Worcester Polytechnic Institute

Interactive Qualifying Project
Combat Robotics Hackathon
Hosted by WPI

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Abstract

The Combat Robotics Hackathon team's mission was to create a framework for an engaging and reproducible event that can be expanded beyond WPI to other universities. The mission had two main objectives: create resources and plans for introducing 3D Printing and Computer Aided Design (CAD) and run a successful combat robotics hackathon event. The hackathon event was run in A term 2018 and was a great success. The forty-five participants made fifteen robots by the end of the weekend. Most of the participants improved their 3D printing and CAD skills and all of them enjoyed the hackathon.

Acknowledgments

This Interactive Qualifying Project was advised by Nicholas Bertozzi, Bradley Miller, and Colleen Shaver. They have provided various useful resources and guidance throughout the development of the IQP. We appreciate the time the advisors took to supervise the event and all of the efforts and support that the advisors put into the project.

We would like to thank James McLaughlin, the Foisie Innovation Studio building manager, and Erica Stults, the Prototyping Lab manager, for helping and providing resources for event preparation in the Foisie Innovation Studio.

We would also like to thank all of the students who participated in the hackathon event and completed the surveys sent out afterward, as well as the Foisie Innovation Studios staff who were willing to stay overnight to monitor the Prototyping Lab printers.

Executive Summary

Many of the first-year students at WPI are unsure about their field of study. This IQP is targeted at those who want a way to test their interests in robotics engineering through an inexpensive hackathon event. The planned hackathon event had two different sections: a series of workshops covering basic skills and a competition where robots compete in a bracket-style tournament.

A Hackathon is an event where a large number of people meet to spend several days collaboratively creating solutions to a certain problem. This hackathon event was focused on combat robotics which provides a competition with low starting cost and high excitement compared to other types of competitions. The event provided students with an introduction to Computer-Aided Design for additive manufacturing.

The IQP team produced and edited videos that covered the basics of both CAD and 3D printing. The CAD videos covered the basics of SolidWorks and the 3D printing videos covered the function of Slic3r, Cura, and 3DPrinterOS. Next, the IQP team prototyped two different template designs to use for the event in case some teams didn't have enough experience to model a whole robot. Three components of each template robot were removed from the SolidWorks assembly provided to participants. The parts were removed to ensure that participants who used template designs still had the opportunity to create parts of their own.

Surveys and knowledge quizzes were given before and after the Hackathon to evaluate the effectiveness of the workshops and videos. The survey was reviewed by Paula Quinn, a survey specialist at WPI's Center for Project Based Learning. Another background knowledge survey was sent before the event to gauge the overall skill level of the group.

In order to run this event, the IQP team sought out building and equipment sponsors within the WPI community. In addition to WPI providing an event venue and access to 3D printing resources, a door fee and sponsors needed to be sought out to subsidize the cost. This door fee also ensured that the participants felt more committed to the event. The WPI Combat Robotics Club sponsored the arena and electronics for all of the robots. Key steps in setting up the event included reserving classroom space, contacting building managers, and getting administrative access to the 3D printing queue.

The event was a weekend-long hackathon where 15 teams of 3 WPI students each were given access to the video curriculum and participated in five hours of workshops lead by the IQP team. At the end of the event, 15 robots competed in a modified swiss style competition. The participants used knowledge from workshops and one-on-one help to design one-pound plastic combat robots. The IQP team's intention was that the workshops would teach participants the basics of CAD in a classroom setting. After the workshops, team members were able to work individually with teams, assisting with software and design decisions. They served as mentors to

the groups, providing help as necessary to ensure that all participants left the event with an increased understanding of the material covered as well as hands-on experience with each process that they learned. The Foisie prototyping lab printers were used throughout the event. There were 16 Ultimaker and 6 TAZ 3D printers used in producing parts for the robots. These printers were all connected through 3DPrinterOS to have a queue for printing robot parts. The Foisie makerspace provided tools and space for assembling the robots.

After running the hackathon style combat robotics event the surveys and quizzes were evaluated. The pre-event survey showed that more than half of the event participants had little to no experience in SolidWorks and 3D printing. The team made the decision that the presence of experienced team members mixed with inexperienced team members would improve the overall performance of the teams. An interesting correlation that appeared in the data was that almost all of the participants with little to no experience were freshmen. A goal of the IQP was to build the introductory skill of freshmen while generating an interest in robotics engineering. The distribution of classes suggests that this goal could be met since greater than 50% of participants were freshmen. Through this IQP, we wanted to affect the most diverse group of people possible. Although half of the participants were robotics engineering majors, there were participants from six different majors. The presence of undecided students showed that the event has the potential for helping students become introduced to robotics engineering as a major. The IQP team was pleased that 73% of the participants claimed to have an improved understanding of SolidWorks and 3D printing after the event. A great achievement of the event was that every participant who filled out the survey said they would participate in a similar event again.

The event was very successful as many students were able to come out of the weekend with new experiences. There were entire teams comprised of freshmen who had never opened SolidWorks, but by the end of the weekend were able to design multi-part robots. The event was unable to provide the amount of freedom with the 3D printers in the Foisie Prototyping Lab that the team had initially planned. There were several areas in which the Foisie spaces were lacking such as having limited tools. The Ultimakers in the Prototyping Lab had a very high fail rate, almost one-third of the prints failed. This posed a unique challenge to the IQP team and the participants. Students had to redesign their parts to take less time to print so that they could finish their robots on time. Over the course of the weekend the team realized that while the workshops were a good way to provide a very basic introduction to the full group, one-on-one meetings were much more effective for advancing the participants’ basic skills.

Authorship

Table 0.1: Authorship

Section	Authors	Editors
Abstract	Timothy Bell, Cooper Bennet, Christian Cooper, David Jin, Danny Lu	Timothy Bell, Cooper Bennet, Christian Cooper, David Jin, Danny Lu
Executive Summary	Timothy Bell, Cooper Bennet, Christian Cooper, David Jin, Danny Lu	Timothy Bell, Cooper Bennet, Christian Cooper, David Jin, Danny Lu
Introduction	Timothy Bell, Cooper Bennet, Christian Cooper, David Jin, Danny Lu	Timothy Bell, Cooper Bennet, Christian Cooper, David Jin, Danny Lu
Background	Timothy Bell, Cooper Bennet, Christian Cooper, David Jin, Danny Lu	Timothy Bell, Cooper Bennet, Christian Cooper, David Jin, Danny Lu
Methodology	Timothy Bell, Cooper Bennet, Christian Cooper, David Jin, Danny Lu	Timothy Bell, Cooper Bennet, Christian Cooper, Danny Lu
Findings	Timothy Bell, Cooper Bennet, Christian Cooper, David Jin, Danny Lu	Timothy Bell, Cooper Bennet, Christian Cooper, David Jin, Danny Lu
Conclusions and Recommendations	Timothy Bell, Cooper Bennet, Christian Cooper, David Jin, Danny Lu	Timothy Bell, Cooper Bennet, Christian Cooper, David Jin, Danny Lu

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1 Introduction

At WPI and other four-year universities, many students enter their first year unsure about what they are interested in. While there is value in taking general education courses, the earlier that a student can identify their interests, the sooner they will be able to select relevant coursework.

There is widespread use of computer modeling in conjunction with 3D printing in fields ranging from Biotech to Fine Arts to Engineering. Regardless of major, getting an early exposure to the effective utilization of these tools is beneficial.

Robotics Engineering is a field that combines specific aspects of three fields of engineering: Mechanical, Electrical, and Computer Science. The following organizations have realized its importance as a new industry and started competitions for high school and middle school students: FIRST Robotics Competition, FIRST Tech Challenge, FIRST LEGO League, and VEX EDR. These competitions have been effective in providing students with hands-on experience in robotics and its related fields, allowing them to enter college with a solid vision and strong motivation to pursue their chosen major. On the other hand, some students have heard of robotics and might think that they are interested, but they have not been able to get sufficient exposure in the field to make an informed decision on their major.

Currently, a popular way for WPI students to confirm whether or not they are interested in robotics engineering is taking the introductory course RBE 1001. The goal of this IQP is to run a hackathon-like event that will take place over a weekend and introduce participants to the basics of SolidWorks and 3D printing. This will also give participants of the event an idea about whether or not they would enjoy taking RBE 1001, before taking the course. The IQP has been broken up into two main components to make this goal more attainable: creating a curriculum and running the event.

A simple Google search for “SolidWorks tutorials” will yield many ten minutes plus videos that teach only a single topic. While some of these videos are incredibly informative, many of them can be long-winded or boring. This IQP aims to create high-quality, brief, and engaging videos that teach only a single topic to keep them as focused as possible. Videos will be five to seven minutes in length and teach topics such as creating parts and assemblies with additive manufacturing in mind. Although these videos will be available to anyone on the internet, they will be tailored to hackathon participants in order to teach them the basics of robot design, or more specifically, combat robot design.

Combat robotics is one of the most easily accessible forms of robotics, this can be seen with both the recent revival and success of shows like BattleBots and Robot Wars. Over the course of the weekend, hackathon participants will be expected to learn how to design and create the components of their own combat robot, so that the event can conclude with a competition. To gauge the success of the event and curriculum, entry and exit surveys will be given to the participants to get both qualitative and quantitative data on their experience.

Our goal is to create the framework for a successful and reproducible event allowing this program to expand beyond WPI and to other universities with engineering programs. The hackathons first run was restricted to WPI students to reduce the logistical complexity of the event. In the future, the IQP team will look at inviting non-students to participate in future events or implementing a similar event at other institutions.

2 Background

To understand the benefits of this event and how they will affect WPI and its participants, key points must be examined in further detail:

2.1 The University's culture
2.2 The Robotics Engineering program
2.3 The definition of a hackathon
2.4 The history of combat robotics competitions
2.5 The history of the WPI Combat Robotics Club
2.6 The growing necessity for experience in CAD
2.7 The rising prevalence of 3D printing in industry
2.8 How this event would compare to other similar collegiate robotics events.

2.1 Worcester Polytechnic Institute

Founded in 1865, Worcester Polytechnic Institute aimed to supply the masses with an education in the arts and sciences. However, Worcester Polytechnic Institute did not gain its current philosophy of Theory and Practice until the late 1960s. This philosophy helps any WPI student gain knowledge and industry experience in their preferred subject area (WPI Plan, n.d). In 2007, WPI was the first university to create a robotics engineering program which would have a focus in Mechanical Engineering, Electrical Engineering, and Computer Science (Professor Michael Gennert, n.d).

2.2 The History of WPI's Robotics Engineering Program

The Robotics Engineering program was founded in 2007 with the goal of educating engineers to take a Systems Engineering approach to problems in the field of robotics (Professor Michael Gennert, n.d). WPI's philosophy of Theory and Practice integrates beautifully into the field of Robotics Engineering (The WPI Plan, n.d). Every class ends with a difficult challenge or project that the students are tasked to complete, perfectly matching the school's philosophy. These challenges range from autonomously blowing out a candle to programming an industrial robotic arm to frost cupcakes. The WPI Robotics Engineering program is ABET accredited (ABET, 2009-present) which shows it is incredibly advanced, but the introductory class, RBE 1001, does little to educate Freshman on how to 3D print and use CAD software. The proposed solution to this problem is to present video tutorials and event workshops on these topics in an easily digestible format, introducing students to the basics of CAD and 3D printing

2.3 An Explanation of Hackathons

A hackathon is an event where a large number of people spend a continuous period of time, usually between a day and a weekend, developing a solution to a problem in alignment with an overarching theme. The first hackathons were software focused events, but now many groups are using the same methodology for a variety of fields. For example, a banking firm hosted a hackathon to determine better ways to attract and retain millennials (Caimi, 2016). A Hackathon is often designed to produce a solution to a large problem by combining the brainpower of many individuals. Due to the very tight time constraints, many hackathons produce simple and clever solutions rather than overly complicated ones.

2.4 The History of Combat Robotics

The importance of the Combat Robotics Hackathon is not only to provide experience in engineering but also to generate interest in combat robotics. Combat robotics events are easily accessible and have low overhead cost compared to other popular competitions, such as those put on by FIRST or VEX. While major robotics competitions such as FIRST Tech Challenge or FIRST Robotics Competitions can cost up to $2,250(Cost & Registration FTC, n.d) and $5,000(Cost & Registration FRC, n.d) respectively, a simple combat robot such as the ones used in the Hackathon will only cost around $100 (Table C.1). Combat robotics ignites the intense energy of the competitors and creates a great show for the audience.

The first combat robotics competition occurred in 1987 and consisted of both basic remote-controlled robots and cable-tethered robots. At this point, the only way a match could be won was if the opponent was unable to move (Robot Battles, n.d). In 1998 Robot Wars aired in the United Kingdom which marked the first time a combat robotics event had been televised. Robot Wars had generated such a following that just two years later BattleBots aired for the first time in the United States. As technology got better, robots got cheaper, lighter, and more accessible to the general public. Now there are eight different weight classes across The United States (NERC, n.d) and interest in the sport is at an all-time high with the resurgence of Robot Wars and BattleBots in the past two years.

2.5 The History of the WPI Combat Robotics Club

Many technology-focused schools have created clubs focused on the creation of combat robots to compete at various events around their region. Worcester Polytechnic Institute's combat robotics group was revived in 2016 and has attended many competitions over the past two years, as shown in Table 2.1 below.

Table 2.5.1: Combat Robotics Club Event History

Event	Location	1lb	3lb	12lb	30lb	60lb	120lb	220lb	Year
Franklin Institute	Franklin, PA	■	■	■	■				2016, 2017
Mass Destruction	Boston, MA	■	■	■					2016, 2017
Motorama Robot Conflict	Harrisburg, PA	■	■	■	■				2017, 2018
Bot Blast	Bloomsburg, PA		■						2017
New York World Maker Faire	New York City, NY	■	■	■					2017, 2018
Robogames	Pleasanton, CA	■	■				■		2018
Dallas Area Robot Combat	Dallas, TX	■	■						2017, 2018

Table 2.5.2: Combat Robotics Club Key

Key	
■	Yes
	No

2.6 The History of CAD Usage in Industry

Computer Aided Design (CAD) has continually grown over the past years and has become a staple in modern day engineering (3D CAD Software, 2018). It helps simplify the drafting and design phases of the engineering process. The first CAD software dates back fifty years to PRONTO, created by Patrick Hanratty (Computer-aided-design, n.d). It was the first commercial numerical-control programming system. The Initial Graphics Exchange Specification (IGES), a file format which enabled CAD systems to exchange information, was introduced for 3D designs in 1980 (Encyclopedia, n.d), which was then taken over by the release of Standard for the Exchange of Product model data (STEP) in 1994 (Chang, 2014). SolidWorks, Autodesk, and ProE are all CAD programs used commonly throughout the modern workplace (60 Years of CAD, 2018). The uses of CAD are broad: simulation, manufacturing (Computer Aided Machining or CAM), and visualization are all common workplace uses of CAD.

2.7 Increased Usage of 3D Printing Technology

3D printing is a relatively new technology that is rapidly gaining popularity. 3D printing is the process of making a physical object by laying thin layers of a material on top of each other. It is being used in some form by most manufacturing companies (Introduction To FDM, n.d). In a recent survey of companies using 3D printing, 47% of the companies said that they had seen an increased return on investment from 3D printing over the previous years (Columbus, 2017). Using 3D printing allows one to create products quicker and cheaper than previously possible. New additive manufacturing companies like Fast Radius claim that "You can now engineer and manufacture production-grade end-use parts that have material properties that mimic those of traditional manufacturing techniques such as injection molding or CNC machining" (Fast Radius, n.d). The increasing demand for complex parts and the decreasing cost of strong 3D printed parts will allow 3D printing to begin challenging traditional manufacturing methods.

2.7.1 Slicers

A slicer is a software that takes a solid model and breaks it down into different layers so that it can be 3D printed. Two of the most popular open source slicing software are Slic3r and Cura. This IQP will focus on this software because they are both free to use and can be configured to work with almost any 3D printer. A slicer software allows the user to customize their 3D print and then generate the machine motion code (GoPrint3D, 2016). Customization options include but are not limited to resolution, density, temperatures, and speeds.

2.8 The Most Common Types of 3D Printing Technology

This section will detail three of the most prominent forms of additive manufacturing. These 3D printing methods have been chosen since they are the cheapest and most easily accessible compared to more industrial solutions. The new Foisie Innovation Studio at WPI will have 21 FDM (Fused Deposition Modeling) 3D printers (Harrington, 2018). This IQP will focus on the use, operation, design for FDM 3D printers due to their relatively low cost and availability to students.

2.8.1 Fused Deposition Modeling (FDM)

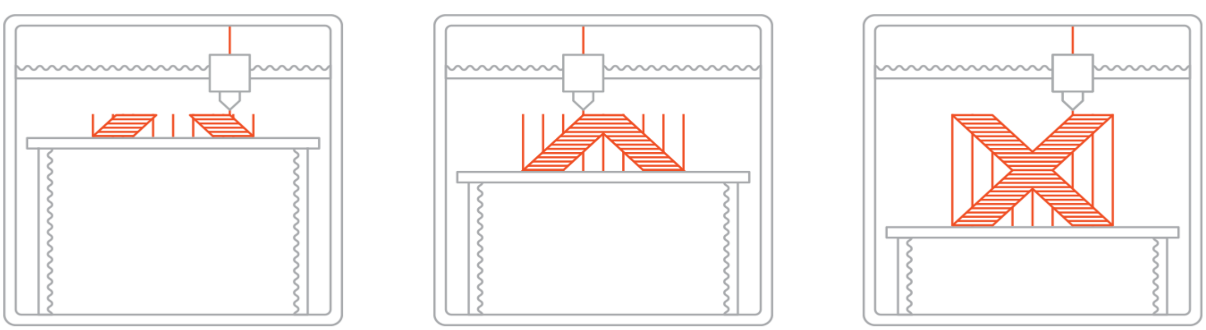

Figure 2.8.1: FDM Process

FDM is the most popular form of additive manufacturing and is used in both personal and industrial settings. This process works by heating a thermoplastic to its glass transition point and laying it down layer by layer until the desired model is created. This method can use a wide range of thermoplastics to create durable parts (Introduction to FDM, n.d). FDM is most often used for prototyping, although it can be used for small production runs. All the 3D printers that will be in the Foisie Innovation Studio will use FDM.

2.8.2 Stereolithography (SLA)

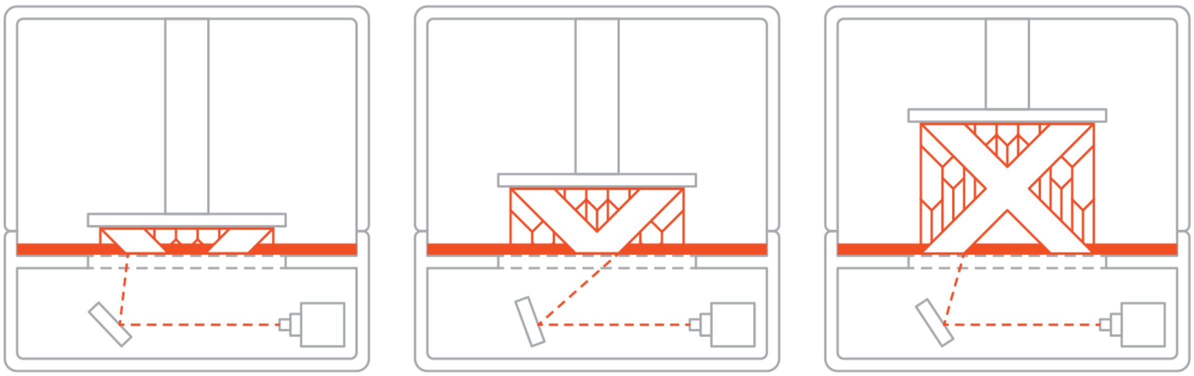

Figure 2.8.2 SLA Process

SLA is a more expensive and slow process; however, it is capable of producing significantly higher resolution prints. This is because SLA printing uses a laser to precisely harden particles in a vat of resin (Introduction to SLA, n.d). The parts do not have distinct layers, making this process perfect for visual parts, and injection mold testing. The result of this printing style is a more brittle part than FDM. This confines SLA printing to a narrower set of use cases.

2.8.3 Selective Laser Sintering (SLS)

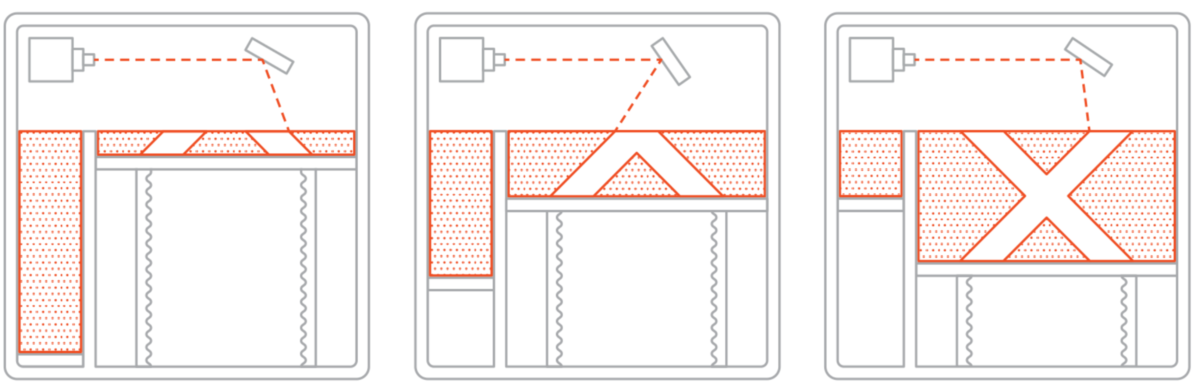

Figure 2.8.3: SLS Process

SLS is the process of using a laser to sinter particles of polymer powder, fusing them together layer by layer, to create parts. Unlike FDM or SLA, SLS has high accuracy and reliable mechanical properties (Introduction to SLS, n.d). SLS does not require the creation of support structures since the part is created within layers of powder. SLS is quickly becoming an economically comparable alternative to injection molds for small batch productions.

2.8.4 FDM and the Combat Robotics Hackathon

The availability and low cost of FDM are the reasons that the combat robotics Hackathon will take advantage of this technology. This event will focus on designing for FDM printing and the operation of common FDM printers. The 3D printers that will be used for the creation of basic robot components are the Lulzbot TAZ 6 and Ultimaker 3 because they will be readily available to students in the new Foisie Innovation Studio. (Harrington, 2018)

2.9 Existing Collegiate Robotics Competitions:

BattleBots IQ used to be the large-scale combat robotics competition for colleges. The competition had the ability to both capture the students' creativity and provide engineering experience. With the increase in popularity of the BattleBots television series, there is more and more interest from students in middle school, high school, and college. This competition provided hands-on experience for students to gain practical knowledge of science, technology, engineering, mathematics, and manufacturing (BattleBots IQ, 2014). BattleBots IQ failed because it was tied with the show, which was canceled in 2005 causing the competition to cease with no reincarnations under the official BattleBots name since.

VEXU is the university level competition created by Innovation First International in 2014. This competition was meant to expand the high school level VEX EDR competition to a more advanced group of participants. This was done by expanding the allowed use of materials from only official VEX EDR structural components and sensors to 3D printed parts and any Commercial Off-The-Shelf (COTS) electronics. This change greatly increases the variety of designs and strategies available. VEXU is given the same challenge to complete as VEX EDR which always takes place on a 12'x12' field, keeping yearly costs low and setup times minimal (Innovation First International, 2018). While VEXU can be an incredibly difficult and advanced competition, it has difficulty generating as much interest as combat robotics does. This can be seen with the popularity of combat robotics TV shows like Robot Wars and BattleBots.

The Nasa Robotic Mining competition is an annual event attended by nearly 50 colleges from across the United States. The goal of this challenge is to investigate and test the robot's ability to remove regolith [a layer of rocky material covering bedrock] from another celestial body (Heiney, 2005). This competition requires both collegiate relationships and a preexisting, extensive, knowledge of robotics in order to compete. While this competition produces a robot that is far more beneficial to society, it is not publicized well and because of that, it is unable to reach potential engineers.

2.10 Interest Research at Worcester Polytechnic Institute

In order to ensure that there would be enough interest from the WPI student body to run the Hackathon there, the members of the Combat Robotics Hackathon IQP conducted an interest survey using the Worcester Polytechnic Institute Facebook pages for each class. The information gathered shows that there is sufficient interest to have a full group at the planned event. In table 2.3, below, the data from the interest surveys is shown and divided by class

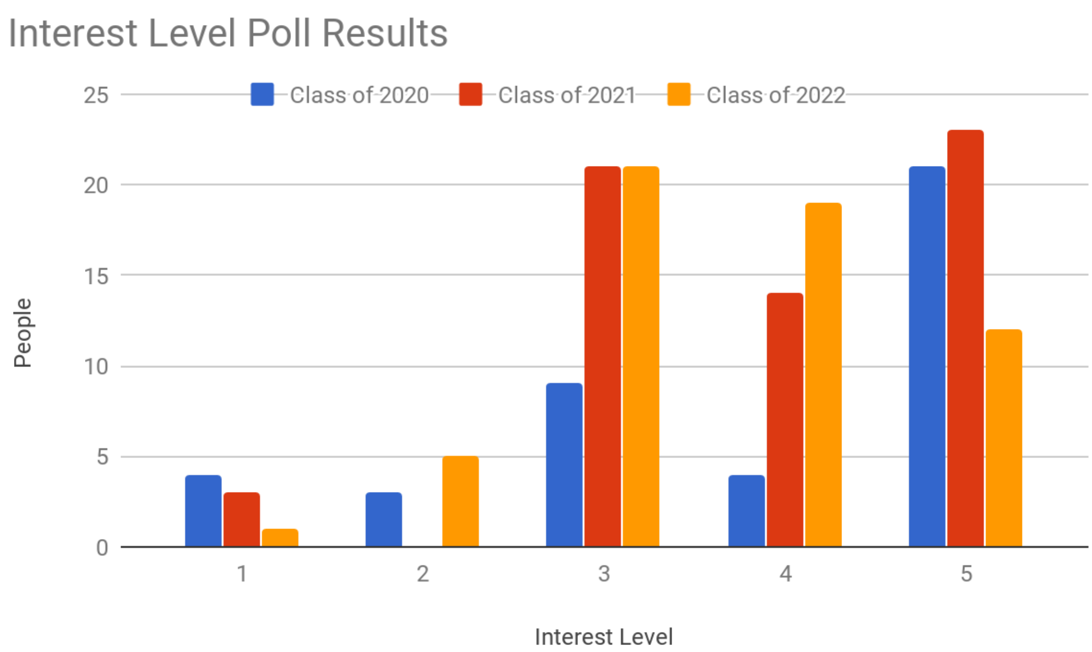

Figure 2.10.1: Interest Poll Results

Table 2.10.1: Interest Poll Results

Interest Level	Class of 2020	Class of 2021	Class of 2022	Total
1	4	3	1	8
2	3	0	5	8
3	9	21	21	51
4	4	14	19	37
5	21	23	12	56

These poll statistics represent the interest level of a small sample size of Worcester Polytechnic Institute students in participating in a workshop/competition relating to combat robotics. It shows that there will be a significant amount of interest in participation from the WPI student body.

3 Methodology

There were two primary deliverables produced by this IQP. The first was a repeatable event framework that served to generate interest in combat robotics, 3D printing, and robotics engineering. The second was a set of reference videos to teach basic and intermediate CAD and 3D printing skills using popular and easily available programs. These videos allowed students to quickly find the answer to any questions they had without having to dig through hours of existing material. In order to complete these deliverables, research into the existing materials needed to be done.

3.1 Roadmap for the IQP

To make sure that everything needed to prepare for the event was known, a series of tasks that were completed leading up to the event were established:

- Produce and edit videos on CAD and 3D printing
- Prototype robot designs to be used in the event
- Develop the material for the workshops to be run at the event
- Create a survey to evaluate the efficacy of the curriculum
- Test and revise the curriculum based on the feedback we receive
- Identify and work with sponsors for the event
- Publish the collection of online resources
- Run the event

3.2 Make videos

A collection of resources that can be accessed by everyone, in the form of a series of short videos that cover the basics of both CAD and 3D printing, was created by the IQP team. Hours of the curriculum were created, although each video was less than ten minutes because it was not too long to lose the viewers' attention. They were made long enough (5+ min) to benefit from YouTube's search algorithms for promoting videos with certain lengths (Gielen, 2017). These videos were the foundation of the knowledge taught through this event. The videos covering CAD used SolidWorks as it was the modeling software preinstalled on all WPI computers. The videos on 3D printing covered the use and operation of Slic3r, Cura, and 3DPrinterOS. Slic3r and Cura are commonly used and are free slicing software. The Foisie Innovation Studio uses 3DPrinterOS as the default software, so it was the most accessible to WPI students.

To get a better understanding of what should be covered by the videos created by this IQP and to create a basis for evaluating how effective the program is, existing video tutorials on CAD and 3D printing were reviewed. After a thorough evaluation of existing SolidWorks and Autodesk Fusion 360 videos, it was determined that high-quality tutorials of Fusion 360 were available, but there was a lack of easy-to-follow videos on SolidWorks. Based on this research, shown in Appendix A, the IQP focused on the creation of SolidWorks tutorial videos.

3.3 Prototype the prepared designs

The robots were designed in SolidWorks and 3D printed so they could be tested before the event to ensure that the robots' functioned as designed. Two basic designs were tested: a drum spinner and vertical spinner. The IQP team chose to supply two templates to the hackathon participants so that they had multiple options to choose from without having to make too many design choices themselves. If a group was advanced and wished to design their own robot or make any custom parts, they able to do that as well. These designs were chosen because they are simple and the IQP group members had experience working with them. Once the designs were finalized, three basic parts from each design were chosen and removed from the materials given to participants. This is so that the students needed to design and learn to print the parts themselves. To ensure the safety of the participants, a set of safety guidelines was created which prohibits the use of anything that could damage the arena or anything outside of it. These guidelines were adapted from safety guidelines used by several combat robotics groups (NERC, n.d).

3.4 Set up workshops

In addition to the videos, there were five hours of in-person workshops that ran at the event. These workshops assumed that the participants have viewed and understood the video content, allowing for a more in-depth and a specific lesson about combat robotics. The workshops covered the additional advanced topics needed to fully design and 3D print a combat robot. There are many existing workshops that give crash courses in CAD and 3D printing. Talking to people who run these kinds of workshops helped to present the material in a way that best conveys the material and helped to ensure the participants have a good understanding of it (Mass D Interview, Appendix G).

3.5 Surveying students

To evaluate how effectively the video content and Hackathon conveyed information, a survey and a knowledge quiz were given before and after the Hackathon. The survey collected subjective data on how much the participants enjoyed the event and the knowledge quiz measured what they actually learned. It was meant to test the user's knowledge and experience with CAD, 3D printing, and robot design. The IQP team intended to give this survey to twelve people in E2 as an initial test of the material but did not get IRB cleared to collect data from human subjects in time.

The IQP team worked with Paula Quinn, a survey specialist at WPI's Center for Project Based Learning, to create a survey that allowed the effectiveness of the material to be easily measured.

Every topic that was covered by the curriculum had at least one survey question corresponding to it so the efficacy of every part of the material could be measured.

Background knowledge was surveyed to gauge the overall skill level of the group attending the event. This allowed the IQP team to properly set up the workshops so that the students got the greatest benefit out of them.

3.6 Curriculum testing

To ensure that the videos and workshops were useful and complete, the material was tested on twelve people during the beginning of A term allowing for the collection of feedback from participants who began the lesson with little to no prior knowledge of either 3D printing or CAD. There was a control group of participants at the event who will not attend the workshops to enable the group to measure their effectiveness. To ensure ethical conduct, the group worked with the IRB to verify that the surveys would not put any of the participants at risk and that their personal information would be kept confidential.

3.7 Sponsorship

In order to run this event, financial support was required. In addition to WPI providing an event venue and access to 3D printing resources, this event needed to either charge a door fee or find someone to help subsidize the cost of the electronics for the robots. The cost of each of these robots was around $100 (see Appendix C), which was partially split amongst team members. The Prototyping Lab space does not open overnight and prints were needed to run overnight to create the robot parts for teams. Jim Mclaughlin, the building manager of the Foisie Innovation Studio, helped us sponsor the paid overtime hours of the Prototyping Lab to keep it open overnight.

The WPI Combat Robotics Club allowed the use of one of their arenas and provided the electronics for all of the robots. The electronics and arena totaled $2,000, however, this cost is no longer required for future events. The IQP team charged a door fee of $10 to help cover the cost of 3D printer filament, robot parts, and make participants feel more committed to attending the event.

3.8 Event planning

The Foisie Innovation Studio was not set up until about two weeks into A term. This meant that it was poorly stocked on tools and 3D printer filament. In order to get the event set up, the IQP team had to get a classroom and the robotics lab reserved, have a special 3DPrinterOS account set up, and arrange building staffing for the off hours of the night.

3.8.1 Room reservation

It was decided that the robotics lab would be the ideal location to hold workshops and allow participants to design because of the easily accessible desktop computers with SolidWorks installed. The IQP team decided FI 105 would be ideal to set up as the workspace and competition area since it was directly next to the robotics lab. In order to reserve these rooms, William and Cathy Battelle had to be emailed with permission from Jim Mclaughlin.

3.8.2 3DPrinterOS account and building staff

Because of how the Foisie Innovation Studio was set up, a special 3DPrinterOS account needed to be created with a preloaded balance. To do this, a meeting had to be set up with Erica Stultz. In this meeting, it was determined that the Foisie Innovation Studio would not be able to sponsor filament, but they would pay for the staff responsible for staying during the off hours. The provided 3DPrinterOS account only had basic user authority which meant none of the speeds or temperatures could be adjusted. The account had a balance of $300 dollars which was obtained from an estimate of 300g of filament per robot at $.05/g, with some extra for spare parts.

3.9 The event

The event took place on the weekend of September 14th, 2018. It was a weekend-long Hackathon where 45 WPI students, in teams of three, watched some of the video curricula and participated in five hours of workshops led by members of this IQP team. These workshops covered CAD and 3D printing along with the strategy and design basics needed for making a combat robot. The participants understanding of the material was measured through the survey and knowledge quiz that participants took at the start and end of the event. They used this knowledge to design a one-pound plastic combat robot to compete in a final competition.

3.9.1 Robot design time

The IQP team intended the workshops to teach participants the basics of CAD in a classroom setting while using the design time to take a more tutor like approach. They served as mentors to the groups, providing help as necessary to ensure that all participants left the event with an increased understanding of the material covered as well as some hands-on experience of each process that they had learned.

3.9.2 Robot assembly time

The materials and space used for the assembly included the Foisie Innovation Studio makerspace and robotics laboratory. The Foisie prototyping lab printers were used throughout the event. There were 16 Ultimaker and 6 TAZ 3D printers used in producing parts for the robots. These printers were all connected through 3DPrinterOS, allowing for a print queue. The Foisie makerspace provided tools for assembling the robots. The robots were created from motors and electronics provided by the WPI combat robotics club.

4 Findings

The implementation of the two major deliverables in this IQP took place over the end of term E2 and beginning of term A. To restate, these two deliverables were multiple videos to teach the basics of 3D printing and SolidWorks along with a repeatable hackathon style combat robotics event. In this section, the results of pre and post-event surveys and in-person evaluations of how the event ran are combined to evaluate the events ability to reach the primary goals of the IQP.

The event ran well with nearly every team completing robots on time and others joining in throughout the duration of the competition. On the day of the competition, there was a full room of viewers surrounding the arena and over 100 unique viewers watching the event online. The primary goal of the event was to introduce people to 3D Printing using SolidWorks with the aim of creating a one-pound combat robot while providing an experience that could interest freshmen in Robotics Engineering. The IQP team believes that a majority of these goals were met; however, participants primarily learned how to design for 3D printing rather than how to operate all of the 3D printers. Although this was a deviation from one of the original goals of the IQP, it is more important that potential robotics engineering students understand how to design for additive manufacturing rather than knowing how to operate a specific 3D printer. This shift was the result of Prototyping Lab policies in the Foisie Innovation Studio. By the end of the event, all teams were able to create 3D printed robots with 24 of these participants having little to no experience with 3D printing. This statistic is detailed below in Figure 4.1.2. Finally, 100% of surveyed participants were willing to participate in a future event. This is important since it shows that those who participated enjoyed the event and would like to see it repeated in the future. The hackathon achieves the goal of creating a repeatable event that participants can both learn from and enjoy.

4.1 Pre-Event Survey

The pre-event survey served to evaluate the incoming skill level of participants in the fields of 3D Printing and SolidWorks. This survey included questions on SolidWorks and 3D Printing prior knowledge and experience. Figure 4.1.1 shows the survey results that were used to determine the experience levels of the participants. Figure 4.1.2 displays the class distribution of the participants, while Figure 4.1.4 displays the distributions of the students’ majors.

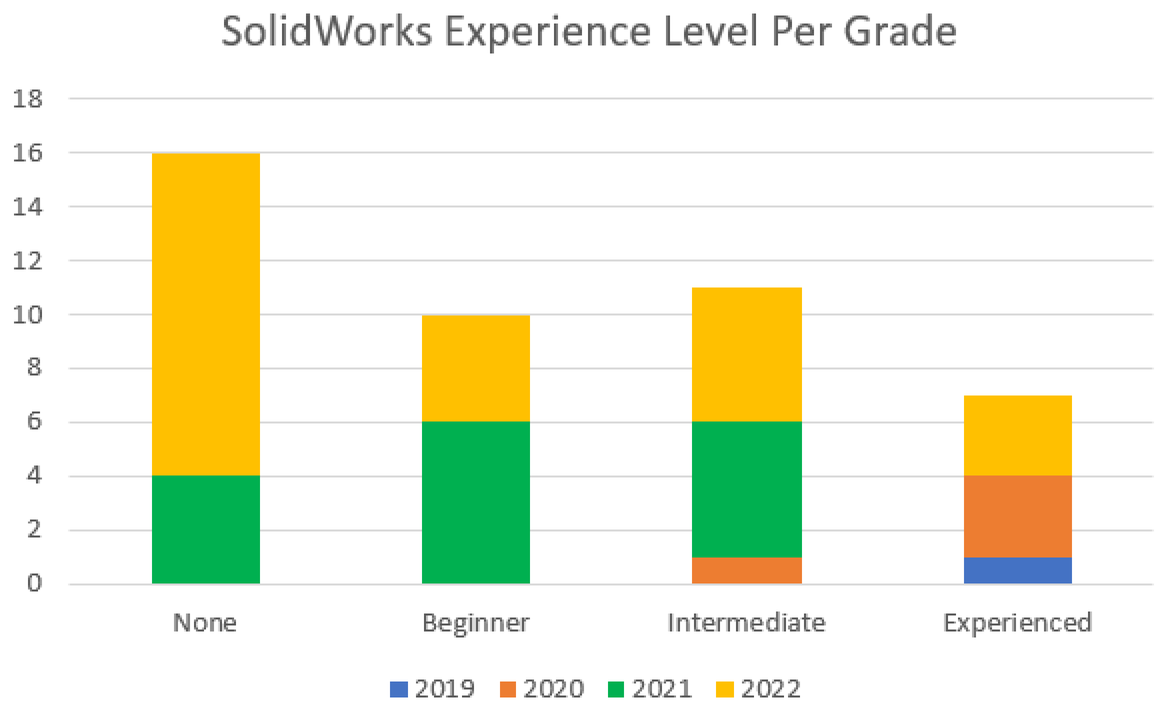

Figure 4.1.1: SolidWorks Experience of Participants

None or no experience was defined as never having used a CAD software. Beginners can make basic parts in a CAD software. Intermediate level participants were either CSWA certified or had made advanced parts and assemblies. Experienced participants were at least CSWP certified or were a CAD lead on a project.

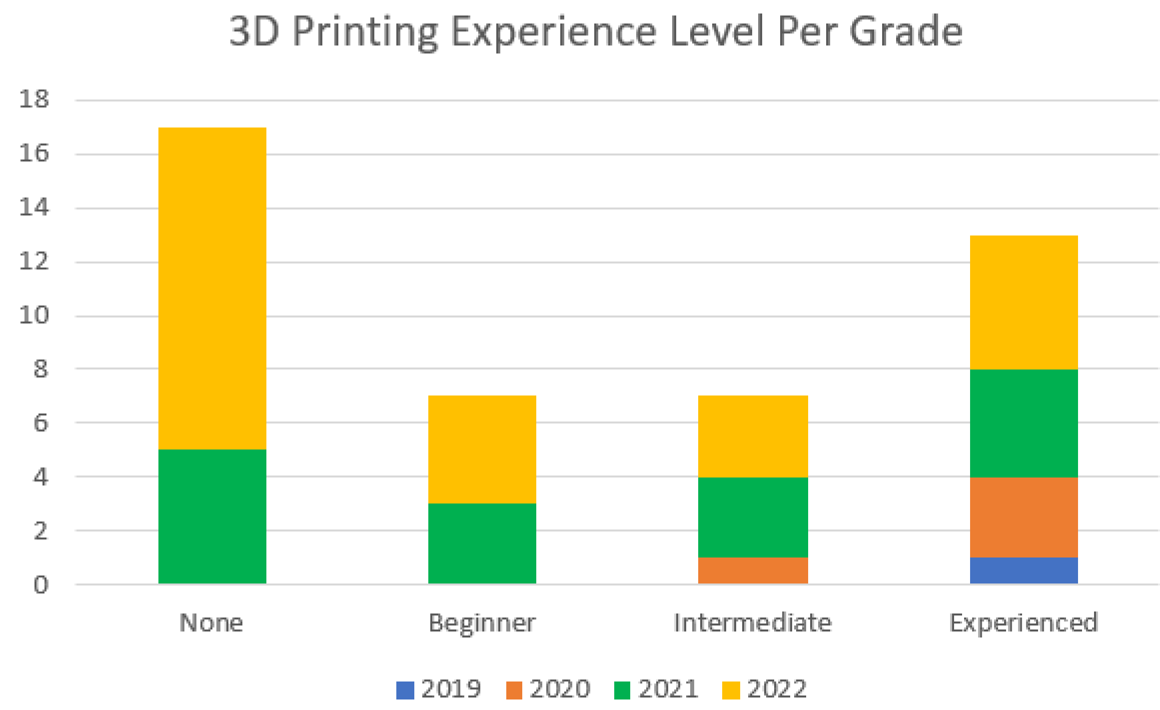

Figure 4.1.2: 3D Printing Experience of Participants

None or no experience was defined as not having operated a 3D printer or created parts for 3D printing. Beginners have used or sent parts to be 3D printed. Intermediate level participants had operated a 3d printer or have sent a small number of 3d prints out to be created. Experienced participants personally owned 3D printers or have heavily operated 3D printers for school or personal projects.

Understanding the 3D printing experience of the incoming participants was important to adjust the workshops to the knowledge of the participants. Since these results show that seventeen of the participants had no experience and a total of 24 participants had little to no experience the decision was made to cover the basics of design for 3D printing and part strength. The team made the decision that the presence of experienced team members mixed with inexperienced team members would improve the overall performance of the teams. An interesting correlation that appeared in the data was that almost all of the participants with little to no experience were freshmen. This could suggest that as students' progress through their academic careers at WPI they are more likely to use or become involved with 3D printing. The figures show that more students rated intermediate or experienced with 3D printing than with SolidWorks.

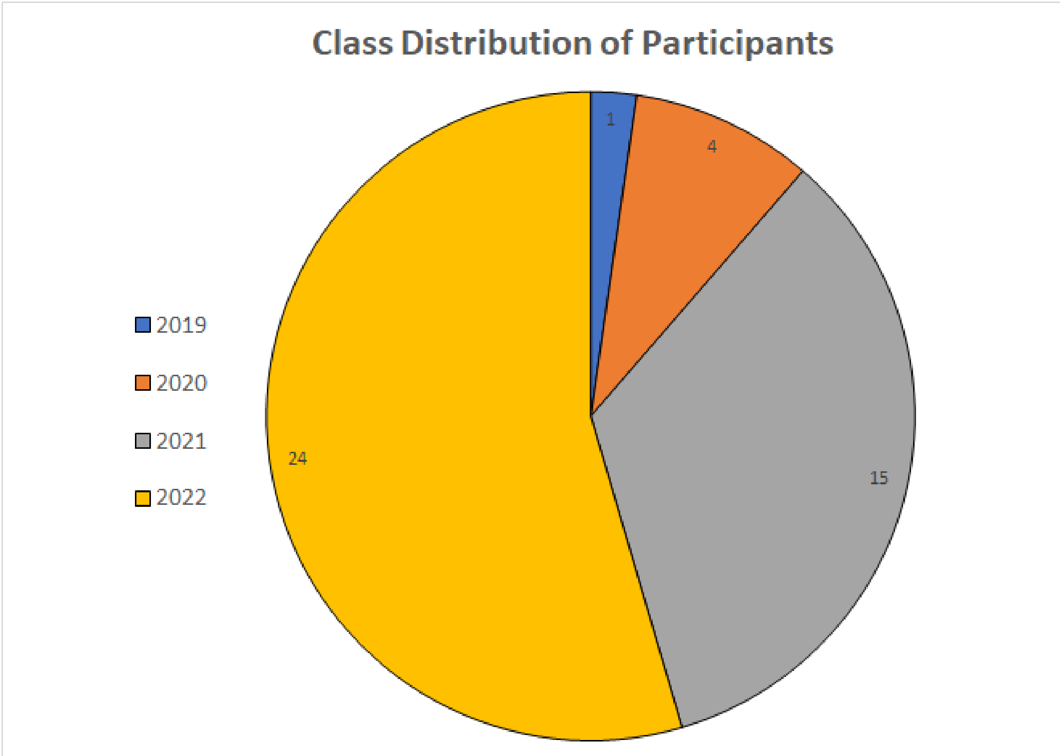

Figure 4.1.3: Class Distribution of Participants

A goal of the IQP was to build up the introductory skills of freshmen while generating an interest in robotics engineering. The distribution of classes suggests that this goal could be met since greater than 50% of participants were freshmen. The next largest grouping of students is sophomores, who are just beginning to enter their major-related coursework. Due to the fact that the event took place early during A term, it still had the ability to pique an interest in robotics engineering while providing an additional learning experience to upperclassmen.

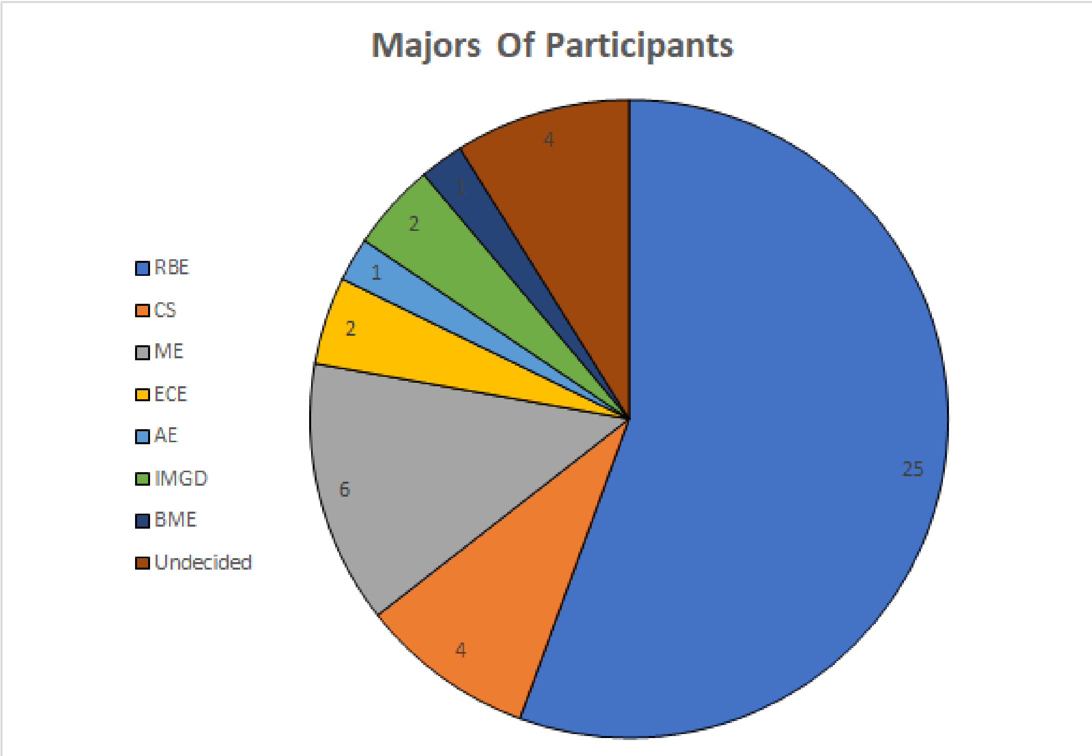

Figure 4.1.4: Major Distribution of Participants

An important goal of any IQP is to affect the largest and most diverse group of people. Although greater than 50% of participants were robotics engineering majors, it was important to see a mix of majors.

4.2 Post Event Surveys

After the event, the team sent out a follow-up survey to find out how the event went from the participants' point of view. Just under two-thirds of the participants responded to the survey, twenty-seven out of forty-five. All of the people who responded said they would participate in this event, or a similar one, in the future.

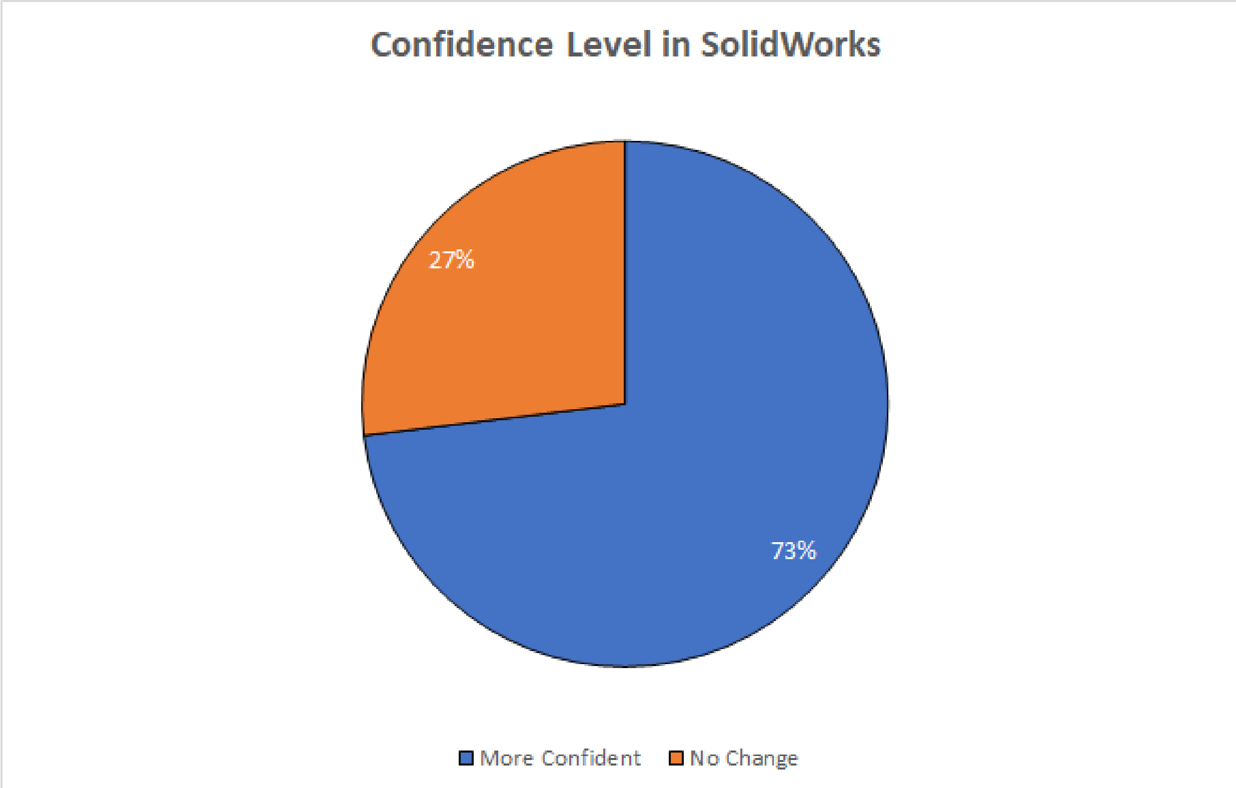

Figure 4.2.1: Confidence Level in SolidWorks After the Event

The IQP team was pleased with the result that 73% of participants claimed to have an improved understanding of SolidWorks after the event. This was great since Figure 4.1.2 shows that 37% of participants had an intermediate or professional level of experience with SolidWorks. This means that the participants with little to no experience were able to improve their SolidWorks knowledge and confidence level throughout the weekend. A large number of people who felt that they improved shows that more than just the beginners were able to improve. This result was expected since the workshops and one-on-one meetings throughout the event were targeted at improving the skills of beginners.

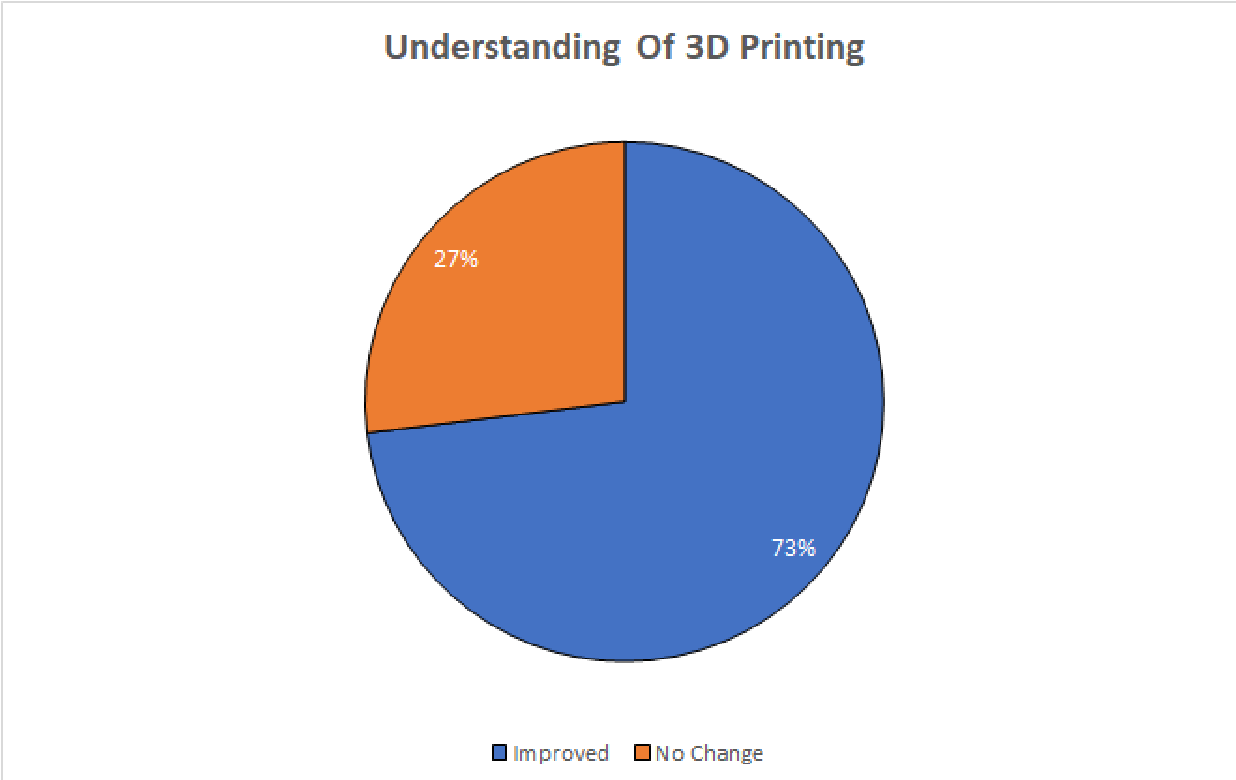

Figure 4.2.2: Understanding of 3D Printing After the Event

The IQP team is pleased with the result that 73% of participants claimed to have an improved understanding of 3D Printing after the event. This is great since Figure 4.1.1 shows that 28% of participants were experienced with 3D printing. This correlation shows that participants who did not have extensive prior knowledge with 3D printing felt that their 3D printing skills were improved. The weekend event is targeted toward lower skilled groups due to the fact that it is far easier to gain a basic skill than it is to learn advanced techniques.

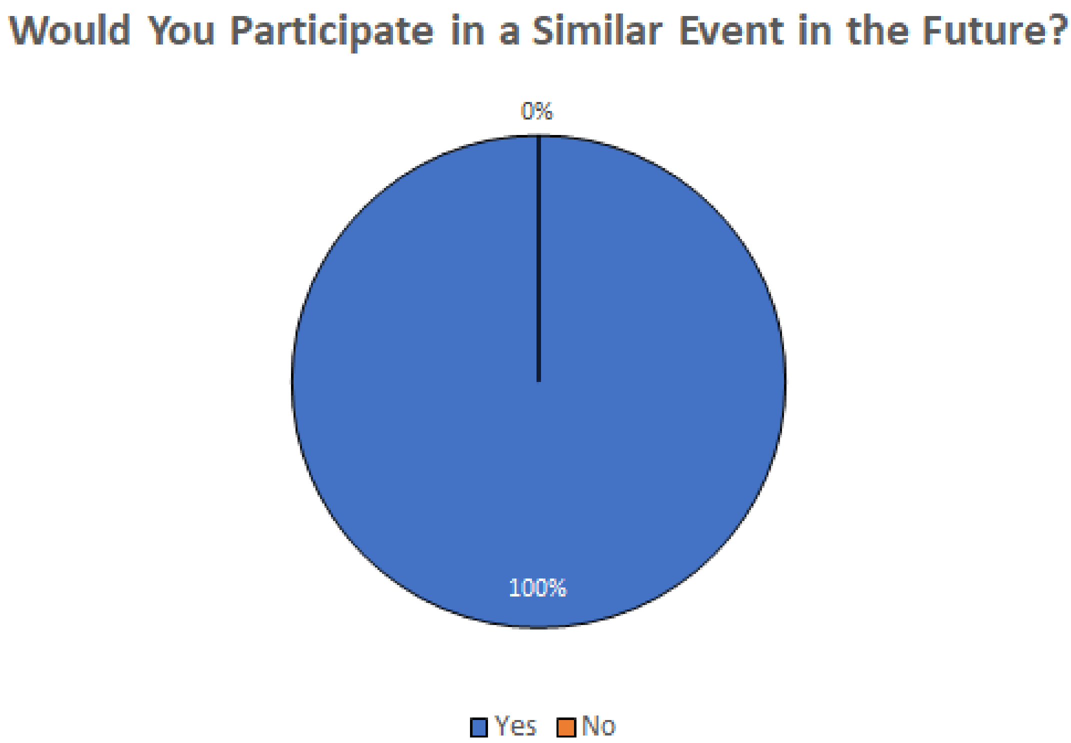

Figure 4.2.3: Willingness of students to participate in a similar event

The results to this question show that the students who participated in this event enjoyed the experience and are willing to participate in a similar event in the future. Looking forward, it would be good to be able to run this event again to allow students to improve their SolidWorks and 3D printing knowledge, while using their existing knowledge to help build the foundations for new participants.

Figure 4.2.4: Event pictures

Students could work in both FI103 and the Foisie Makerspace. They had access to basic hand tools, as well as computers with SolidWorks. A selection of participant robots is pictured above. There were a variety of bots including; shell spinners, drum spinners, horizontal spinners, undercutters, and a ram bot. These were all designed during the hackathon and printed on the Foisie printers. The event was held in FI105 and around 50 students attended aside from the 45 participants involved in the event. The competition was also live streamed and had over 100 viewers online.

4.3 Successes

The event was a "HUGE" (see Appendix: H) success as many students were able to come out of the weekend with newfound experiences. There were entire teams comprised of freshmen who had never opened SolidWorks before, but by the end of the weekend they were able to design multi-part robots. They learned to create parts with sketches on multiple planes and take those parts and form an assembly. Although there were issues along the way, it was clear that the IQP members sitting down with students was significantly more effective than the classes. The classes were good for showing basic button placements within the software, but it is not possible to cover everything in a single sitting. The IQP team found that allowing groups to explore on their own was a much more valuable learning experience. This way, the IQP members could answer specific questions about the task the participants were working on. Although this put extra stress on the IQP team, it allowed groups to learn at their own pace and ultimately make progress on their designs.

The event was unable to provide full control of the 3D printers in the Foisie Prototyping Lab to participants as the team had initially planned. A shared system was used instead and worked well. Groups could submit their parts to a Google Drive folder, where the IQP team could access and view parts before sending them to the Foisie Printers. This system allowed the team to give feedback on parts and explain things such as print orientation and overly complex geometry to the groups. For example, overhang geometry and excessively thin features cannot print. This method also streamlined the payment process with Foisie, as all the prints could be charged to a single account.

4.4 Failures

As shown in Appendix D, the Foisie Innovation Studio spaces were lacking key equipment required for assembling robots. The Ultimakers in the Prototyping Lab had a very high fail rate, almost one-third of the prints had to be aborted, and many of the prints that finished were warped or otherwise deformed. This posed a unique challenge to the IQP team and the participants. Students had to redesign their parts to take less time to print so that they could finish their robots on time. This was accomplished through the use of one-on-one sessions with the teams. Although many of these robots were finished it was not ideal for the teams to have to redesign to compensate for the faults in the Foisie makerspace.

Another key thing that the team learned as a result of running the workshops is that they were less effective in communicating skills than a one-on-one session. Throughout the course of the event, the IQP team split up to ensure that the 3D printing and modeling questions were addressed. It became clear the two-hour long workshops were ineffective at imparting the knowledge they were intended to.

There was also a constant necessity for the IQP team to be present in the Foisie Makerspace, as the majority of the participants did not have experience using the tools available. This meant that the team was stretched thin between SolidWorks, 3D printing, and Makerspace questions. Even teams that claimed to have experience would oftentimes cause more damage as they did not truly know how to use the tools.

The IQP team also struggled with properly providing electronics to the participants. Due to various reasons, the team was unable to provide spares of every component, and during the event, there were far more electronics failures than expected. Overall, around $2000 was spent on parts, however, this only resulted in spares for certain components, and exact amounts for others. One team attempted to solder their own electronics, which resulted in the loss of a motor controller, so the IQP team decided to take care of all the soldering. Throughout the weekend, electronics were being broken before the actual competition even began. There were multiple cases of participants plugging in batteries backward, which fortunately did not result in any fires. There was also a surprising amount of motors lost during the event. Many participants superglued their gearboxes so that they could no longer move, while other teams used long bolts and broke the coils inside the brushless motors. Further instruction is needed to explain how motors work and what to avoid doing.

4.5 Unexpected

While we had built the template robots no team ended up using them. Every single team designed their robot entirely from scratch. Despite this being unexpected, it was great to see that every team was willing to take on the challenge of designing and building their own robot.

5 Conclusions and Recommendations

The first task for the IQP team was to create a playlist of videos to introduce students to SolidWorks and the basics behind additive manufacturing. In total, the team developed twenty videos, fourteen of which were about SolidWorks, and six were about 3D Printing. To gauge the success of the videos, the team gave participants a pre-event survey and post-event survey. From these surveys, 73% of participants found that they were more comfortable using SolidWorks after watching the videos and attending the classes during the event. Furthermore, the remaining 27% could have been the participants who entered the event as intermediate or advanced SolidWorks users, as initially, 37% of the participants claimed to have that experience level. Similarly, 73% of participants claimed to feel more confident with 3D Printing following the event. Before the event, there were 28% of students who were comfortable with 3D Printing, so an improvement from 73% of students is great. From these surveys, the IQP team clearly succeeded in providing new information to the participants.

The event itself was also a success, as 100% of participants said that they would want to be a part of the event again in the future. This means that the organization of the event and the parts and resources provided were all sufficient, although the team ran across some issues behind the scenes. Not only was the building time beneficial for the participants, but the team was also able to run a successful competition at the end. A total of 15 robots competed on the third day of the event in a modified Swiss bracket-style tournament.

Overall, the IQP team was able to reach all the initial goals of the IQP and have set in place the stepping stones for running a similar event in the future. Many of the problems the team experienced during the event should cease to exist following updates to the Foisie Makerspace. In addition, the remaining parts from the robots and event arena can be reused. However, many parts were broken during the event, and need to be replaced before being run again. Before the event begins, there should be at least 1.5 times the number of parts necessary for all the competitors to avoid running out of any parts during the event.

There does not need to be many changes to the class curriculum, as it was only meant to introduce participants to the most basic functions of SolidWorks. However, further improvement to the organization and control of 3D Printers would greatly improve the printing experience for the students. For the IQP event, all prints were set up and run by the IQP team, however, in the future, the system should allow participants to set up their own prints. This would allow them to gain more experience about the printing process and help them with using Foisie printers later. Otherwise, the event went very smoothly, and could easily be run again in the future.

Appendix A: Video Tutorial Research

Table A.1: Existing Fusion 360 Video Tutorials

Title	Link	Duration	Topic	Content Description and Notes
Designing and 3D Printing an Enclosure for Arduino Uno	Link	18:14	Sketching, Creating Components, Multipart Assembly	Medium length, Outdated version for Fusion 360, good narration covers a wide range of essential skills, give you enough information to use those skill and then figure out the details
Fusion 360: Modeling a Dining Room Table! FF47	Link	6:35	Sketching, Components	Short length, Keystrokes are displayed on the screen and the audio is clear. Great tutorial for beginners
Fusion 360 Joints & Motion Link Tutorial: Micrometer Screw! FF77	Link	7:38	Assembling, Motion Links	Short length, Clear audio, a good description of features
Fusion Friday #1: Frying Pan!	Link	10:01	Sketching, Modeling	Short length, Clear audio, keystrokes displayed on the screen, good basics tutorial for beginners
Fusion 360: Modeling Outside the Box	Link	6:20	Sketching Modeling	Short Length, Clear audio, displays how you can use many different techniques to create the same part
Designing a Laser Cut Laptop Stand with Fusion 360	Link	20:24	Sketching, Modeling, Assembling, Inspection	Medium Length, Clear Audio, would be perfect for RBE 1001 students who want to design for laser cutting

Table A.2: Existing SolidWorks Video Tutorials

Title	Link	Duration	Topic	Content Description and notes
E1 SolidWorks 2016 - Basic Modeling 1 Tutorial	Link	112:39	Basic Modeling	Long video, excellent content. over explains non essential details
1. The Basics of SolidWorks 2017	Link	27:47	Software Basics	Covers the SolidWorks interface and navigation tools.
SolidWorks Tutorials/ Learning SolidWorks for beginners Part (1/3) / SolidWorks	Link	14:27	Sketching/basic extrude	A shorter video, skills are hard to pick out due to the poor production quality (lack of script, pauses) outdated SolidWorks version
SolidWorks Tutorial For Beginners Part Modeling - 01	Link	11:38	Sketching/basic extrude	A shorter video, good content and covers a broad range of essential skills, however no voice narration.
SolidWorks Tutorial 1 Creating Sketches	Link	127:01	Basic sketching	Long video, covers all aspects of sketching, wastes time detailing mouse movements that are intuitive
SolidWorks tutorial beginner - Absolute beginner 1 Step-by-step	Link	13:10	Basic sketching and part modification	A short video, an old version of SolidWorks and long pauses between sentences.

Appendix B: IQP Video Resources

Table B.1: IQP Created SolidWorks Video Tutorials

Title	Link	Duration	Topic
Swiss Cube SolidWorks Tutorial	Link	9:44	Basic Sketching, Extrusion, Cuts, Patterning, Mirroring
SolidWorks How To Create a D shaft Hub	Link	4:51	Basic Sketching, Extrusion, Cuts, Patterning, Mirroring
SolidWorks Basic Shapes	Link	3:40	Basic shapes used in sketching
SolidWorks Relations	Link	3:15	Relations and how to use them to improve sketching
SolidWorks Patterning	Link	4:08	How to use Linear, Circular pattern and mirroring
SolidWorks Smart Dimension Tool	Link	2:19	Basic use and operation of the Smart Dimension Tool
SolidWorks Installation Video	Link	4:27	How to install SolidWorks through WPI
SolidWorks Fillets and Chamfers Basics	Link	2:23	How to use Fillets and Chamfers
SolidWorks Navigational Shortcuts and Units	Link	2:10	This video shows basic navigational techniques for SolidWorks 2017
SolidWorks Revolve Tool	Link	3:11	How to use the revolve tool to create basic parts.
Creating Wheel Guards	Link	6:49	How to create basic wheel guards for drum spinner robots in SolidWorks
SolidWorks Extruded Cut and Boss	Link	5:19	How to create an extruded boss and cut features
SolidWorks Assembly Basics	Link	14:38	How to use mates and assemble a basic drum spinner
Creating An STL File	Link	1:26	How to export an STL from SolidWorks

Table B.2: IQP Created 3D-Printing Video Tutorials

Title	Link	Duration	Topic
What is Slicing?	Link	1:41	A video explaining what slicing is and how it is a part of 3D printing.
Basics of FDM 3D Printers	Link	2:14	An introduction to Fused Deposition Modeling and the technologies involved in this form of 3D printing.
Orienting A 3D Print	Link	1:59	An explanation of why the orientation of a 3D print affects the strength of the part.
Supports, Bridges, and Overhangs	Link	2:19	An explanation of Supports, Bridges, and overhangs and how they affect 3D Print quality.
Cura Lulzbot Edition Basics	Link	6:50	How to import and set up a part for 3D printing in Cura Lulzbot edition
3D Printing in Foisie	Link	4:40	An explanation of the steps to create an account and send a print to the Foisie print lab.

Appendix C: Plastic Ant Robot Cost

The total cost to build one of the combat robots that will be used in the event is $91.38.

Table C.1: Plastic Ant Robot Cost

Name	Description	Vendor	Part Number	Link	Cost	Quantity	Total
Weapon Motor	NTM Prop Drive Series V2 28-26 1100kv	HobbyKing	9192000315-0	link	$4.99	1	$4.99
Weapon ESC	HobbyKing 30A ESC 3A UBEC	HobbyKing	F-30A	link	$4.99	1	$4.99
Battery	ZIPPY Compact 350mAh 3S 25C Lipo Pack	HobbyKing	9067000361-0	link	$6.18	1	$6.18
Transmitter	Turnigy T6A-V2 AFHDS 2.4GHz 6Ch Transmitter	HobbyKing	9114000074-0	link	$30.49	1	$30.49
Drive Motor	12V DC 800RPM Mini Torque Gear Box Motor	eBay	NA	link	$9.25	2	$18.50
Drive ESC	Motor Controller 29	VexPro	276-2193	link	$9.99	2	$19.98
Wheels	Dave Brown Products Lite Flite Wheels, 2-1/2"	Amazon	NA	link	$6.25	1	$6.25
						Total Cost:	$91.38

Appendix D: Knowledge Quiz

- All construction geometry affects the geometry of the part. (T/F)
- By default, a sketch that is blue is fully defined. (T/F)
- What type of mate would you use to center a part between two other parts in an assembly? (Width, Concentric, Profile Center, or Angle)
- What does a coincident mate do? (Align two axes, Make two faces or edges perpendicular, Make two faces or edges coplanar, or Set a distance between two faces)
- What is the difference between a dimension and a relation? (short answer)
- A .stl file is what a 3D printer reads when printing. (T/F)
- A 3D printer uses simultaneous 3D movement. (T/F)
- Which of the following are common 3D printer filaments? (PLA, ABS, PETG, Aluminum, TPU, PTFE, UHMW, and/or HDPE)
- All materials should be printed at the same speed. (T/F)
- A higher percentage of infill will always create a stronger part. (T/F)
- Print strength is the same regardless of orientation. (T/F)
- When saving a .stl file the precision is not important. (T/F)

Appendix E: Robot Fighting Safety Guidelines

Master kill switch:

All bots must have a manually operated master kill switch or removable link. This switch or link will shut off the main weapon and drive power. Simply turning off the receiver is not sufficient. A remotely operated relay or contactor to break main power does NOT fulfill the killswitch requirement. The switch or link must be quickly and easily accessible. Having to remove armor panels etc. to access the switch is not acceptable. A single switch or removable link is preferred, but two switches/links will be allowed if they are easily accessible.

Power Source:

Batteries must be sealed, enclosed, immobilized-electrolyte types (such as gel cells, lithium, NiCads, NiMH, or dry cells).

Safety/Inspection:

All entries will be required to pass a safety inspection before competing. All operating principles must be clearly explained and demonstrated during this inspection. All robots must be on some type of 'stand' to keep drive wheels off the ground while in the pit area. The judges reserve the right to disqualify, at any time, any robot that poses a threat to anything other than the arena surface or its opponent(s). If you have a questionable design, please contact event volunteers constructing your robot. Weapons must have a safety cover on any sharp edges. Weapons that could harm a person outside the arena must have some kind of mechanical locking device in case of accidental activation. There will be absolutely NO weapon testing of robots outside the enclosed arena. Robot weapon testing MUST be carried out under the supervision event officials with the appropriate frequency clip.

Banned weapons include:

- Liquid projectiles
- Any kind of flammable liquid.
- Flame-based weapons.
- Any kind of explosive or intentionally ignited solid.
- Nets, tape, glue, or any other entanglement device.
- Radio jamming, tazers, tesla coils, or any other high-voltage device.
- Un-tethered projectiles.
- Tethered projectiles are allowed with a maximum tether length of 4 feet.

Any robot, which comes into contact with the floor outside the arena, will be declared defeated.

At the start of a combat round, all electric motors must be stopped. Any exposed rotating devices must be stationary.

During combat, no part of the operator's body or their remote antenna or any other device may penetrate the arena surfaces during combat. Interfering with a combat underway will be grounds for immediate disqualification.

After a match is over, any dropped or thrown objects must be cleaned up, by the operator responsible, to the best of their ability.

A competitor will be declared immobile if it cannot display linear motion of at least one inch in a time period of 30 seconds. A bot with one side of its drivetrain disabled will not be counted out if it can demonstrate some degree of controlled movement. A bot that is completely motionless will be KO'd after a 10-second count.

If a part of another robot becomes entangled in its opponent and cannot be freed within 15 seconds, the match will be paused until a NERC official removes the entangled piece

A bot may not lift, hold, or pin its opponent for more than 15 sec.

Combat:

- Two robots shall be placed in opposite corners of the arena.
- The objective of each will be to disable its opponent by any means within the rules.
- If both bots are still mobile, when the match time is up, the judges will call the winner based on aggression, damage, and strategy.
- Competition style may vary

Don’t be dumb!
Guidelines modified from nerc.us

Appendix F: Surveys

Pre-Event Survey Questions

- Name
- Class (i.e. Class of 2021)
- Quickly describe your prior CAD experience (short response)
- Quickly describe your prior 3D printing experience (short response)
- If you have a team already, please list their first and last names separated by commas. (Groups of three and you will be paired with the listed people only if they also list you)

Post Event Survey

- How much did you enjoy the event? (1-5, where 1 is "Had a great time")
- How helpful were the workshops? (1-5, where 1 is "very helpful")
- Do you feel more confident with SolidWorks after this weekend? (yes/no)
- Do you feel that you have an improved understanding of 3D printing? (yes/no)
- What is one thing you learned this weekend? (short response)
- Would you participate in this event, or a similar one in the future? (yes/no)
- What would you want us to change about the event if we were to run it again? (short response)
- What would you change about the Foisie Makerspace to help students utilize it better in the future? (short response)
- What would you change about the Prototyping Lab to help students utilize it in the future? (short response)
- Do you have any other feedback for us? (short response)

Appendix G: Mass D Interview

Context:

MassDestruction is a Massachusetts based combat robotics competition that has 1lb antweights, 1lb plastic antweights, 3lb beetleweights, and 12lb sportsman hobbyweights. The competition is usually held in the greater Boston area and has been hosted by WPI once in the past. The Combat Robotics Club goes to these events 4-5 times a year.

Who's the first person you contact when planning an event? Competitors, Co-organizers, Venue, Sponsors?

The first person we reach out to is usually the venue to help dial in what dates are available to run our event. I guess when I say "we", I mean I'm already in contact with the co-organizers; there's a lot to do and it's easier to delegate some of it out.

What is the easiest way to gauge interest? What do you do if interest is low? Conversely, what do you do if interest is far higher than expected and surpasses the limitations of the venue?

Asking competitors at similar events if they would have an interest in an event the way I'm planning on doing it. If the interest is low, I'd probably try to see if there was a way to have more community/audience involvement to fill the space. If it surpasses the limitations of the venue, this is part of why pre-signups and Eventbrite are good things.

How are the door fees calculated?

Door fees are usually calculated around similar events and what they charge, as well as a price point that makes it less likely for competitors to bail last minute. If you have a fair amount of money invested in a thing, you're less likely to no-show.

What is a general overview of the things that need to be completed before the event is made public?

1. Secure venue
2. Make sure arena can be transported to/from the venue with the help
3. Setup Facebook and Eventbrite event pages then go live.

Have you ever done workshops/instruction at your events? If so how was it structured and how successful was it? How much interest was there for the instruction compared to the event?

We sort of did this with the Plas-Destruction event we ran at MIT last year. Fred made himself available all week at MITERS for any newbies to come in and learn how to build a robot to fight. Less structured helps with the variety of skill sets that are present, but that's only if you have folks around to help support those with questions (like the various folks that spend time at MITERS and know how to make a robot). This event had a fair amount of new people come in to make a robot, but I don't think a similar event with a fee attached (MIT had covered the cost of components) would gain public interest.

Appendix H: We're kind of a big deal

Figure H.1: HUGE at WPI

Figure H.2 HUGE shirt

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