the report. Below we break down the sections that each team member authored.

### 4.1 Jeremy

- Introduction
- Abstract
- Findings
- Executive Summary
- Appendix 5 - Interview Transcripts

### 4.2 Kristen

- Acknowledgements
- Background
- Findings
- References
- Appendix 5 - Interview Transcripts

### 4.3 Nathaniel

- Methodology
- Conclusions & Recommendations
- Executive Summary
- Appendices 1, 2, 3, 4, 6, and 7

### 4.4 Arjun

- Methodology
- Findings
- Executive Summary
- Conclusions & Recommendations

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## 5 Introduction

As students first joining the WPI community, it's almost mandatory to feel overwhelmed with the seemingly boundless opportunities on campus. Our IQP team of four Robotics Engineers certainly felt this way. With all of us coming to WPI having already heavily participated in making robots and personal projects, the simple questions of where, when, and how to do this here posed a challenge to answer. As the terms passed, each of us employed different strategies to navigate this uncharted experience. While some of us explored buildings room by room, others found experienced students to help guide our inquiries. A few joined leadership positions in technical classes and shops, close to faculty and staff in hopes of gaining a greater lay of the land as to where we could build our projects. After two years of experimentation, we all as friends were able to share our findings which cumulatively encompassed a great swathe of the available resources for building projects on campus, but still we would later find, there were many places and possibilities we had failed to recognize.

For students beginning their search of interests or for those less determined, this barrier to understanding can be extinguishing to curiosity. As passionate engineers and doers, we knew there was a better way to excite and inform fellow students about what we can make here at WPI.

We began our Interactive Qualifying Project by developing a greater understanding of the needs of the community, setting up interviews with lab managers and department heads while surveying students, all the while implementing techniques we had learned for not imparting our bias into our researchers. After having collected an extensive amount of information about how people felt, it became our task to convert all of the ideas and data into ways we could address and remedy the pain points so many were experiencing. We conducted data analysis on the survey responses that would inform answers to our research questions and carefully combed through transcriptions and recordings of interviews to distill salient sentiments.

From this concentration of information, we brainstormed ideas that would serve the needs of all. We landed on the concept of creating a website that would act as a map for makers - a MakerMap. Luck would have it that our team had a strong skill set of software development and rapidly was able to produce a conceptual website. With the prototype in hand, we approached interviewees for feedback and took careful note of concerns and recommendations. With our advisors, we developed a website development and maintenance sustainability plan as we progressed into full software development with the most impactful features first.

We now have a website that simplifies access and communication around getting involved with making on the WPI campus.

## 6 Background

### 6.1 Project Setting

The setting for our project is Worcester Polytechnic Institute, a technical university that takes pride in its motto of “theory and practice.” Students are encouraged, and in many cases required, to perform hands-on activities. As such, the WPI campus is rich with a variety of labs, shops, and maker spaces. Many of these maker resources are open for students to use regardless of their background or major, so long as they pass a certain training.

### 6.2 Major Stakeholders

#### 6.2.1 Students

With an enrollment of over six thousand students, the WPI undergraduate and graduate population are major stakeholders in our project. Whether a student is a new or seasoned maker, whether they are working on a personal project or a graduation requirement, and whether their project is independent or part of a club, students on campus need information and accessibility to the resources WPI promises them.

#### **Maker**

There are students who come to WPI with little to no making experience and hope to gain skills during their time in college. These students need to know where to start: which people to talk to, which websites to visit, which training to complete, which software to learn, which tools to use.

New makers have all the motivation necessary to carry out a project, but they may not have enough information to know how to ask the right questions.

*Stakeholder persona:*

Linda is a freshman BME student who hasn't built much physically. Walking through Foisie every day on her way to class has exposed her to lots of people making things, especially in the RBE lab and 3D printing space. Emboldened by her peers, she wants to replace some missing pieces for a board game by making them but doesn't know where to start. Should she use a 3D printer or make them out of wood? How do you find/make 3D printer files? What tools are good for what?

#### **Personal Projects**

There are other students at WPI who may have previous experience using a variety of tools and maker equipment, but do not know where similar tools are located at WPI or how to gain access to them. These students need access to a lab space, and they need a place where they can find information on tool listings and how to get trained to use those tools.

*Stakeholder persona:*

Nathan is a freshman ME student at WPI who has just arrived on campus for his first year. He toured around campus when he was applying to schools but has not learned in depth about how to access WPI's making equipment. He had used his high school machine shop for FIRST Robotics and is familiar with most of the tools. He walked into the Foisie

Innovation Studio after seeing the 3D printers on the tour and wants to learn more about what machines are available on campus but doesn't know who to ask.

## **Clubs**

There is a multitude of student organizations at WPI that either focus on making or require access to maker resources as part of their events and activities. These clubs need a way to increase advertising so they can reach a larger portion of the WPI community and yield a higher membership, which also helps increase their funding.

In addition to more advertising, WPI's student organizations also need ready access lab resources, including information on training and tool availability.

*Stakeholder persona:*

WPI's Monopoly Gamers club wants to 3D print board game pieces for display at the Activities Fair to attract new members. None of the exec members have ever 3D printed before. They know that Foisie has a lab full of 3D printers because they see the lab whenever they walk through the building. They are not sure how to gain access to the lab or who to ask for help with figuring out how to 3D print.

## **IQP and MQP Teams**

An integral component of a WPI education are the IQP and MQP experiences. Because a lot of these projects involve designing and making, students need information on what tools they need, where to find them, and how to get trained to use them. Additionally, these students have project deadlines and need to fulfill graduation requirements, which means they may need high priority scheduling and better access to materials and lab space.

*Stakeholder persona:*

Joanne is a senior RBE student at WPI working on MQP. She has created CAD models of his robot, and now she needs to machine the parts. Joanne is vaguely aware that Washburn Shops is well-equipped with highly advanced tools, but she doesn't know how to get access or learn how to use the equipment. She asks her teammates, but none of them know either.

### **6.2.2 Lab Manager**

Lab Managers at WPI are vital members of the community, performing tasks such as ensuring that equipment is properly maintained and that users receive proper training and follow safety procedures. Each manager oversees their lab uniquely and has their own methods for keeping track of tool usage, ensuring tools are accessed only by those with authorization, maintaining inventory, and making new purchases. However, since each lab is uniquely managed, there is no overarching system for sharing information among labs, and managers will often purchase equipment already available elsewhere on campus.

*Stakeholder persona:*

Katrina is a lab manager who has redone the system for students getting certification and shop access multiple times over the last few years. The opening of a new maker space has further increased confusion among new students regarding where to go and how to get access.

### 6.2.3 Individual Departments

WPI has a variety of well-funded departments, yet the campus needs more inter-departmental communication regarding the possession and availability of maker resources.

*Stakeholder persona:*

John is a mechanical engineering professor advising a cross-disciplinary MQP. Some of the students on his team are double majors in mechanical engineering and civil and environmental engineering. His students need access to building materials not available in his labs in Higgins, and he wants to know what resources the Civil and Environmental Engineering department has to offer.

### 6.2.4 CFO & Finance

The WPI Financial Office needs a place where they can find all the tools on campus to reduce the redundancy of resources and allocate finances in a way that maximizes the community benefit.

*Stakeholder persona:*

The WPI Financial Office needs to approve a request for funding a new piece of equipment for the Foisie Makerspace. The office needs to know whether this machinery already exists elsewhere on campus, since that may influence their adjudication of the request.

### 6.2.5 Professors

Since students most frequently interact with their course professors and faculty advisors, professors are often the first point of contact that link students to the appropriate maker resources. Professors are in a position where they can direct students to the information they need on how to gain access to a maker facility.

Moreover, professors conduct research that may often be interdisciplinary. Having easy access to information on what resources are available in other departments would be very beneficial to their research.

*Stakeholder persona:*

Craig is a professor. He often needs to schedule space and tools for his various research projects. Craig only knows what tools are available in Washburn and in his lab in 85 Prescott. Craig often has to spend money on tools WPI may already own.

### 6.2.6 Marketing

The WPI Marketing team needs an efficient way to capture the diverse projects students undertake on campus. There are students building their own electric skateboards while others build warm shelters for wild bunnies. Many of these projects are undocumented yet reveal much about the WPI community: that its students are innovative, resourceful, and enthusiastic. Being able to track all the student projects that go unnoticed would benefit WPI marketing immensely.

Having more access to project data, such as which tools are most frequently used and which maker spaces are most popular, would also help the marketing team focus spending on areas that impact students the most. WPI would be able to compile an inventory of completed projects and their contributors, while highlighting the resources that made such ventures possible.

*Stakeholder persona:*

Michael is a Crimson Key tour guide. A prospective student asks Michael for examples of personal projects WPI students work on. Michael responds with projects he and his friends have worked on, but realizes he does not know where to find a listing of all the ongoing projects at WPI. After the tour, Michael reaches out to the WPI marketing team, who responds with a list of student IQP's and MQP's, but Michael still does not have any information on personal projects students are currently working on.

### **6.3 Identifying the Problem**

All of the stakeholders detailed in section 2 present a common theme: maker spaces and labs at WPI lack centralization of information. Students don't know what tools are available or how to gain access to them. Lab managers use an array of different software and have no means to check whether they are purchasing redundant tools other labs already own.

### **6.4 Problem Causes**

Each lab manager uses a different set of software to manage their space. A single lab might make use of several software tools, and there is no right or wrong way to manage a lab. The problem is none of these tools are specifically tailored for WPI, and none of these tools are created with the idea of having multiple independent labs in communication with each other.

A lab manager might have their process for reordering well delineated, but they might realize few students know about the lab and how to use its resources. This problem affects every member of the community who is in any way involved with making.

### **6.5 Alternate Approaches**

#### **6.5.1 Mobius**

MIT students struggle to gain access to the institution's many maker spaces because they are unaware the resources exist, do not know how to receive training, or believe they need to pay membership fees to use tools. MIT alumnus Marty Culpepper says, "it can take a student up to nine months to get into a space and build anything." [10]

To solve this problem, members of the MIT community created the Mobius iOS app that lets students browse the maker facilities and easily access information about what tools are available, how to receive training, and whom to communicate with for further information. [10]

### **6.5.2 Manus**

Project Manus is a large-scale MIT project aiming to combine several programs into a “gold standard” maker system. Implementing the standard in three distinct phases, MIT is integrating programs such as Mobius, mentoring, virtual tours, and consortiums to enhance the maker experience. [1]

### **6.5.3 Fabman**

Fabman is a company that sells a maker space management product that can be purchased and integrated into any business. Their features include integrating machines into the Fabman operating system, registering members with user accounts and benefits, an online resource booking platform, and user billing handling. [7]

### **6.5.4 smpl**

Similar to Fabman, smpl is another product offering a variety of features targeted at managing maker spaces. These features include user management, team management, automated payment processing, and resource booking. [5]

## 7 Methodology

This section presents the methods we used to design and develop a website dedicated to helping the maker community on campus better organize and access information. These methods were developed with experience we gained surveying ID2050 and working with software in academic classes.

### 7.1 Better Understanding Stakeholders

At this stage of our project we set about engaging students, staff, and faculty directly to hear their perspectives. Our largest questions were as follows.

- How do people currently discover information about making on campus?
- What do students and faculty already know about maker resources?
- How much interest in making already exists?
- What resource management tools are currently used?
  - What do those tools do well?
  - What do those tools not do well?
- With what immediacy do community members need information and help?

After working with Joe Doiron and surveying his ID 2050 class we decided the best method to answer these questions was actually two methods, a survey for students and interviewing faculty/staff. That way we could more directly focus questions on the various stakeholders and get a large sample size of future users.

#### 7.1.1 Surveying Students

To hear directly from our expected largest segment of end users, students on campus, we created an online survey using Qualtrics. This software, which WPI had an existing license for, allowed us to conduct the survey entirely anonymously to ensure we obtained IRB approval in a timely fashion. The survey, which can be found in Appendix 2, was written specifically to collect quantitative data. Our research and study had informed us that using open ended questions in a survey designed for mass distribution would lead to unusable data, so we tried to offer multiple choice ranges or check all that apply options rather than having students fill in what labs they used or why. In addition, we made use of features built into Qualtrics to control what questions were shown based on the previous answers given. This allowed us to keep the number of questions as low as possible for every survey taker and increase the completion percentage.

When distributing the survey to students we did our best to avoid bias. To that end, rather than just sending it to all of our friends, we emailed the survey and a written explanation to the officers of every single club on campus. The email also asked them to share the link with their members. This approach was inspired by the methods used during



the 2019-20 school year by students circulating petitions to protest space inadequacies on campus, and it worked well. We also posted our survey on the WPI Reddit page, the WPI student Discord group, and had several departments email it to all of their students (including Mechanical Engineering). All in all we received almost 600 interactions with the survey, with 448 students fully completing it.

### 7.1.2 Interviewing Staff and Faculty

Given the more flexible and more open ended nature of this approach, we developed an additional secondary list topics we wanted to address in various interviews.

- Areas of potential collaboration
- Barriers to adoption of a solution we devise?
- What are the needs of high importance stakeholders?
- What are the pain points with existing systems in use
- Usage patterns for existing tools from the lab side

We also decided to focus on interviewing two main groups, lab managers and department heads, and came up with different interview questions for both. Those questions can be found in appendix 4.

For conducting interviews we took a two person approach, with one team member taking notes and the other doing the interview. We also requested that we be allowed to record interviews directly. This approach allowed us to get the most information out of every interview. In addition, our research led to us decide that our interviews would be best if they were informal and conversational, rather than rigidly sticking to pre-written questions. We made this decision because we anticipated that every department or lab would be run differently enough to warrant a variety of follow ups. We also spoke as little as possible, merely guiding the conversation instead of asking a multitude of questions. This was done in order to limit any bias our questions may have contained.

When interviewing lab managers we wanted to learn more about their existing methods of operation and how we could improve it. After all, our project would get nowhere if the staff directly in control of making resources on campus weren't on-board. We also made an effort to meet and interview inside of their labs. This allowed us to physically see and ask questions about the space, as well as familiarizing us with the locations for making our map.

Interviews with department heads were slightly different. For these, we focused on what resources the department controlled and how they felt about those outside the department knowing about or even using them. We had decided early on that we needed to build in support for limiting access to resources within the MakerMap, as it was unlikely that every department and lab manager would be totally forthcoming and on-board. We also used these interviews to ask about resources in research labs. While not part of our original proposal, we had identified research equipment as a potential expansion of MakerMap early on.

We also interviewed a few other major stakeholders, including the CFO, people from the office of the Provost, and Environmental Health and Safety. These interviews were needed to understand what if any involvement these players wanted to/needed to have in our project. It was important to talk to as many people as possible in the planning phase to identify and work around any roadblocks to widespread and official campus adoption as early as possible.

## **7.2 Website Process**

Any application can be described by its software stack, the software stack is a series of software subsystems that provide all the needed functionality of an application. For this application we built a stack on Amazon Web Services(AWS).AWS is a comprehensive and broadly adopted cloud platform it offers many different services for building your application. Our software stack consists of the following tools:

### **7.2.1 Amazon Relational Database Service**

A RDS is a way of creating a relational database hosted on the Amazon Servers with all the needed security features built in. For this database we used a MySQL backend. MySQL is an open source relational database that is used all across industry. The RDS stores all of our information and allows us to query for it when needed.

### **7.2.2 Amazon Lambda Functions**

Lambda functions are a micro service architecture that allows you to build small dedicated functions with a variety of programming languages and link them to many different AWS services. We use lambda functions to pull and push data in and out of the backend as well as store certain large format data in Amazon S3 buckets.

### **7.2.3 Amazon API Gateway**

API Gateway provides a simple way to deploy a REST API for our application. We write the API in a language called Swagger, then deploy the service using API Gateway. Each endpoint on the API is hooked up to a custom Lambda Function. The API serves as the data transfer between API Gateway inputs the API call and translates the request into a format easily understood by lambda. Then takes the output of lambda and formats it back into an appropriate response.

### **7.2.4 Amazon S3 Buckets**

Amazon S3 Buckets are used for two purposes in our application. They store some large format data that would be impractical to store into a database, like images, and gives each one a unique URL we can retrieve it using. Additionally it hosts our static front end site, through the static site hosting feature. This automatically loads our index.html file when the bucket is accessed.

### **7.2.5 React**

React is a JavaScript library that is used to make our user interface(UI). React is a Component-Based framework each small part of the website can be put into a separate component with all of the needed functionality hidden inside that component.

### **7.2.6 Node.js**

Node.js is a JavaScript run time we use for locally building and testing our application before deployment. We also use the node package manager to manage all of our dependencies for the project.

### **7.2.7 Parcel**

Parcel is a fast simple web application bundler that we use for testing and deploying our app.

## 8 Findings

### 8.1 Interviews

#### 8.1.1 Finding Resources

From speaking with professors and department heads, we discovered the desire for a searchable database of machines and instrumentation. Key features in finding resources include descriptive information about what a tool is, how old or depreciated it is, where it or others like it are located, when is it available, what training is needed to access it, and who is the point person managing the resource. Reaching out directly to the managing staff was a way that managers felt comfortable with allowing more open access, as not all managers desire having their more restricted instruments publicly displayed.

##### *Interview Responses*

- I would like it to have a descriptive text of the instruments that's searchable. That's what I would want, to be able to browse and search a database. Picture, model numbers, all of that stuff. Almost like a Wikipedia of on-campus tools. (Section 11.5.15, Petkie)
- Along with a searchable database, who's your first point of contact. And what training do you need. (Section 11.5.15, Petkie)
- Needs details on the make and model of machines (Section 11.5.13, Eggleston)
- Booking spaces to practice arts is very important (Section 11.5.8, Moncrief)
- Useful to have universal inventory (e.g. who has quartz balance) (Section 11.5.13, Eggleston)
- At the end of the year, knowing how often a tool is used would be useful as info for whether to purchase new tool or just fix it/get rid of it (Section 11.5.3, Loiselle)
- Washburn is chewing through budget and doesn't keep track of who takes what; simply restock parts but there's no gating (Section 11.5.1, Harrington)
- Having a comprehensive, indexable list of equipment would be very valuable to us. (Section 11.5.2, Kris Sullivan)
- I would be interested in an assessment of what we have: how old is it, how depreciated is it? (Section 11.5.2, Kris Sullivan)
- We've got this group of equipment that's red. We know that in the next capital cycle, that's the equipment that's replaced first. Then that becomes green and the yellow cycle becomes red. Right now we have a capital inventory but it's on an excel sheet and it's not how we would like it (Section 11.5.2, Kris Sullivan)
- I'm buying instruments for LEAP and I don't know what all is on campus. I don't want to buy one if somebody else has one (Section 11.5.15, Petkie)

- She has enough stuff to update, make it so the lab staff don't have to manage the website (Section 11.5.6, Stults)
- Set student expectations about how long the process takes (Section 11.5.6, Stults)
- Worthwhile to point students to resources, i.e. there are machine shops in Worcester where if you need a high-precision job you can get it there. Would be useful to add a shortlist of recommended machine-shops/welder/glassblowers, things like that (Section 11.5.12, Blandino)
- Standardized tracking across campus is important (Section 11.5.11, Lang)
- I don't have a problem with the shop services being advertised. I can help students from any department build things, but I do need to prioritize work for Chemical Engineering. (Section 11.5.4, Partington)
- How do we publicize and encourage people to use the resources they have? If I'm just starting something sitting around the Makerspace, where do I go as my next step? To have that one place would be fantastic (Section 11.5.5, Soloman)

### 8.1.2 Connecting People

Many lab managers, while open to publicly sharing their inventories of machines and resources, emphasized the importance of sending MakerMap users to the right people first rather than just showing up and using tools. There are great teams in most labs whose jobs are to help users learn how to best use the resources they provide. These human resources should not be overlooked.

#### *Interview Responses*

- Emphasize that our platform is not the only tool: There are people like Dr. Stults who wants to help people in person (Section 11.5.6, Stults)
- Importance of sending students to the right people and not just to the machine with design solutions (Section 11.5.6, Stults)
- Wish students would consult with Washburn before ordering stock materials (Section 11.5.3, Loiselle)
- Happy to share tools; direct users to lab managers and check in before deployment of MakerMap (Section 11.5.9, Wall)

### 8.1.3 Training

Getting the word out to students about workshop events and how to access shops and labs has been a challenge to many departments. Lab managers expressed interest in consolidating maker space safety and tool training into one experience that students could use in qualifying for shop access. While the Environmental Health and Safety department on campus leaves how safety training is conducted up to the individual labs, the lab is

responsible for all incidents that may occur. This freedom would allow for labs to work together in developing a universal safety and tool training repository.

#### *Interview Responses*

- Basic user training the same across maker spaces (Section 11.5.17, Sears)
- Hosting workshops in Foisie (Section 11.5.8, Moncrief)
- Need more skill building workshops. More instances, maybe not more variety. E.g. run a lot more soldering workshops (Section 11.5.1, Harrington)
- EHS doesn't care how we advertise safety training, but the responsibility is on the owner of the space. (Section 11.5.16, Sarachick)

### **8.1.4 Community Engagement**

Using analytics on lab access can be a great tool for understanding the awesome projects that are happening on campus as well as supporting funding proposals. Having a way to track and showcase student projects is a great way to benefit not only individual labs but also WPI marketing as a whole. Moreover, having a tool to advertise upcoming calendar events such as safety training sessions and workshops would help increase students' awareness of the resources available to them. Some lab managers are open to advertising all their resources to the community, while others prefer to keep some resources private and accessible only to groups that meet certain qualifications.

#### *Interview Responses*

- Would love to be able to say "this is how many people came into the lab today and this is what they worked on" (Section 11.5.3, Loiselle)
- Global calendar for the community (Section 11.5.7, John Sullivan)
- Have hard time broadcasting to community what we have available (Section 11.5.17, Sears)
- It's hard to find us unless you have a direct link (Section 11.5.17, Sears)
- Students don't know what they need to produce; problem with understanding what manufacturing processes exist to fulfill your needs; if you know what exists you know how to ask the right questions (Section 11.5.1, Harrington)
- Trying to get machine shop to be more of a user facility but getting the word out is hard (Section 11.5.15, Petkie)
- Public vs. private: can make list public but not reveal location (Section 11.5.16, Sarachick)
- NOT common resource for campus, but specifically for students working on research/project (Section 11.5.12, Blandino)

- Advertised in the context of research instead of context of facilities (Section 11.5.12, Blandino)
- At some point there is a demarcation between a mill/band-saw/lathe/3Dprinter. When you get to something like a wind tunnel, a vacuum tube, a specific laser, I wouldn't put that on there. I think it's a great idea, but I think it makes the most sense for the general tools. Other than those general things, there aren't any aerospace facilities that'll populate the MakerMap. These are expensive, they're delicate, they require supervision so they're usually done as part of a research grant. We've had civil engineering students use the wind tunnel, but something like that would be done through a professor on a very case-by-case basis. (Section 11.5.12, Blandino)
- When you click on the widget, it should tell you if it's only accessible to certain people/you need training (Section 11.5.12, Blandino)
- People would rather hide their resources than share them. There isn't money to fix things if mistakes are made (Section 11.5.6, Stults)
- The tenure system tends to isolate professors and resources rather than encourage collaboration (Section 11.5.6, Stults)
- Provide a better incentivisation (Section 11.5.6, Stults)
- Some professors in some labs might be more reserved about their labs (Section 11.5.3, Loiselle)

### 8.1.5 Finances

We found that there is a financial disincentivization to openly share research instruments between departments as the owner of the resource is responsible for all consumable costs and maintenance if the tool was to be broken. Some methods for minimizing this financial risk could be leasing equipment rather than purchasing and developing a shared funding pool for maintenance and consumables if machines and research instrumentation were able to be shared between departments.

#### *Interview Responses*

- Big change they want to implement: user fees (Section 11.5.13, Eggleston)
- Help with universal maintenance budget (Section 11.5.13, Eggleston)
- Recommends leasing machines instead of purchasing as this would enable more upgrade and maintenance opportunities (Section 11.5.11, Lang)
- Hard to predict the recurring cost of consumables and maintenance with so much variable use (Section 11.5.18, Yao)

- Funding is an issue and a more universal system of understanding who is using shops and how they get equipment is what some features should cater to (Section 11.5.14, Anderson)
- Having MakerMap sort of system would help researchers save money and move faster (Section 11.5.11, Lang)

## 8.2 Student Survey

The student survey results supported our initial hypotheses and proved demand for our idea. As seen in Appendix 3, it was clear that WPI students on average wanted to be making more on campus and that enough people identified with the moniker “maker” to justify our name. Furthermore, the questions about how resource information was being found are evidence that the existing solutions to finding resources on campus are lacking, with students heavily relying on friends in the know. This was useful in getting official support from the office of the provost and IT. Finally, well not initially useful, we plan on using our lab specific data to work with individual lab managers when MakerMap is being rolled out.

## 8.3 Website

After interviewing many faculty and staff members as well as surveying over 400 students, the problem that WPI’s maker spaces face is a lack of communication between our faculty, administration, and students. While organizing faculty events or a board to solve this problem had potential to provide better communication, we have learned that as faculty retire and students graduate, these task forces tend to get dissolved and forgotten. For WPI to create a solution that persists, the answer is a clear, accessible to all, faculty independent platform. The ideal tool for this is a website. Based on the above findings we will be explaining each needed feature of the website below.

### 8.3.1 Finding Resources

To find resources on campus we decided that two features were needed. One feature for exploring what resources we had, and another for visualizing the exact location of the tools you need. We also added a wiki style page for each tool to show all the needed information about a tool.

**Tool Explorer** To explore tools on campus we wanted to include a card list of all the tools on campus. Each card shows the following:

- A picture of the tool
- The current status of the tool
- The name of the tool
- What lab the tool is in



- Hours available
- How to book the tool

Clicking on the tool will bring you to the tools wiki page that shows all information that we have about the tool.

The tool list will have a search bar that can filter tools by the displayed parameters.

**Map** To pinpoint exact locations on a map we will use a scroll-able and draggable map of campus. The map has a search bar at top which allows you to search either by building, lab, or tool.

When selected the map will display pins at each of the locations that exists a tool, lab or building that matches the query.

Clicking on the pin pulls up a modal with the following information about the tool.

- A picture of the tool
- The current status of the tool
- The name of the tool
- What lab the tool is in
- Hours available
- How to book the tool

Clicking the "more information" button on the tool will take you to the tools wiki page.

### 8.3.2 Connecting People

To solve the problem of directing students and faculty to the correct resource we will implement a search able resources page.

This page will show the following information about each of the faculty members who volunteer their time to meet with students:

- Name and Title
- Short Description
- Office
- Skill Set and Interests
- How to book time with them

The page will be have a search bar allowing users to search for people by this parameter.

### 8.3.3 Training

To train students we wish to construct a centralized training platform for WPI. The goal of this platform is to provide an easy to use interface through which which students can log on and see what training is available. After they complete the training, either in person or online, the system will award them a training tag or badge for completing the training. Any administrator will be able to view what training a student has completed. The goal of this is to reduce redundant training and information. For example training for a bandsaw in Washburn and Olin would only happen once. Once a student is trained on the tool they should be able to use it at any of the locations.

Lab Managers should also be able to easily create online trainings for any tool or resource as well as schedule and manage in person training sections.

### 8.3.4 Community Engagement

**Event Management Tool** To solve this problem we will be building a centralized event management platform. The platform will be able to manage and create events for the community. It should be able to perform the following:

- Display time location of each event
- Be able to have reservations for each event
- Have an individual booking calendar for each tool allowing students to reserve time.
- Be search-able by event meta data

This system can be leveraged to help build the training management system for MakerMap.

#### **Data Logging**

Developing such a comprehensive tool gives us access to a large amount of information that tracks how students are using the current system, allow us to provide valuable feedback as to how and what WPI needs to change.

### 8.3.5 Finances

Further work needs to be done in research to figure out how to properly create a making community where all tools can be public access. For now however MakerMap has an inbuilt tag system that allows only students and faculty with appropriate permissions to view certain tools.

The tag system works as such. Create a custom tag. And assign it to the tool you would like to restrict. Then assign it to the user you assign permission to view this tool. When the user log in if the tags match then the tool will be considered visible.

## 9 Conclusions & Recommendations

In this section we discuss how our information gathering through interviews and surveys allowed us to design the best website possible to meet the existing needs on campus. We also summarize the current state of MakerMap and what it accomplishes, along with where we see future development going. Finally, we cover the new plan for introduction of MakerMap to campus, given that the initial plan was delayed due to the outbreak of COVID-19 in the USA.

### 9.1 Understanding Campus Needs

Constantly talking to and working with lab managers and department heads across campus throughout our project allowed us to build a website tailor built for their needs. For example, well we had hoped to make all maker information available to everyone on campus, it quickly became apparent that faculty needed to be able to hide resources in their possession from the public eye, resulting in us adopting a user sign-in model. This constant communication was key to our project's success. As we collaborated with the WPI community we built relationships that will be critical as MakerMap is introduced to the student body at large.

Collecting mass data from the student body gave us backing when dealing with school administration and department heads. Backed with data proving our problem was a major need, we managed to enter a partnership with the office of the provost and begin the process of being integrated into the WPI SSO login system. It should also prove extremely helpful when working with individual labs to integrate MakerMap and document their tools.

### 9.2 Summary of the Website

Currently we've implemented a few of the above features. We have the Map and Explore Features implemented. We are also currently in progress of working with the IT department here at WPI to get integration with the SSO protocol. This will create native user accounts for every member of the community by default.

### 9.3 Future Development Plan

We will be working with Adam Sears to create a pathway for students to continue working and maintaining the MakerMap system and implementing features that campus needs. We also hope to continue working with the provost office and IT to ensure long term support for MakerMap. The following is a shortlist of features we would like to implement soon or that will be passed on to the next developers.

- Write out documentation for current application
- Create admin dashboard
- Create user profiles

- Dockerize application to remove dependency from AWS servers
- Create event management system
- Create training management system
- Integrate with email services and calendars

## 9.4 Introduction to Campus

Our initial plan to introduce MakerMap to campus was a big gathering of Lab Managers and other members of the campus community at the start of D-term. This would have consisted of a presentation walking through the website, and then an interactive portion where participants learned how to add the resources they control and limit access to them appropriately. Following this, we planned on working individually with key labs and shops to build a critical mass of useful information in our database before introducing MakerMap to the student body later in the term.

This plan was thrown on its head by the arrival of COVID-19 on US shores. Following the decision that D-term would be conducted entirely online, we made the decision as a team to postpone the introduction of MakerMap to A-term next year rather than continue our plans digitally. We feel that the tool will have a better chance of being adopted if students and staff are on campus and able to use it immediately.

To that end, we have committed to using the extra time between now and A-term 2020 to complete more of our planned feature list and deliver a polished and complete product when MakerMap is introduced on campus.

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# 11 Appendices

## 11.1 Appendix 1 - Research Questions for each Stakeholder Group

### Students

- Brand new maker
  - How does access to information affect the ability to complete projects?
  - What do students know about making?
  - How do brand new students currently find information?
  - What resources at WPI are needed by this group?
- Personal Projects
  - How does access to information affect the ability to complete projects?
  - How do students currently find information?
  - What resources at WPI are needed by this group?
- Clubs
  - How do clubs use the resources available?
  - What resources at WPI are needed by this group?
  - What training and expertise do clubs have to offer?
- IQP/MQP teams
  - How do IQP/MQP use the resources available?
  - What resources at WPI are needed by this group?

### Lab Managers

- What do lab managers need out of a schoolwide resource management system?
- Do lab managers feel their labs are adequately used?
- What are the functions that a lab manager performs with respect to the WPI ecosystem?
- What does student involvement look like in various labs?
- What training is required to use lab resources?
- What is the lab managers position on resource duplication?

### Individual Departments

- How do departments decide to spend money on new resources?
- What does interdepartmental collaboration look like?
- Who are the key decision makers in each department?
- What data do departments want out of making on campus?

#### **CFO & Finance**

- How does the school decide to spend money on new resources?
- What is the school's position on resource duplication?

#### **WPI as a Whole**

- What data does WPI want out of making on campus?
- Who are the key decision makers for WPI?

#### **Professors**

- How do professors use the shops?
- What does class based access to resources look like?



## 11.2 Appendix 2 - Student Survey Questions

Are you 18 or older? *Note: This question will be used to gate the rest of the survey*

- Yes/No

Do you consider yourself a “Maker”?

- Yes/No

Do you have a desire to make more things?

- Yes/No

What technical training programs have you participated in outside of class? (Check all that apply)

- MFE Labs Basic User Training
- MFE Labs Advanced User Training (Legacy Training)
- MFE Labs Lab Monitor Training
- MFE Labs Welding Training
- CollabLab Training
- Foisie Makerspace Basic User Training
- Foisie Makerspace Additive Manufacturing - Basic User
- Foisie Makerspace Additive Manufacturing - Full User
- Foisie Makerspace Laser Cutter Training
- Higgins Manual Mill Training
- Higgins Manual Lathe Training
- Other: ----

Have you used any of the making resources on campus (e.g. Foisie Innovation Studio, Washburn Labs, CollabLab)? *Note: This question gates the next section*

- Yes/No

When you make something on campus, where do you go? (Check all that apply)

- Washburn Shops
- Foisie Makerspace
- CollabLab

- Higgins Machine Shop
- Robotics Engineering Suite (85 Prescott)
- Gateway Park I (60 Prescott)
- Gateway Park II (50 Prescott)
- Kaven Machine Shop
- Goddard Hall Machine Shop
- Other: \_\_\_\_

*For every shop selected in question 6*

- How often do you use *Shop Name* on average?
  - Multiple times a week
  - Once a week
  - Once a month
  - Less than once a month
- For which of the following have you used *Shop Name*
  - A Class
  - A Club
  - An IQP/MQP
  - A Personal Project
  - Startup

What methods do you use to locate making resources on campus? (Check all that apply)

- WPI website
- MFE Labs website
- Ask professors
- Ask friends
- Washburn Shops Faculty
- Foisie Innovation Studio Canvas
- Foisie Innovation Studio Help Desk
- Other: \_\_\_\_

What is your favorite method to locate making resources on campus?

- WPI website
- MFE Labs website
- Ask professors
- Ask friends
- Washburn Shops Faculty
- Foisie Innovation Studio Canvas
- Foisie Innovation Studio Help Desk
- Other:\_\_\_\_\_

How quickly (on average) do you find this information?

- 1-5 hours
- 6-24 hours
- 1 day to 1 week
- Greater than 1 week

How quickly (on average) do you need this information?

- 1-5 hours
- 6-24 hours
- 1 day to 1 week
- Greater than 1 week

### 11.3 Appendix 3 - Student Survey Responses

The following responses come from 448 unique WPI students, although the exact number of responses per question varies.

#### Question 1 - Do you consider yourself a "Maker"?

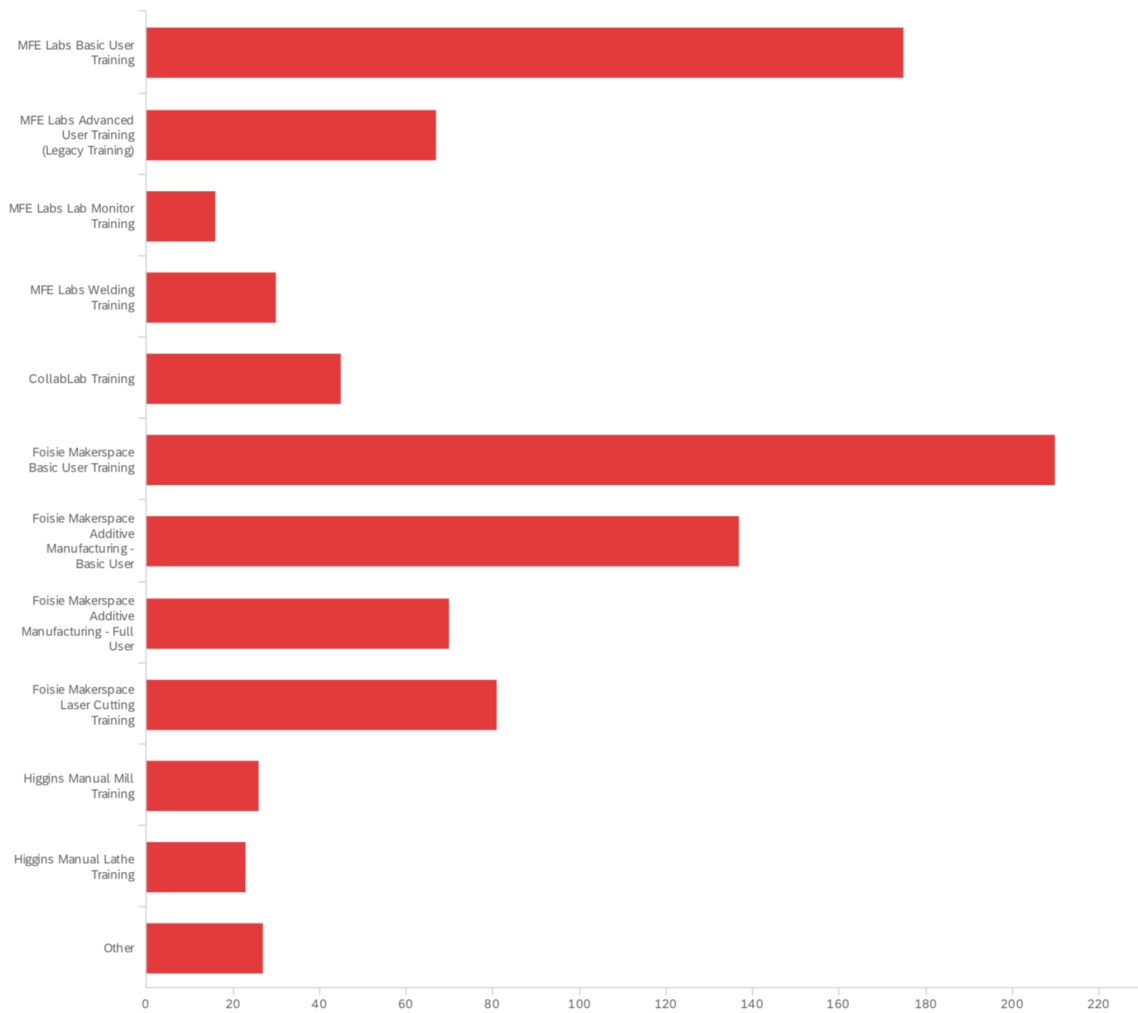
Answer	Respondents	%
Yes	249	55.58
No	199	44.42

#### Question 2 - Do you have a desire to make more things?

Answer	Respondents	%
Yes	370	82.59
No	78	17.41

**Question 3 - What technical training programs have you participated in outside of class?**

Training Program	Respondents	%
MFE Labs Basic User	175	60.34
MFE Labs Advanced User (Legacy)	67	23.10
MFE Labs Lab Monitor	16	5.52
MFE Labs Welding	30	10.34
CollabLab	45	15.52
Foisie Makerspace Basic User	210	72.41
Foisie Makerspace Additive Manufacturing - Basic User	137	47.24
Foisie Makerspace Additive Manufacturing - Full User	70	24.14
Foisie Makerspace Laser Cutter	81	27.93
Higgins Manual Mill	26	8.97
Higgins Manual Lathe	23	7.93
Other	27	9.31

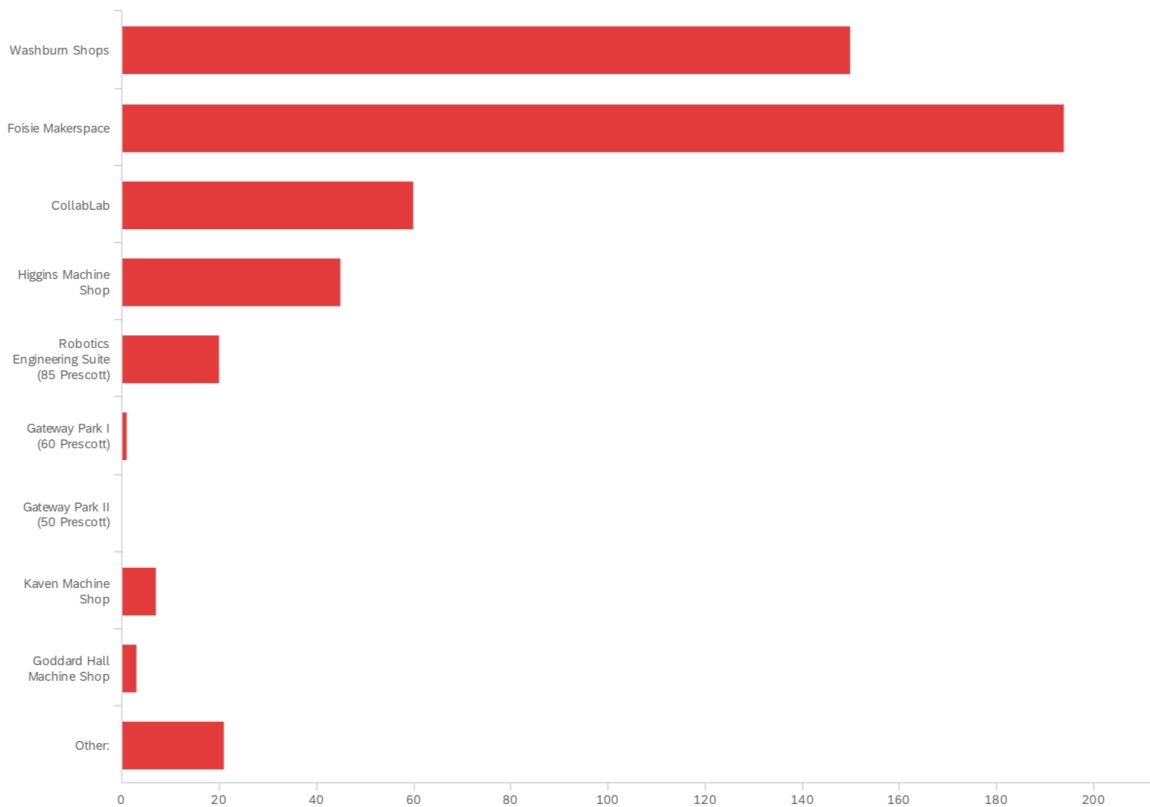


**Question 4 - Have you used any of the making resources on campus (e.g. Foisie Makerspace, Washburn Shops, Collablab)?**

Answer	Respondents	%
Yes	279	62.28
No	169	37.72

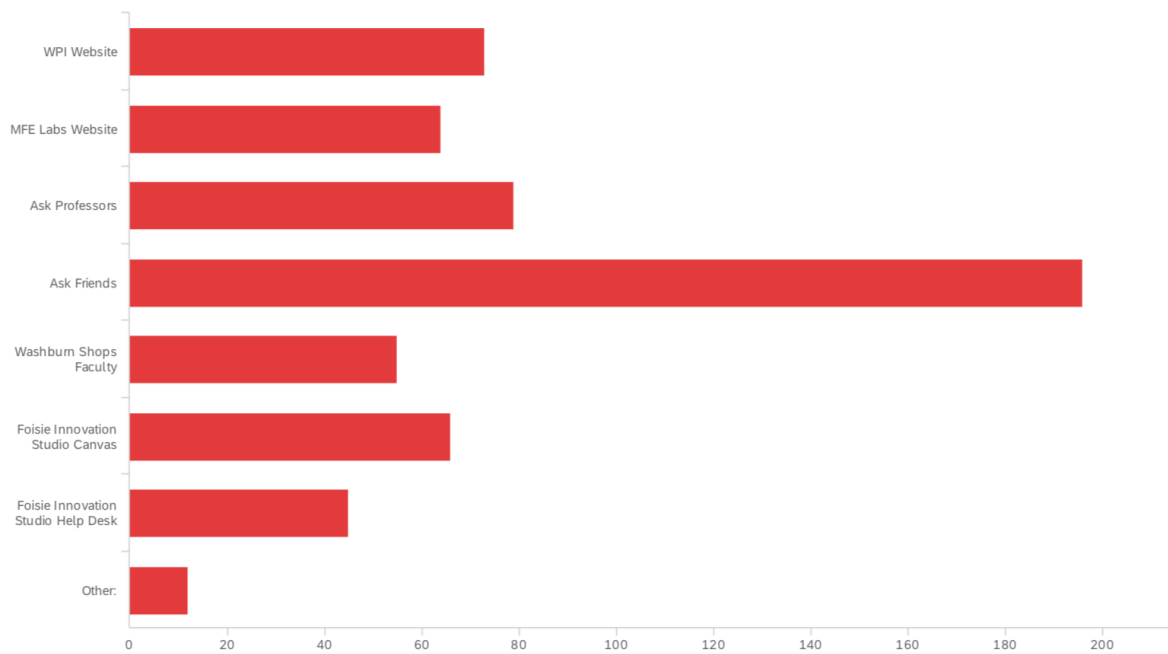
**Question 5 - When you make something on campus, where do you go?**

Shop/Lab	Respondents	%
Washburn Shops	150	56.39
Foisie Makerspace	194	72.93
Collablab	60	22.56
Higgins Machine Shop	45	16.92
Robotics Engineering Suite (85 Prescott)	20	7.52
Gateway Park I (60 Prescott)	1	0.38
Gateway Park II (50 Prescott)	0	0.00
Kaven Machine Shop	7	2.63
Goddard Hall Machine Shop	3	1.13
Other	21	7.89



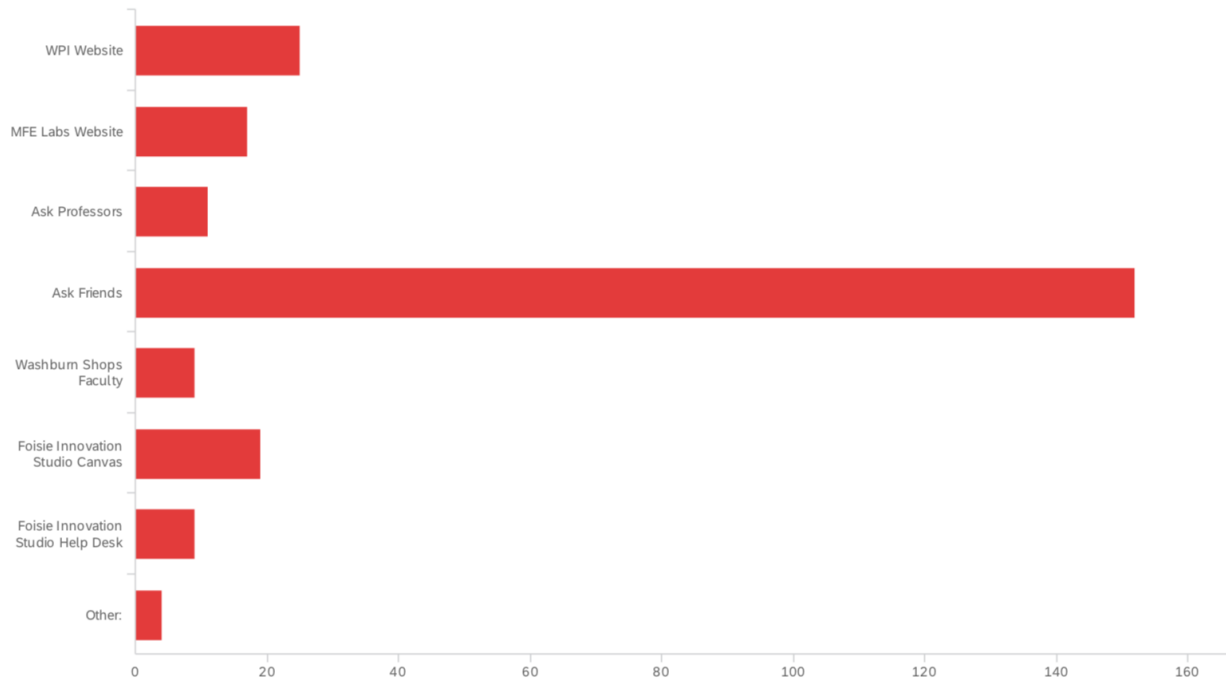
**Question 6 - What methods do you use to locate making resources on campus?**

Method	Respondents	%
WPI Website	73	29.44
MFE Labs Website	64	25.81
Ask Professors	79	31.85
Ask Friends	196	79.03
Washburn Shops Faculty	55	22.18
Foiese Innovation Studio Canvas	66	26.61
Foiese Innovation Studio Help Desk	45	18.15
Other	12	4.84



**Question 7 - What is your favorite method to locate making resources on campus?**

Method	Respondents	%
WPI Website	25	10.16
MFE Labs Website	17	6.91
Ask Professors	11	4.47
Ask Friends	152	61.79
Washburn Shops Faculty	9	3.66
Foiese Innovation Studio Canvas	19	7.72
Foiese Innovation Studio Help Desk	9	3.66
Other	4	1.63



**Question 8 - How quickly (on average) do you find this information?**

Length of Time	Respondents	%
1-5 Hours	166	66.67
6-24 Hours	38	15.26
At Least 1 Day	28	11.24
At Least 1 Week	17	6.83



Question 9 - How quickly (on average) do you need this information?

Length of Time	Respondents	%
1-5 Hours	102	40.80
6-24 Hours	42	16.80
At Least 1 Day	53	21.20
At Least 1 Week	53	21.20

*If you are interested in a full copy of our anonymized results, including data about usage patterns for individual labs across campus, please email [gr-makermap@wpi.edu](mailto:gr-makermap@wpi.edu)*

## 11.4 Appendix 4 - Interview Questions

*Note that a subsection of these questions may be used for an individual interview depending on the interviewee's position*

### 11.4.1 Department Heads

Lab Needs:

- Could you tell me about the lab resources your department has?
- How does your department go about acquiring resources that it needs either for research or for projects?
- How do you track usage of your resources?
  - Would you like this process to be easier to access?
- Who should and should not have access to your resources?
- Are you okay with the resources your department has being public knowledge?
- How do you market your department and research opportunities that you have available?

Professorial Needs:

- Could you tell me about the lab resources you use for your research?
  - Are you directing this lab space/people?
  - How often do you collaborate with external shops or departments?
  - Who manages your lab and IT?

### 11.4.2 Lab Managers

#### Current Lab Protocol

- What are the roles and responsibilities associated with your lab?
- How do you currently track usage of your lab?
- How do you currently request/obtain new resources for your lab
  - What are difficult/annoying parts to this process
  - What are the great parts to this process
- How often do you collaborate with external shops or departments?
- How do you manage the inventory and resources your lab has?
- How do you feel about student involvement in the lab you manage?
- What training is required to use lab resources?

#### Future Wishes and Needs

- Do you desire more student involvement in your lab?

## 11.5 Appendix 5 - Interview Transcripts

### 11.5.1 Kevin Harrington, Robotics Lab Manager

#### **What are your responsibilities?**

I manage the undergrad RBE labs in the context of academic classes, which means I make sure tools and equipment are available to students and lab procedures are accurate and tested with the hardware.

#### **Do you use any software for lab management?**

I use Odoo to manage stock and inventory. There's a purchasing backend and also a frontend for students to borrow parts for classes. Parts can only be lent out, and only to students currently enrolled in an RBE class. All purchases go through Odoo first, and Workday is occasionally used—Odoo can sometimes send python to Workday.

#### **Do you keep track of lab resource usage?**

I am not currently tracking when students come into the lab. For inventory, RBE has the most liberal policy: you can borrow anything you want, but you must return everything, and if you break something you buy it. With this policy, students have materials available without worrying about financial costs.

#### **Is lab equipment open for campus-wide use?**

I am glad to help anyone with questions, but the lab equipment is exclusively reserved for students in RBE courses.

#### **What do you think about the way shops around campus are currently run?**

Just like my lab serves undergrad RBE students, a lot of Washburn is restricted to people outside of the ME department. Washburn has an unofficial social system of access. There's no mechanism for learning how to machine if you don't already have experience; you need years of experience and you can't just start off from zero at WPI. You should not touch a Washburn machine if you don't already have the experience. The problem is Washburn does not have enough staff/resources to teach everyone how to become a machinist. I think WPI should have a job shop production system so students can get their projects produced by an expert. Students need to have experience knowing how to interface with a job-shop because that is what they will need in the real world. I have a lot of design work and need a job shop because I do not have time to make the things myself. I 3D print most things because there's a system to make those things.

#### **How do you feel about the advertisement of workshops?**

Something to ask students is where did they look? Where were the first, second, third places they looked for information and did not find it?

#### **How do you feel about the awareness of maker resources on campus?**

A lot of the time students don't know what they need to produce or how to ask the right questions. The biggest impediment is not that students don't know where stuff is, it's that they don't have enough time to learn how to use the machines well enough to be able to use them.

#### **What would you like to see at WPI to improve the maker scene?**

Students should not be prevented from using something because of a lack of available tools, such as lasers booked out for months. Ideally have more job shop interface, and more hardware interface for all the supplies. An appropriate hardware store for engineers is

missing from campus. There should be a formal system and a lot of inventory available. We need more skill-building workshops. More instances of them at least, maybe not more variety. For example, we should run a lot more soldering workshops. I also think there should be a human with decades of experience who sits at a desk in the makerspace hanging out all day and when someone describes their project they can tell them what resources to use. Currently at the Foisie Makerspace, the students working there don't know those things because they would need decades of experience. It can't be a training session that teaches the student how to answer questions, and it can't be an automated process. There should be a human whose exclusive job is to direct students where to go. The worker needs to be someone bubbly who can see, hear, pick up on everything students are doing and give them advice and information.

## 11.5.2 Kristopher Sullivan, Associate Vice President of Academic Affairs

### **Do you keep an inventory of all the lab and maker tools on campus?**

I started doing an equipment inventory in all the research and teaching labs. I'd like to have this available in some form so it can be used by multiple audiences. Having a comprehensive, indexable list of equipment would be very valuable to us.

### **How are you currently doing development on your inventory tool?**

I've got pdf's of everything and we annotate those pdf's and send them out to a firm off-campus. They put them into an index file and turn them into html. I've hired a student to help me with the inventory so when I say it needs to be updated, that's currently what we're doing.

### **How are you currently storing data?**

I've got a proprietary site that's behind CAS.

### **What features would you like to see on our MakerMap?**

We would like to classify the equipment into three general categories, red, yellow and green based on age and depreciation. For the equipment that falls into the red category, we know to include it in the capital budget as a priority for replacement. That group of equipment then becomes green and we move on to the yellow. This helps with planning on a regular replacement cycle.

### **11.5.3 James Loiselle, Senior Instructional Lab Technician**

#### **How would you describe Washburn Shops and the work you do?**

We are the WPI Manufacturing Laboratories, comprised of both the Washburn Shops (WB 105,107,108) and the Higgins Shop (HL004). We have a total of 11 Haas CNC machines, two manual mills, a manual lathe, vertical & horizontal bandsaws, laser cutters, sheet metal equipment and full weld shop to name some of our equipment. I float back and forth supporting both the Washburn and Higgins facilities. Our job in addition to maintaining the facilities is to teach students how to safely use our equipment and how to make the things they need to make for their coursework or projects. We conduct design reviews as well to ensure parts are manufacturable and meet their design intent. The process of manufacturing the component is also discussed along with the proper stock material to purchase. Many times, students purchase material that is inappropriate to make their parts out of. Just because all the parts fit into a volume of material doesn't mean we can make all the parts out of it.

#### **How do you track users?**

All users of the WPI Manufacturing Laboratories must first complete an online basic user training prior to working in our facilities. This basic user training reviews our lab policies, procedures and safety. The training also covers basic skills with some of the common tools you will find in our labs. Additional training is required for pieces of equipment that don't have full enclosures such as bandsaws and drill presses. We have a check in system at the entrance to the Washburn facility that all users must check in at. Our system keeps track of the users in the facility at any given time along with the number of times they have checked in and out and the number of hours they have spent in the facility. This same check in system also keeps track of the training the user has completed and prints a user badge at each instance of check in. The badge indicates which pieces of equipment the user has successfully completed training on and can use. The system doesn't currently track which pieces of equipment are being used at any given time. We do have a separate scheduling system for our CNC machines, laser cutters, industrial robots and weld shop. Other pieces of equipment like the bandsaws and drill presses are harder to track instances of use on.

#### **Is there anything hard to track that you'd like to be able to track?**

At the end of the year, knowing how often a tool is used would be useful information for whether to purchase additional equipment, fix or replace broken equipment or get rid of unused equipment to make room for more useful equipment. Having point of access control on machines would be very cool. This would help ensure that users have been properly trained and provided access to the piece of equipment before using it.

#### **How do you request new tools?**

New capital needs are discussed between Professor Bergstrom, Ian and me. Professor Bergstrom is the one in the end who will submit the requests for approval.

#### **How would you like to connect to other shops on campus?**

It would be great to have periodic meetings among different labs and shops. It would be good to have universal training, but one point of concern is slight variations in equipment between the different facilities. For example, the controls for the bandsaw in Washburn may be different than a bandsaw in Goddard. Each facility may need to require

additional mini trainings for their specific equipment. Each shop on campus also functions differently, too—Tom in Goddard is more of a job shop whereas Washburn is more open to student use.

### **How do you advertise the resources in Washburn?**

The Manufacturing Laboratories doesn't currently advertise their facilities or services, it's just word of mouth. We do encourage professors who require things be made in their class to have us come give a quick talk to their class at the beginning of the term. We like to explain the procedure for using our facilities, the equipment available to them as well as the help services we provide to students. We encourage students to have design consultations with the Manufacturing Labs staff prior to ordering stock materials or having parts made through outside vendors. Through these meetings we can help ensure parts are manufacturable and how to adjust them if they're not so they can be made. We also discuss the process of how to make the parts and indicate the proper material to be purchased.

### **How would you describe your current workflow, and what software do you use?**

We don't currently use an electronic inventory management system. We do make use of a Kanban card system for commonly ordered tools and materials. When stock gets below a certain threshold, we place an order for more. Tools broken in the facility need to be reported by emailing [ibrokethis@wpi.edu](mailto:ibrokethis@wpi.edu). In the email we ask the student to include what broke, including a picture, how it broke, the cost for WPI to replace it and what could be done in the future to prevent it from happening again. This system works great and provides good data to figure out where training needs to be improved and what we can do to further reduce broken tools in our facility. We also utilize the email alias [imadethis@wpi.edu](mailto:imadethis@wpi.edu) for students to showcase things they have made in our facilities. These images are then also shared with an Instagram account.

### **How do you track projects?**

On our website, we have a project registration form, which takes information such as who is in the group, who the advisor is, and what the project is. We use this data to justify our budget and capital equipment requests.

### **How do you feel about a MakerMap tool that shows where maker resources are?**

I am very excited about a MakerMap tool what will show students where maker resources are on campus. Unfortunately, there are some labs and workspaces on campus that aren't currently accessible to all of campus. The equipment in some of these facilities has been purchased through specific grants and programs and has restricted access. The WPI Manufacturing Labs, which are comprised of the Washburn Shops (WB105,107,108) and the Higgins Shop (HL004), can be accessed by all of campus once users have completed our basic user training.

### **Is there a feature you would like to see on MakerMap?**

I would love to be able to say, "this is how many people came into the lab today and this is what they worked on."



#### **11.5.4 Thomas Partington, Chemical Engineering Machine Shop Lab Manager**

##### **Could you tell us about the shop?**

The machine shop here in Goddard Hall is part of the Chemical Engineering department. It is a resource for the students, labs and faculty working in the department. In the shop, I help students with their MQPs and graduate research projects. The focus is on Chemical Engineering, but as time permits, I have helped with projects from nearly every other WPI department. The other part of my job here at WPI is managing the Unit Operations Lab here in Goddard Hall. This takes most of my time during A and B terms, but I fit in machine work when I can. During C and D terms I am busy with MQPs and other projects. In the Goddard Hall Machine Shop, I do most of the precision machining. I do supervise students working in the shop and can provide instruction to those who are interested in learning more about the Machining processes. Work in this shop must be supervised at all times.

##### **Do you keep track of usage?**

I track who I am working with by using “work request forms”. These contain info about the person requesting the services; the date, their name, contact info, their faculty advisor or principal investigator, and a brief description of the project. This is an informal process, but useful for providing information to my department. They are also helpful with keeping track of the jobs as they move thru the shop.

##### **What do you keep track of?**

In this shop, I keep track of the work in process, the tooling for the machines, the materials and hardware on hand, and the maintenance needs of the machinery. Most of the machines here are older and require constant maintenance. We have one new Prototrak 2 axis turret mill, which we have calibrated once a year. Would you be OK being advertised? I don't have a problem with the shop services being advertised. I can help students from any department build things, but I do need to prioritize work for Chemical Engineering.

##### **What software do you use in your shop?**

For design work, I use Autocad and Solidworks. For some of the machining, I use the Prototrak software on the new milling machine.

##### **Can you describe your daily operation?**

This time of year (A and B term) I start at 6:30 am getting the Unit Operations lab ready for the day. The lab runs between 8 am and 1 pm. I monitor the lab activities and trouble shoot equipment. During C and D terms I am usually in the shop working with students and helping them with their projects. I am also the Safety Officer for the Chemical Engineering department. In this role I do bi-weekly safety inspections of our Chemical Engineering labs and provide feedback to the lab users.

### **11.5.5 Jeffrey Solomon, Executive Vice President & CFO**

#### **What is your vision for the Foisie Innovation Studio?**

I envision Foisie to be a pre-prototype innovation space for ideation and a small-scale launching place to then go to other places on campus like Washburn or AK. We also have a concierge ability within makerspace that redirects you to other places.

#### **Do you see our MakerMap fitting in with your vision of Foisie?**

There is the kiosk in the makerspace of the FIS. Students could have access to the MakerMap and the helpdesk could expand on the information, kind of like a reference librarian. The MakerMap could be an app that all students could download.

#### **Do you have an inventory of all the tools on campus?**

The Financial Office has an inventory list that includes what the piece of equipment is and where it's located. We only list equipment that's above a threshold value—anything over \$5k we keep track of. Everything on campus has a budget, but the Financial Office cannot possibly run a budget for every makerspace. If there's something in the ECE department that's available to all students it might just be maintained under their operating budget. Some equipment may be aggregated in a larger department budget.

#### **What do you think is the greatest challenge surrounding maker culture at WPI?**

How do we publicize and encourage people to use the resources they have? If I'm just starting something sitting around the makerspace, where do I go as my next step? To have that one place would be fantastic.

#### **What feature would like to see in our MakerMap?**

Like the idea of sign-in, because we can't publicize every single piece of equipment across the entire institution.

### **11.5.6 Erica Stults, Director of Rapid Prototyping Lab**

#### **What are the roles and responsibilities associated with your lab?**

- The Advanced Rapid Prototyping lab operates specialty 3D printing machines.
- Has been only for professors and students working on academic projects but recently has opened for general use.
- Orders to this lab are filtered for things that can't be made elsewhere.
- Dr. Stults will consult about the best way to make something.

#### **How do you currently track usage of your lab?**

- Different sharepoint form used for each machine.
- Current copies in and out of excel by hand.
- Currently in the process of making a custom software tool just for the RP lab.

#### **How do you currently request/obtain new resources for your lab?**

- Many machines are requested by faculty (generally Mechanical Engineering), and purchased through the Academic Resource Center.
- Some machines were acquired through a grant and needed a place to be put and operated.

#### **What cross-department collaboration does your lab experience, if any?**

- Faculty know who to ask and talk to each other.
- No want for a slack chat style communication system.

#### **Do you want more user involvement in your lab?**

- Yes, more user participation in the introductory sessions would save a lot of effort in repeated teaching and information distribution.
- Session advertisement channels have been challenging.

#### **Do you have any feedback on our MakerMap prototype?**

- Focus on connecting users to the right people rather than have all information needing to be constantly updated on our tool.
- Set user expectations for how long processes take.
- Define the strengths and weaknesses of each of the tools to help filter order submissions.

### **11.5.7 John Sullivan, Professor & Associate Department Head of Mechanical Engineering**

**Could you tell us about the lab resources your department has?**

- Around twenty disparate labs in physically difficult to access, small rooms.
  - The Engineering Experimentation lab is used for different courses
  - Washburn is in need of a major renovation
  - The Foisie makerspace has a physically good access flow
  - Materials labs are not unified
  - Mechanical Engineering MQP lab

**How does your department go about acquiring resources that it needs either for research or for projects?**

- All funding comes from the Mechanical Engineering operating budget.
- FIRST robotics in the basement of Higgins is funded through the robotic resource center.

**How is usage of these resources tracked?**

- Washburn has a good tracking system.
- Recommends speaking with Ian Anderson and James Loiselle.
- Expresses interest in having all shops be somehow centralized.
- The other labs have minimal if any tracking or data logging.

**How do you market your department and research opportunities that you have available?**

- The current method for sharing information with students is through email aliases.
- Expresses interest in ways to share information to more students with a simple and unified system.

**Do you have any feedback on our MakerMap prototype?**

- Interest in global calendar for student outreach.
- Having detailed floor by floor maps for finding the labs will be important.

### 11.5.8 Kathryn Moncrief, Professor & Department Head of Arts & Sciences

Could you tell us about the lab resources your department has?

- Black box theatre
- Music
  - Whisper room
  - Sanford Riley Music Labs
  - Alden
    - \* Performance space
    - \* Jazz history database room
- Riley Commons
  - Figure drawing
- Glass Blowing
  - Worcester Arts Crafts by the bus station
  - Not a WPI owned space but WPI agreement
- Choral Groups
  - Rent space in 1st Baptist church
- Practice Rooms
  - 2 rooms
  - Grand piano is in the hallway
- Salisbury Labs
  - Clay classes
    - \* Bathroom used for water source

**How does your department go about acquiring resources that it needs either for research or for projects?**

- Grants have gone to things like the jazz history library
- Theater and music budget comes from grants, the Humanities and Arts department budget, as well as SGA
- Quiet rooms have been heavily requested.

**How is usage of these resources tracked?**

- 25 Live is currently how the music team approves use of space
- For venues like the First baptist Church, emails are sent.
- Expresses interest in the data of space usage.

**How do you market your department and research opportunities that you have available?**

- Student groups and classes are how students find out about the resources available.

**Do you have any feedback on our MakerMap prototype?**

- Reserving rehearsal space feature request.
- Interest in holding workshops in interdisciplinary spaces like the Foisie Makerspace.
- Storage space and booking feature.

### **11.5.9 Lisa Wall, Biomedical Engineering Lab Manager**

#### **What are the roles and responsibilities associated with your lab?**

- Biomedical Labs
  - Cell Engineering Lab
  - Biomechanics Lab
  - Bioinstrumentation Lab
  - Shared MQP Lab
  - Shared Physiology lab with Chemistry Department
- Goddard Machine shop is in the same building and sees some student use.
- Lab Managers are responsible for class lab set up, clean up, maintenance on equipment, help MQP students get supplies, and keep the inventories stocked.

#### **How do you currently track usage of your lab?**

- Weekly inventory sheets
  - Work Study students fill out the sheets and if an item quantity gets below a certain level, it is put on order.
- Not many personal projects are worked on in these labs.

#### **How do you currently request/obtain new resources for your lab?**

- Department funds go toward regular class materials and equipment acquisitions
- Student projects are funded through their MQP budget.
- Some equipment is donated.
- There is some collaboration with other departments in accessing needed equipment such as Instron testing, biocompatible materials.

#### **What training is required to use lab resources?**

- Work study training is in-depth and in person.
- All students who use the labs require training on equipment.
- Not many non-BME students use the labs.

#### **Do you want more student involvement in your lab?**

- Happy to have more student involvement and content with current showing.

### **11.5.10 Patrick Crowe, Instructor of Humanities & Arts**

#### **Could you tell us about your shop?**

- This shop is a woodworking space, primarily used for set construction for the theater department and is run by HUA
- Will be used for set building and design class next year
- The space was revamped over the summer with safety as a big focus
- The space is not open to the general student population because there is no system in place for it.
  - This would require space managers and a different philosophy.
  - At the current usage rate the space would not be able to handle additional projects.

#### **How do you currently track usage of your lab?**

- Currently there is no shop use or inventory tracking system
- Student employees that keep things working use google sheet for tracking tasks.

#### **How do you currently request/obtain new resources for your lab?**

- Tool purchases come from department budget
  - Ensuring the tools are as safe as possible
- Some tools like the Table Saw are acquired through EHS as safety upgrades

#### **What training is required to use lab resources?**

- Buddy system - A student can't work without someone else present
- Lab monitor presence is required
  - Lab monitors have EHS and shop specific training
  - Student employees help keep things working

#### **What do you think the WPI campus needs?**

- CNC router
- More space for shop



### **11.5.11 Russell Lang, Civil & Environmental Engineering Lab Manager**

#### **What are the roles and responsibilities associated with your lab?**

- Civil and Environmental Engineering Labs have two lab managers.
  - Russell Lang - Materials and Structural testing lab.
  - Wenwen Yao - Environmental lab.

#### **How do you currently track usage of your lab?**

- Paper logbook.
  - Documents date, student, and machine used.
  - Currently, data is not used but could be valuable in stating cases for funding.

#### **How do you currently request/obtain new resources for your lab?**

- No major purchases have occurred in a while.
  - Instead, maintenance and consumables of machines are the real costs.
  - The lifetime of instruments and machines is unpredictable.
    - \* Both repair and preventative maintenance are expensive.
- Recommends leasing machines instead of purchasing as this would enable more upgrade and maintenance opportunities.

#### **What training is required to use lab resources?**

- One-on-one training is set up for each case of machine use.
  - After a student has used the machine before, notifying Russ is all that is required.

#### **Do you want more student involvement in your lab?**

- Yes
  - Having more freshman and sophomore student involvement would better prepare them for MQP projects and as engineers.
  - Currently many mechanical engineering and other department students are using the space and having those departments collaborate with funding would be beneficial.

#### **Do you have any feedback on our MakerMap prototype?**

- Standardized tracking across campus is important.
- Having this sort of system would help researchers save money and move faster.

### **11.5.12 John Blandino, Associate Professor of Mechanical Engineering**

#### **Could you tell us a bit about the aerospace labs?**

We have a series of labs used for grad research and an MQP lab dedicated for MQP projects. The graduate catalogue lists research labs, which are primarily supported through research grants. Faculty get a startup package and then they might get a grant to do research. If there's equipment purchased for that research it then becomes part of the lab. MQP labs are different because they are funded for education, so they are not sponsored by a company for research.

#### **Do you keep inventory of your labs?**

I very scrutinously keep detailed inventory of all equipment, including model numbers and serial numbers. Other faculty might not keep as close track of everything.

#### **How do you monitor who has access to the labs?**

Each lab has a cognisant faculty who is responsible for issuing keys, and we submit the names of MQP students who need access. Some labs have physical keys and students pay a \$20 deposit.

#### **How does a student know to come into contact with you?**

When I meet with a student, I'll say "okay you need access to this lab and this lab." The aero labs are not a common resource for campus but specifically for students working on research or a project. Our resources are not advertised; instead they come up when needed, when a student starts doing research.

#### **How do you market research opportunities?**

At every advising session, we talk about research and make it clear to undergrads that the hands-on components are primarily through MQP. We tell undergrads that as part of a BS/MS program they can do directed research in the lab. We advertise resources in the context of research instead of facilities. In the beginning of A term, Professor Dimitrio sends an email to all graduate students advertising directed research projects offered that year. Students will say "oh Professor Blandino is doing this project in B term, I'll go talk to him." For PhD students, opportunities are different, as they learn about opportunities through websites/conferences.

#### **How do you connect with Washburn Shops and other general campus resources?**

We communicate to students, if you want to use the 3D printers in Foisie, this is the procedure. If you want to use the 3D printers in Higgins, this is the procedure. All is communicated to them at the beginning of their projects. Go to mfelabs, get training, learn how to use these things.

#### **Is the list of procedures updated often?**

Not unless they are asked for; if I need an update I'd email Toby. It would be nice to have a clearing house, though it's important to be careful because some are department specific while others are campus-wide and accessibility varies.

#### **How often do you collaborate with other departments?**

Some research is collaborative, but mostly we have faculty-to-faculty connections. Sometimes students have double major MQPs that require collaboration among departments.

#### **Would you like to see a MakerMap tool that lets users see where all the**

### **campus resources are?**

At some point there is a demarcation between types of tools. When you get to something like a windtunnel, a vacuum tube, a specific laser, I wouldn't put that on there. I think it's a great idea, but I think it makes the most sense for the general tools like mills, bandsaws, lathes, and 3D printers. Other than those general things, there aren't any aerospace facilities that'll populate the makermap. These are expensive, they're delicate, and they require supervision, so they're usually used as part of a research grant. We've had civil engineering students use the windtunnel, but something like that would be handled through a professor on a very case-by-case basis.

### **How would you envision your ideal MakerMap?**

The front desk in foisie could be this MakerMap hub. The worker wouldn't know everything but would have a database to look at things. Say you have a program working well and populated with information, it could live at the foisie front desk and that could be the hub of information. And it could be not only accessible to the Makerspace, but also students could look it up online. When you click on the widget for a tool, it should tell you if it's only accessible to certain people or if you need training.

### **What additional features would you like MakerMap to have?**

It would be worthwhile to point students to off-campus resources. For example, there are machine shops in Worcester where if you need a high-precision job you can get it there. It would be useful to add a shortlist of recommended machine-shops, welders, glassblowers, things like that.

### **11.5.13 Carrick Eggleston, Professor and Department Head of Civil & Environmental Engineering**

**Could you tell us about the lab resources your department has?**

- Recommends contacting Russell Lang and Wenwen Yao for more depth on labs/shops.
  - Russell Lang oversees the civil engineering machines.
  - Wenwen Yao oversees the environmental testing machines.

**How does your department go about acquiring resources that it needs either for research or for projects?**

- This has been a challenge.
  - No department budget for acquisitions of more than a thousand dollar range.
  - Has searched for money in faculty budgets, dean budgets, and lab startup money.
  - Maintaining machines with this system is difficult.
  - Leads to having outdated machinery as technology is progressing evermore rapidly.

**How is usage of these resources tracked?**

- The lab managers track usage of machines.
  - Considering implementing user fees.
    - \* Cannot afford to stock consumables.
    - \* Will be a culture change.

**Are there any restrictions on who can access your labs?**

- Labs are open to anyone interested.
  - First come, first serve with prioritization on Civil and Environmental engineering students for machine reservation.

**How do you market your department and research opportunities that you have available?**

- Knowledge of the shops comes primarily from civil and environmental professor recommendations.

- With greater marketing might come larger waves of users with consumable and maintenance expenses exceeding what the labs have.

**Do you have any feedback on our MakerMap prototype?**

- Machine details are very important.
- Would be very useful to the department.
- Training processing would be a useful feature.

#### **11.5.14 Ian Anderson, Senior Instructional Lab Technician**

##### **What are the roles and responsibilities associated with your job?**

- Helping people with products
- Upkeep and maintenance, organization
- Shop administration
- Manage work studies
- ME1800 labs

##### **How do you currently track usage of your lab?**

- Multiple methods
  - User check in/out system
  - Machine Scheduling system
  - Project registration: personal, MQP, graduate, classwork, ect.
  - Tool Inventory
    - \* Kanban system
- This data is used for backing need for funding

##### **How do you currently request/obtain new resources for your lab?**

- Yearly capital funding requests
- WPI affiliated Grants outside of capital requests
- Donations from companies or organizations
- Currently there are many aging machines that require a lot of human time to upkeep

##### **What training is required to use lab resources?**

- Everyone using the shop is required to have completed the basic user training
  - This includes hand tools, and non interlock tools.
- Students can add on tool training through training events.

##### **Do you want more student involvement in your lab?**

- Yes

- Maintenance on machines takes a lot of time away from otherwise helping more students.
  - \* With this, it can be very busy with just Ian and James
- Washburn shops serves more than just mechanical engineering students
  - Students from other departments
  - Collaboration with Worcester public schools
  - Adult career training in the past
- Interest in more collaboration with Foisie, having more open labs like Washburn, and unified training across campus

**What tools do you think the WPI campus needs?**

- CNC gantry router (4x4 or larger)
- Industrial Waterjet
- Large plasma cutter table
- Wood shop with saw stop table saw
- More space for these

### **11.5.15 Douglas Petkie, Professor and Department Head of Physics**

#### **What resources does your department have and how do you manage them?**

A couple of questions are how do you manage safety with a machine shop, and how do you get people to know about it. There's a machine shop downstairs and a technical operations manager that oversees it. At one point we were close to shutting it down and three people from Washburn came over. In the springtime my understanding is it's very hard to find machines to use because everyone's in a rush. Our tech ops manager's job is broader so he can't be there just for helping students.

We are trying to get the machine shop to be more of a user facility but getting the word out is hard. A lot of people doing IQP's and MQP's just want simple instruments and sometimes use the tools in the physics labs, but those are not advertised. Part of advertising is what does each tool do and what can it be used for. As an example, how many people know about a sonic ranger? 50 Prescott is opening a new lab, and people will have to pay to use those instruments, so we'll try to do a much better job of advertising it. This LEAP facility in 50 Prescott is meant to be for campus and regionally. It's not open yet so we're trying to figure out the best way to manage it, and we are trying to get tours set up with the department heads.

#### **What do you think about having a universal training system?**

In terms of training, my thought for the downstairs machine shop is however students get trained in Washburn is sufficient.

#### **What software do you use to manage your labs?**

For the LEAP facility we are moving towards Agilent iLab's lab management software to solve certain problems. In iLabs, people have to make registration and we're using that software for registration/tracking/charging. The big thing is how do we charge MQP's, since they get a little bit of money to spend but not a lot. We're still trying to figure out those details. iLabs right now is our solution for managing the LEAP facility.

#### **What features would you like to see in our MakerMap?**

I'm buying instruments for LEAP and I don't know what all is on campus. I don't want to buy one if somebody else has one. I would like the MakerMap to have a descriptive text of the instruments that's searchable. That's what I would want, to be able to browse and search a database. Pictures, model numbers, all of that stuff. Almost like a wikipedia of on-campus tools. Along with a searchable database, I'd like information on who's your first point of contact and what training you need.



### 11.5.16 Daniel Sarachick, Director of Environmental Health & Safety

#### **Can you describe EHS' safety requirements?**

Our safety requirements are that the person in charge of that space is responsible for that space. Managers must be responsible for all activities, access, safety, and supervising in that space.

#### **What do you think about having a universal training system among different labs?**

The biggest hurdle in that process is that individuals must receive bench-top specific training and demonstrate competency. EHS has very little involvement with machine-specific training other than general safety guidelines—individual lab managers determine that. There's only EHS-specific training when getting into chemicals.

#### **Some faculty and lab managers would like to keep certain resources private, whereas others would like the list to be entirely public. What are your views on restricting what tools users see on the MakerMap?**

There is a challenge about “who owns this machine” when there are lots of students using a machine and it's more publicly available but there's no manager personally responsible for the machine. One way you could reach a compromise is to make the list public but not reveal the location of restricted tools.

#### **Are there any EHS guidelines on how safety training can be advertised?**

EHS doesn't care how we advertise safety training, but the responsibility is on the owner of the space. Currently safety training is advertised on the EHS website.

### **11.5.17 Adam Sears, Foisie Innovation Studio Makerspace Manager**

#### **What labs do you manage?**

I manage the Foisie Innovation Studio Makerspace and Prototyping Lab, which is open to the entire WPI community.

#### **What is your current lab protocol?**

I'm carrying out the system Dr. Stults set up last year. There is currently no tracking for access of the lab, but there is tracking for who is signing out tools. Users have to take a basic user quiz on canvas, and passing the quiz lets them checkout tools. The quantities of tools are in a web system. There's a Canvas discussion board managers have access to. If a tool is damaged by a user, the tool is taken out of webcheckout and put into a separate bin to be checked weekly for fixing or reordering. That system isn't working great, as we end up having for example a sacrificial screwdriver kit to refill other kits.

#### **Can you describe any collaboration that currently exists among labs and shops?**

I have a close working relationship with James and Ian from Washburn. We talk about our shops and connect Washburn and Foisie.

#### **What protocol changes would you like to see over time?**

I would love to see a system that's less manual and have a shadow board checked every day or have a drawer system with computer vision that automatically keeps track of which tools are stored where. I would like more cross-collaboration among labs. I would like basic user training to be the same across shops and makerspaces so users don't have to do multiple training sessions across multiple systems to have access to duplicate tools.

#### **How do you advertise your lab resources and events?**

We're mostly found by people who were brought through the tours/people who walk through makerspace. We have a hard time broadcasting to the community what we have available. We advertise makerspace workshops on whiteboards by the Foisie entrance, but otherwise it's hard to find us unless you have a direct link. We're looking into using StartupTree for advertising.

#### **What software do you currently use for management?**

We use Acuity scheduling software, and we use Canvas quizzes for user training. WebCheckout is a system for giving permissions, but it's not connected to Canvas so each morning a human goes through the Canvas quiz grades and enters WebCheckout permissions. 3DPrinterOS also involves an assistant manually entering Canvas quiz grades into the software. We use Odoos for inventory management. Schedule management happens on WhenToWork. We have a lot of systems that focus on one particular aspect but everything is scattered about. Washburn gave up on Canvas and uses Typeform to manage their quizzes, but they're having issues with it.

### **11.5.18 Wenwen Yao, Civil & Environmental Engineering Lab Manager**

#### **What are the roles and responsibilities associated with your lab?**

- Civil and Environmental Engineering Labs have two lab managers
  - Wenwen Yao - Environmental lab
    - \* Mostly serves IQP/MQP, and companies.
    - \* Assists with student test methodology
  - Russell Lang - Materials and Structural testing lab

#### **How do you currently track usage of your lab?**

- Paper logbook
  - Documents date, student, and machine used
  - Currently, data is not used but could be valuable in stating cases for funding
- Tried Teema
  - Took twice as long for the same result as paper

#### **How do you currently request/obtain new resources for your lab?**

- Recently Obtained a GC Mass Spectrometer
  - Was given a budget for this purchase
  - But hard to predict the recurring cost of consumables
- Considering student/professor charge for consumables

#### **What training is required to use lab resources?**

- For most machines, coming in and using the machines after one-on one instruction
- For some high value and more risk machines, supervision by the lab manager is required

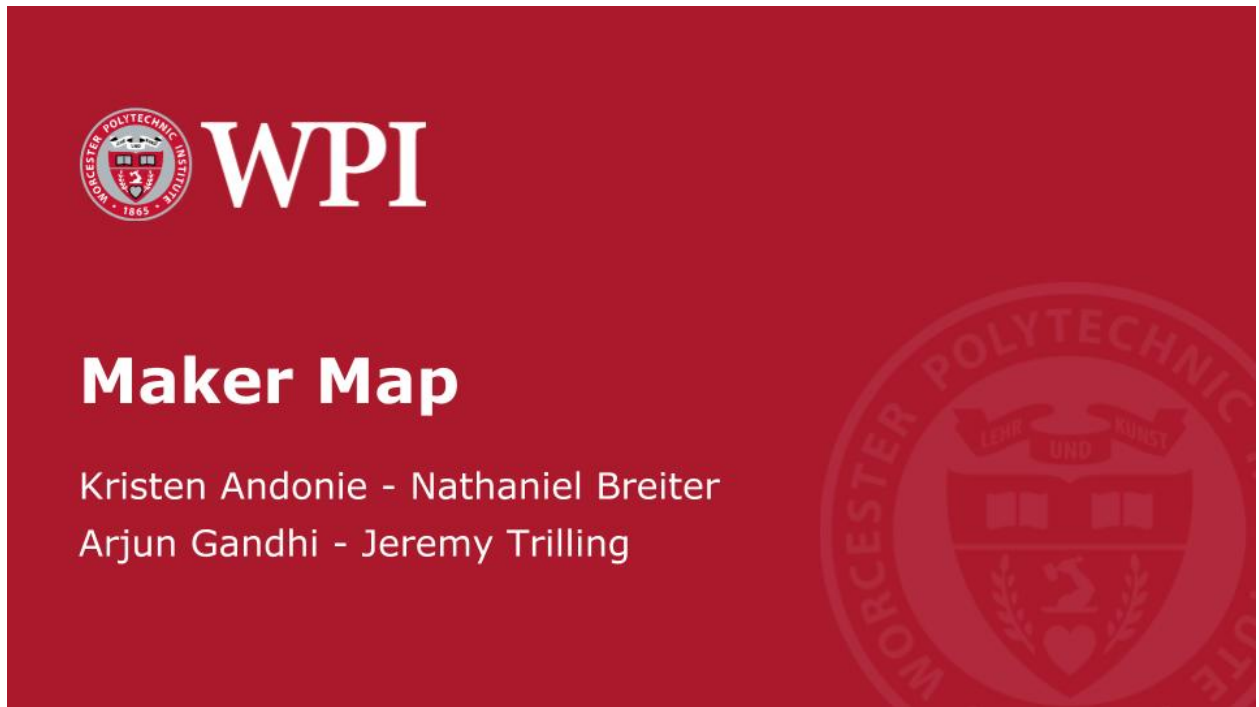
#### **Do you want more student involvement in your lab?**

- Yes
  - Many of the machines are useful in many engineering fields and more students from different departments would be great

#### **Do you have any feedback on our MakerMap prototype?**

- Standardized tracking across campus is important
- Having this sort of system would help researchers save money and move faster

## 11.6 Appendix 6 - Tinkerbox Application Presentation



### **Problem**

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Members of the WPI community struggle to find the makerspace information and resources they need to pursue their project ideas.

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## Proposed Solution

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We believe that having all the information associated with making resources available to students in one place - a **Maker Map** - would benefit this experience.

We would like to accomplish three goals with our solution:

1. Unify safety and tool training
2. Unify information about tools, techniques, shop access, and any other facet of the making experience on campus
3. Link students who need help to experienced community members

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## Data Gathering

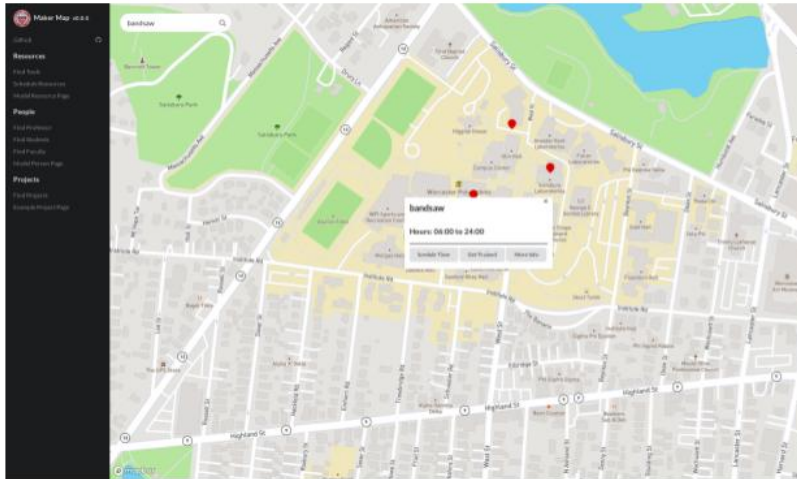
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- Student Survey
  - Set a baseline for the current situation
  - Figure out the largest needs of student makers
- Faculty Interviews
  - Better understand how to ensure implementation and continual use of Maker Map
  - Identify needed features and their importance

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## Prototype - makermap.arjungandhi.com

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### Implemented:

- Map based on mapbox
- Ability to search for several tools

### Coming Soon:

- Training integration
- Ability to schedule tools

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## Milestones

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- B-Term
  - Stakeholder Research completed
  - Minimum Viable Product completed and integrated with external systems throughout campus.
- C-Term:
  - Feature additions and revision based on stakeholder feedback
  - Firm plan for continuation past conclusion of IQP

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## Budget

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Description	Cost	Value
Server Hosting	\$500	Allows quicker development of prototype enabling use of some of AWS' more advanced features.
Market Research	\$1000	Provides feedback to enable iteration on our prototype
Interactive Map Display and Installation	\$3500	Provides a constant source of UI testing for product growth and establishes Foise as the center of making at WPI

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## Interactive Maker Map Kiosk

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The image features a large, solid red rectangular area at the top. Centered within this red area is the text "Thank you" in a bold, white, sans-serif font. Behind the text is a faint, circular watermark of the Worcester Polytechnic Institute seal. The seal contains the text "WORCESTER POLYTECHNIC INSTITUTE" around the top and "1865" at the bottom, with a central crest and a banner that reads "LEARN AND KNOW".

**Thank you**



## 11.7 Appendix 7 - About Page Content

### The MakerMap Team

#### **Arjun Gandhi**

*Robotics Engineering 2021*

Arjun demonstrated his passion for this project before it even started, dreaming up MakerMap's features and bouncing his ideas off of faculty and friends. Arjun brought his experience as a full stack developer of a start-up company to set up the servers and create MakerMap's framework and frontend.

#### **Cooper Bennet**

*Robotics Engineering and Computer Science 2021*

Cooper is hard-wired to help people. So much so that he deemed his thirty hours a week helping struggling lab students insufficient and decided to take on the additional task of volunteering his indispensable assistance to our IQP team. Cooper has helped with writing the python lambda functions of our backend web design.

#### **Jeremy Trilling**

*Robotics Engineering 2022*

Jeremy loves to make! From robotic tattoos to flying cars, he finds using tools to bring ideas into reality endlessly fulfilling. When given the chance to enhance the way people enjoy this pleasure at WPI, Jeremy couldn't wait to help! Joining the IQP project as a sophomore, Jeremy led faculty and staff interviews, informing our team of the needs in our community as well as collecting machine census data in the major making labs on campus.

#### **Kristen Andonie**

*Robotics Engineering and Computer Science 2021*

Kristen joined this project because she has first-hand experience on how hard it can be to become involved in labs and makerspaces. She became a maker by talking to friends who showed her the ropes, and now she wants to help simplify the process of connecting people to maker resources. On the MakerMap team, Kristen wrote the api, helped conduct interviews, and made sure the team stayed on track with its many administrative tasks.

#### **Nathaniel Breiter**

*Robotics Engineering 2021*

Nathaniel joined this project to ensure the team dotted their I's and crossed their T's. His experience as a former Washburn Shops work study employee was helpful in understanding the needs of lab managers. As part of MakerMap he led the IRB application process, created and distributed a student facing survey, assisted in interviews, and developed the website's SQL backend. He is also involved in Savage Soccer and Rho Beta Epsilon around campus.

### MakerMap's Current Features

#### **Resource Map**

MakerMap's landing page acts as a map of all the making resources on campus. You can use it to find buildings, labs/shops, and even individual tools. Selecting nodes on the map brings up information about the resource selected. Everything from the location to the model number and how to use it. Furthermore, you can use the navigational controls within the popup to browse other resources available at the same location

#### **Events Calendar**

This page acts as a collection point for the various calendar pages and systems that maker-related events around campus get posted to. Currently MakerMap pulls events from the Washburn Shops, Foisie Makerspace, and EHS. There are also links to sign up for and RSVP to various events.

*Coming Soon: Create your own events within MakerMap. Other people will be able to sign up without leaving this page*

### **Profile Pages**

MakerMap also serves as a directory of makers. In addition to letting you see the tools you can access, user profiles exist to help you find other members of the community to learn from. You can also fully edit your profile description to let everyone else know what you are working on and the knowledge you can share.

### **Why MakerMap Was Developed**

We believed that finding out about the exciting making happening on campus and how to get involved is a challenge. Even with the brand new Foisie makerspace, most making continues to happen in various small labs all over campus, each run by different departments and lab managers. This system results in a reality where knowledge about how to make stuff on campus, where tools are and who can help you, is controlled by who you know rather than available to everyone. Our goal was to solve this problem. By creating a centralized platform where you can learn about the making resources available across campus, we hope that many of you will find it easier to get involved and learn new skills.

### **Our Process**

#### **Initial Groundwork**

Beginning in A-term of 2019 the MakerMap team began to gather research and write proposals. Our largest hurdle was the WPI Internal Review Board. We knew we wanted to conduct surveys and interviews in B-term but first we had to get approval. To assist with this process our advisor Curtis had us survey an ID 2050 class. While ID 2050 wasn't required because our IQP was on campus, attending the class sessions and working with an ID 2050 professor was helpful in learning about how to conduct ethical data collection and what methods would best fit our needs. By the end of A-term we had submitted an IRB proposal that included exact details about the survey and interviews we wanted to conduct. During this period we also did background research and started to organize and plan the rest of our project.

#### **Interviewing Faculty and Staff**

During B-term we split into two pairs, Arjun-Kristen and Jeremy-Nathaniel, to conduct interviews all over campus, with one person talking and the other taking notes. We tried to talk to as many potential stakeholders as possible, ranging from lab managers and department heads to the CFO. The goal of these interviews was two-fold. Of course we needed answers to a bunch of questions about what resources were on campus, who was onboard with the idea, what the website needed to do, etc. But we also wanted to use the interviews as a way to raise awareness and support for our efforts. To that end Arjun threw together a quick mock-up of the website we could use to show people and get them excited. Over the course of the term we interviewed around 20 members of the community we felt were critical to our project.

#### **Surveying the Student Body**

Our other major task in B-term was to survey the student body. Nathaniel took the

questions that had been approved by the IRB and digitized them using Qualtrics. You can find that survey here if you want to look at it. The goal of the survey was to learn about existing lab use on campus and how much need there was for our project. We also used it to double check our name was a good one. Once the survey was complete (there were multiple rounds of revisions with wording and flow changes) all four of us tried to distribute it as much as possible. We used email, slack, groupme, discord, reddit, and text message to distribute the survey to friends, clubs, and even multiple entire departments. In the end we had over 400 student responses, a remarkable success.

### **Development**

We wanted to make this system scale and grow with WPI, so we built the entire project on AWS. We used an RDS for the database, Lambda functions for our API, and an S3 bucket to host our static website. The front-end is built using React.js, a framework built by Facebook that allows us to break up the website into nice, neat components. We are currently in progress attempting to merge our prototype with WPI's SSO. Doing this will allow us to have seamless integration with the WPI ecosystem.

### **The Future of MakerMap**

There is a bright and active future ahead for MakerMap. We will be working closely with Adam Sears, the new director of the Foise Makerspace on setting up an infrastructure to actively maintain this project. We also have a whole host of features we hope to help implement in the future.

- User Profiles for Faculty and Staff
- An event management system for Maker related events
- A centralized booking system for all tools on campus
- A centralized training management system
- Integration with e-portfolio and e-projects
- A student / faculty search in order to help find partners and advisors for your projects.

We are looking for some bright students who can carry the torch of this ecosystem in the next year. If you are interested, want to help, or just learn more, shoot us an email at [gr-makermap@wpi.edu](mailto:gr-makermap@wpi.edu)