

Tiger Bytes Robotics Competition

Preliminary Design Report Draft – Spring 2023



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Electrical and Computer Engineering
Auburn University

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Executive Summary

The goal of this project is to plan and execute a robotics competition for the Auburn Electrical and Computer Engineering Department. This competition will be something that can consistently be held at Auburn University. It will allow members of the department, college students, high school students, and middle school students to participate in it. We will be incorporating aspects of coding and physical robotic builds for the students to complete in a series of events. As a team, we will be providing the guidelines to the competition through extensive research, building equipment such as score counters and competition platforms, and marketing the competition to local schools through different media sources. The goal of the competition is to allow students with all types of resources to be able to participate. This will not have one particular base to build upon, but events that could be completed using any type of software or hardware. This will be an all-inclusive robotics competition for the students of Alabama.

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Technical Approach

When planning and designing aspects of the Tiger Bytes competition, we have had to adjust frequently as we've gone along. We have broken our schedule into four categories: networking, building, logistics, and marketing. Networking consists of making contacts within the robotics community. We're reaching out to schools and attending other events for inspiration. This will set us up to have a collective list of those interested in participating in the competition along with those aiding us in the planning process. The building category will not be very prevalent until our second semester of work. However, we have begun designing the arenas for each competition. Logistics consists of all the behind-the-scenes work that needs to be completed to have this competition become a reality. This includes booking a space, completing any training, researching regulations, and creating an itinerary. Lastly, marketing will be important to get students and teachers interested in the competition. This includes all social media, flyers, or our website. Our Work Breakdown Structure can be viewed in Figure 1.

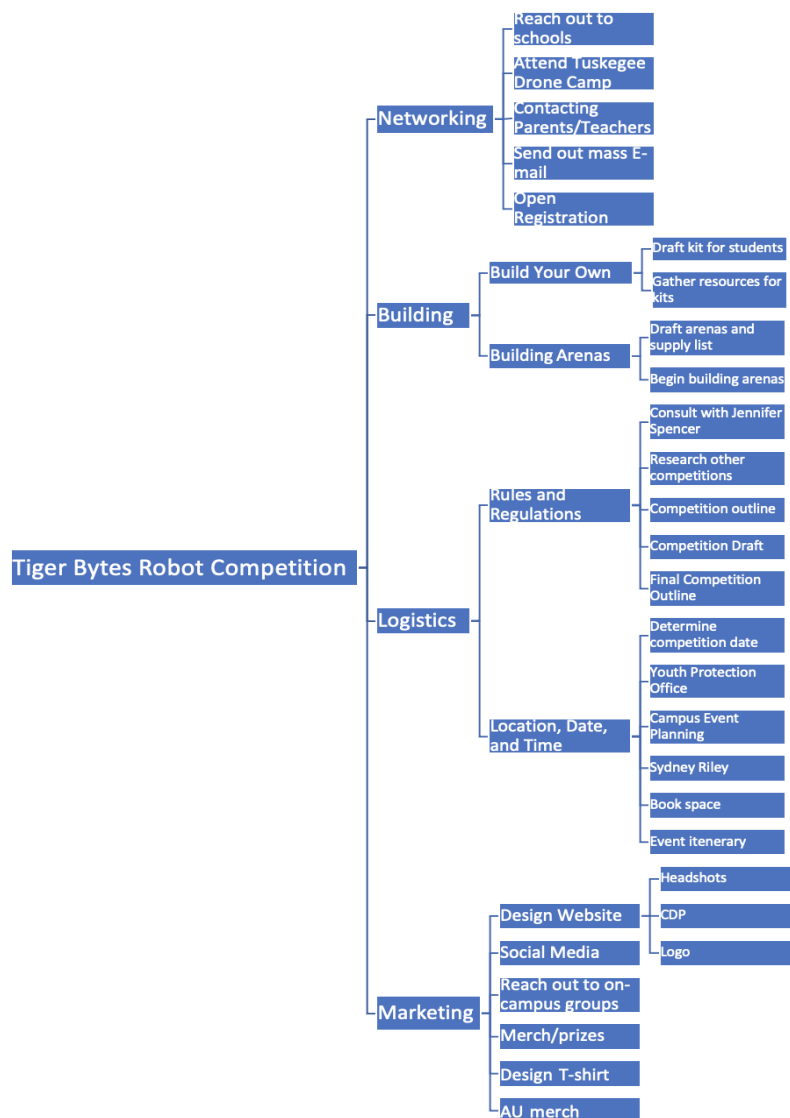


FIGURE 1: WBS

Without Subject Matter Experts (SME's), we would not have been able to attempt this project. Our first SME is Thaddeus Roppel [1] is an Associate Professor in the Electrical and Computer Engineering Department at Auburn University. Dr. Roppel participates in multiple robotics outreach events in the area and is the sponsor for the Student Projects and Robotics Club (SPARC). Dr. Roppel has been a great guide to all things concerning Tiger Bytes. He has regularly checked in with us about our progress and given advice on any small obstacles we have faced. He has been a great resource on who to contact within Auburn University that would help us accomplish our goals. Dr. Roppel pointed us to meet with Jennifer Spencer [2]. She is the Assistant Director of the Southeastern Center of Robotics Education (SCORE). Jennifer has given us an outline for what a robotics competition looks like. She was able to get our information out to schools in the area and contacts to talk to in the planning process. She gave us the information that allowed us to create our outline for running this competition. SCORE also has hardware for us to experiment with when it comes to planning our individual competitions. Lastly, Jeff Gray [3], from the University of Alabama has been a great resource for us. He leads the Alabama Robotics Competition in early April at UA. The intentions we had for our project lined up closely with what Dr. Gray has already accomplished at UA. Jennifer and Dr. Gray both showed us how we can incorporate coding into these competitions, not just physical builds. We plan to meet directly with Dr. Gray in the coming weeks.

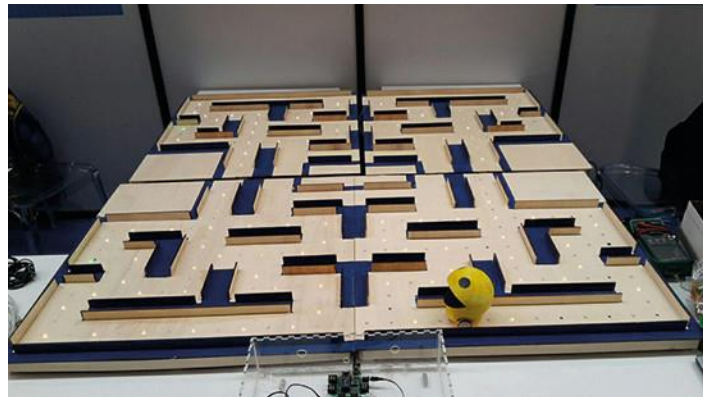


FIGURE 2: EXAMPLE OF PACMAN COMPETITION

When we began designing this competition, we started from scratch with no understanding of what a robotics competition is supposed to look like. We originally wanted the students to strictly build their robots to compete in the competitions and would use the sumo robots [6] for another competition. We did conduct research on the sumo robots but found that they would not be a good fit. You can see in Figure 3 the Pugh chart for that.

TutorialsForExcel.com Excel Courses and Templates	Baseline	Budget	Participant Engagement	Building Materials	Space Needed	Scalable Difficulty	Totals	Rank
Sumo Competition	▲ 0 ▼	▼ -1	▼ -1	▲ 1	▼ -1	▼ -1	-3	2
Obstacle Competition	○ 0 ○	○ 0	▲ 1	▼ -1	▲ 1	▲ 1	2	1

FIGURE 3: PUGH CHART FOR SUMO ROBOTS

After communicating with our SME’s, we had a much better understanding of what the competition should look like. We redid our schedule and began designing the competitions. We decided to incorporate a hardware and software aspect in each of our competitions. The hardware and software would be flexible to whatever is available to the participants. The participants would only need to make sure their design follows along with our guidelines.



FIGURE 4: STUDENTS WORKING WITH HARDWARE AND SOFTWARE

With that decision made, we began coming up with a theme for the competitions to keep the students engaged. Recently, we landed on an arcade theme. One of those competition ideas is shown in Figure 2. We have used Jeff Gray’s past competitions [4] as a reference for guidelines, rules, and regulations for the events. Below in Figure 5, you can see a Pugh Chart comparing those competition ideas. Once the team begins forming rules and regulations, we hope to log that into a Pugh Chart as well, to find the best information to give to our participants.

Alternatives	Baseline	Budget	Participant Engagement	Building Materials	Space Needed	Scalable Difficulty to Create	Totals	Rank
Pac-Man	▲ 0	▲ 1	▲ 1	▲ 1	○ 0	○ 0	3	3
Pinball	○ 0	▼ -1	▲ 1	▼ -1	○ 0	▼ -1	-2	8
Pool	○ 0	○ 0	○ 0	▲ 1	○ 0	○ 0	1	5
Air Hockey	○ 0	▼ -1	○ 0	▼ -1	○ 0	▼ -1	-3	10
Brick Breaker	○ 0	▲ 1	○ 0	▲ 1	○ 0	○ 0	2	4
Frogger	○ 0	▼ -1	▲ 1	▼ -1	○ 0	▼ -1	-2	8
Asteroids	○ 0	○ 0	○ 0	▲ 1	○ 0	○ 0	1	5
Balloon Fight	○ 0	▲ 1	▲ 1	▲ 1	○ 0	▲ 1	4	1
Tetris	○ 0	○ 0	○ 0	▲ 1	○ 0	○ 0	1	5
Street Fighter	○ 0	○ 0	▲ 1	▲ 1	▲ 1	▲ 1	4	1

FIGURE 5: PUGH CHART FOR COMPETITION IDEAS

We continue to research other competitions to view their goals and the outcomes they wish for the students to have. Some institutions have gone into detail about experimentation between many different ideas for their competitions, which has been very helpful in our planning process. One

institution had planned an all-inclusive competition like our own. We wanted to evaluate the true goal of this project, whether this should be based on winning a competition or based on the knowledge gained from these activities. We’ve created a Pugh Chart analyzing this in Figure 6. This source stated this, “The purpose of the event is mainly to bring robotics forward to the general public and to motivate students to engage rather than introduce new technologies or solve a specific problem” [9]. We want to increase interest in STEM rather than push a specific set of requirements for students to learn. This allows our competition to be less structured, but still beneficial. At Cal Poly State University, they also allow students to receive capstone/senior project credit for their work aiding in the planning of a robotics competition [8]. Every competition held is different and each institution has comments on things they have learned over the years. All these insights have been vital in our planning, consolidating of our goals, and seeing the benefits of robotics competitions to the STEM community.

Alternatives	Baseline	Non-Strict Requirments	Focus on Learning	Inclusive	Participant Engagement	Increased Interest in STEM	Totals	Rank
Structured Events	0	-1	-1	-1	-1	0	-4	2
Non-Structured Events	0	1	1	1	1	1	5	1

FIGURE 6: PUGH CHART ON STRUCTURED VS. NON-STRUCTURED EVENTS

When it comes to fulfilling the ABET requirements, we have shown in Table 1 how the course objectives are demonstrated on this project. We use these objectives to guide us, and we use ABET to help us find realistic constraints in our design. One constraint we’ve found would be accessibility. If we had a student with disabilities, how could we change aspects of our competition so that they would be able to participate fully? If that student were blind or deaf, how could we assist them in participating in the competition? We will need to come up with an alternative way for them to participate. Another constraint we’ve found is cost. The goal of this project is for all students with different resources to be able to participate. We know that once we begin finalizing our budget, we will need to find the financial resources. If we are unable to find sponsors, the sign-up cost for our competition could go up, diminishing accessibility for some students. We hope to have a plan and the proper resources to keep the sign-up cost to a minimum for maximum participation. Our last constraint would be marketability. All STEM events are heavily sponsored and there are many opportunities to participate in robotics events in Alabama. However, we’re afraid Tiger Bytes may not get the attention and participation we hope for. Finding ways to set us apart and be inclusive will be a goal to mitigate this constraint.

TABLE 1: ABET COURSE OBJECTIVES

#	Formal Statement of Course Objective	Demonstration on This Project
1	Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	Identifying the need for this competition, formulating a plan of executing it, and solving all technical and interpersonal problems

2	Apply engineering design to produce solutions that meet specified needs with consideration for public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.	This competition would be affected constantly by real-world constraints. We could even outline solutions to issues that have not happened yet.
3	Communicate effectively with a range of audiences.	We will be appealing to a wide range of audiences: peers, instructors, employers, and younger students.
4	Recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	We will outline the rules of this competition in an ethical way, considering all possibilities.
5	Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Demonstrate effective teaming, delegating to others and using each of our personal interests and skills to achieve the goal.
6	Develop and conduct appropriate experimentation, analyze, and interpret data, and use engineering judgment to draw conclusions	We will plan, test, and analyze robotics that would be included in this competition. Ensuring we have a wide range of understanding.
7	Acquire and apply new knowledge as needed, using appropriate learning strategies	Update the plan for this competition as we reach out to others that have completed something similar and take suggestions from others with open ears.

As a competition that will be involved heavily with the Alabama Public School System, we hope to fulfill the standards the state has set before the teachers. In our planning process, we want to make sure we develop competitions based on topics defined by Alabama Course of Study (ALCOS), which is based on the Next Generation Science Standards (NGSS). With this as a guideline, teachers will be able to take the things experienced at the competition and utilize them in the classroom. As far as the physical competition is concerned, we hope to follow all applicable guidelines outlined in the National Electric Code (NFPA 70). We will ensure the setup of the competition is safe for all participants and volunteers. We know that when planning an event such as Tiger Bytes, safety and accessibility should be a priority. All apparatus and public spaces developed within the scope of this project will consider the human factors analysis presented in the Guidance on the Application of Human Factors to Consumer Products [11]. The main purpose is to minimize the risk of injury to participants.

Management Approach

When making decisions on this project, it is important that it is always a team decision. We utilize a Gantt Chart and a shared OneNote to communicate on upcoming activities. When meeting as a team, all ideas, notes, and tasks are recorded in the OneNote. This allows us to go back to see the progress we've made so that everyone has equal access to information. We meet every Monday during our class time to plan out the week and will usually meet on Wednesdays in Broun Hall to check in on the progress of tasks and for group brainstorming. The OneNote also doubles as our minutes in case a team member is not able to attend a meeting. For more information on our project and to see the ins and outs, please visit the link to our project notebook: [Capstone Team \(Web view\)](#). You can also visit our website at: <https://lkb0038.wixsite.com/tiger-bytes>.

Budget

For our project, we only included the design project expenses. In the Fall 2023 semester, we plan on creating a separate budget for the competition as a separate activity. We plan to base the registration cost on the supplies needed for the actual event (t-shirts, decorations, lunch, etc.). We also plan to have an itemized list of the materials needed for the individual arenas.

Tiger Bytes Robot Competition BUDGET

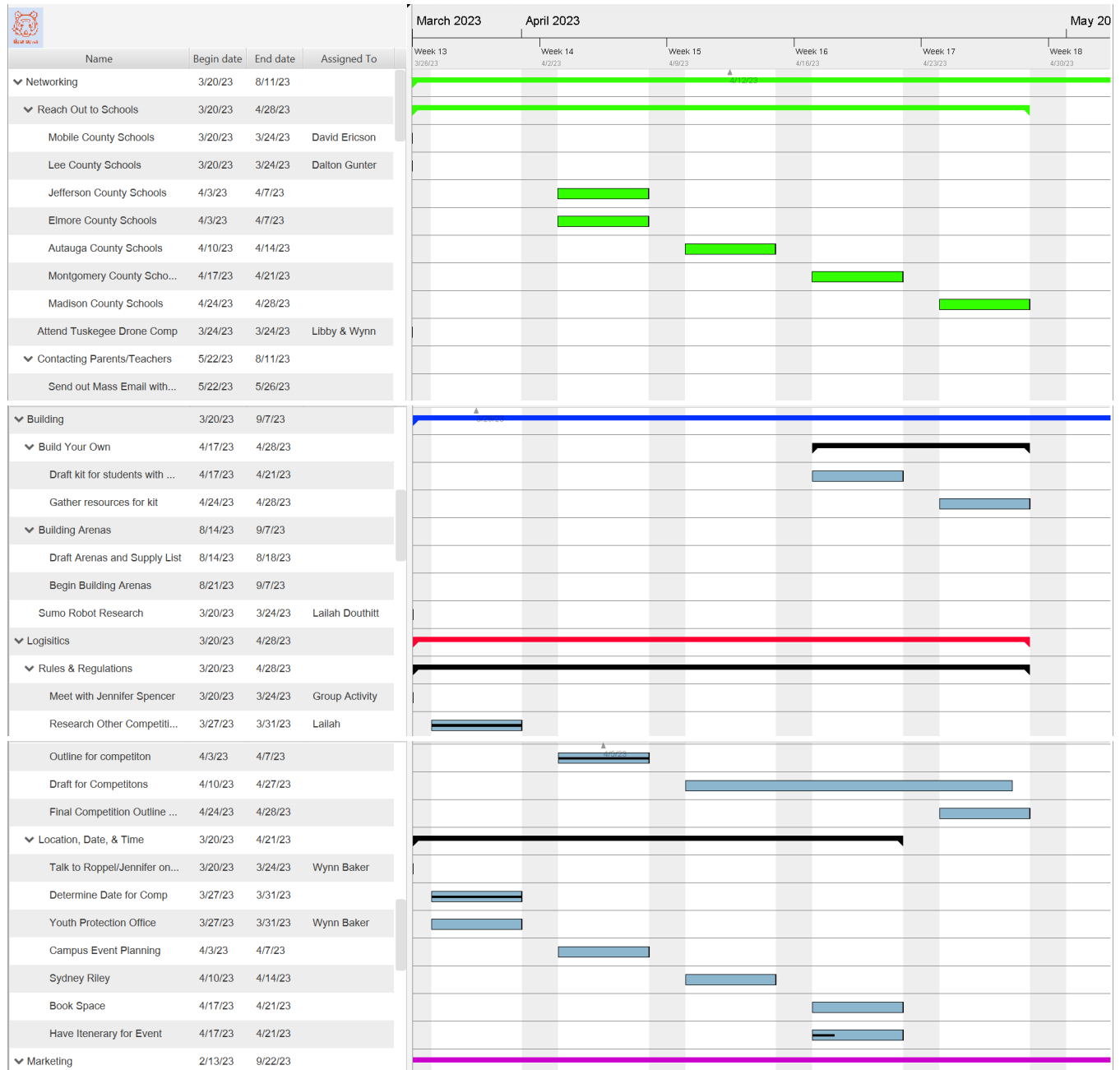
Detail

EXPENSE	AMOUNT	NOTES
Logo Design	\$30.00	
Scorekeeping Device	\$30.00	includes all materials to build and resources from department (free)
Website Domain	\$108.00	Core Design by Wix, will allow own domain and registration on site
Flyers	\$30.00	
Arena Materials	\$200.00	includes all materials to build the arenas, will use some resources from department (free) and some will be purchased
INCOME		
Out of Pocket Costs	\$199.00	
ECE Department	\$199.00	
Total	\$0.00	

Timeline

In Figure 7, we have the Gantt Chart schedule for our project. To view the entire schedule, click the link here:

https://drive.google.com/file/d/1aYZqLiSs5gAknKOqEDrArk_OfTJxRjfu/view?usp=share_link



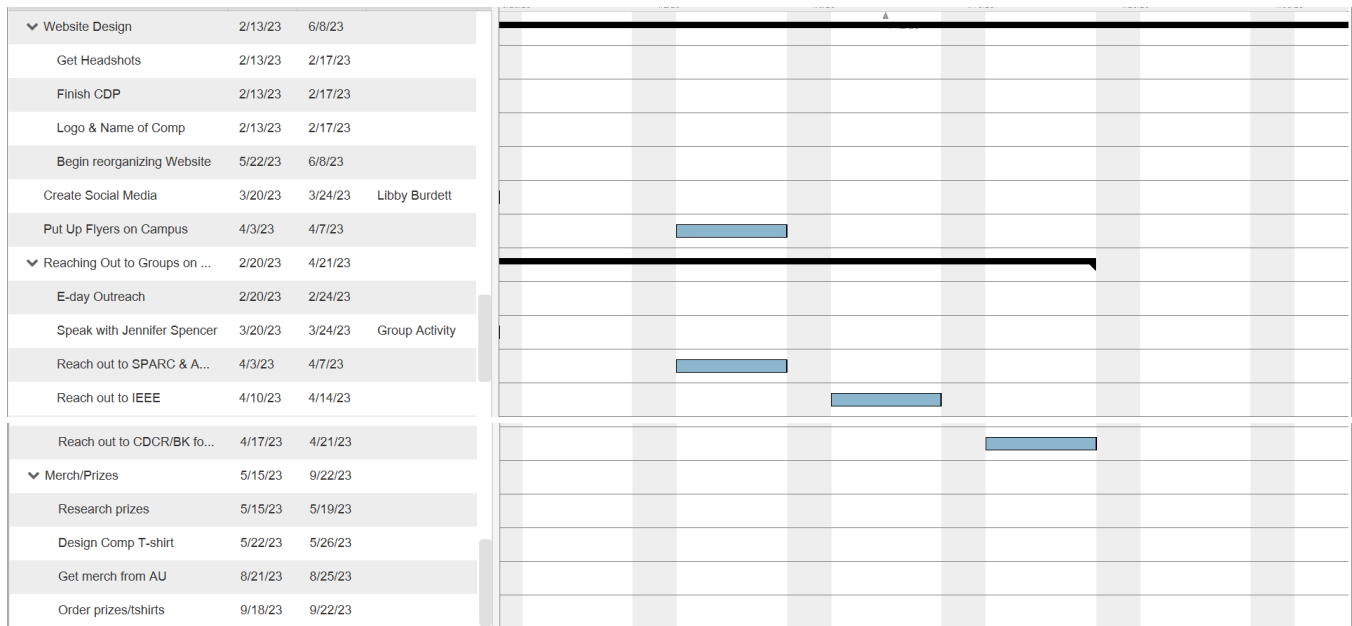


FIGURE 7: PROJECT GANTT CHART

Facilities

To complete our project, our biggest facility to use will be Brown-Koppel. We plan on booking a large ballroom in Brown-Koppel to hold our competition. Along with Brown-Koppel, we regularly use study spaces in Broun Hall to hold our meetings. We predict we will also be using Broun 307, the Capstone Lab, to build our arenas for the competition.

Disposition Agreement

At the end of the semester, in December 2023, this project and all its details will be passed on to another on campus group. When we began designing this competition, it was with the intention that is planned yearly to be held at Auburn University. This was designed because the groups listed below did not have the resources to design this type of competition. These groups could be but are not limited to the Electrical and Computer Engineering Department at Auburn University (ECE-AU), Institute of Electrical and Electronics Engineers at Auburn University (IEEE-AU), Student Projects and Research Committee (SPARC), or the Southeastern Center for Robotics Education (SCORE).



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Libby Burdett

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References

SME's Contact Information

- [1] Thaddeus Roppel, Associate Professor at Auburn University in Electrical and Computer Engineering, roppeth@auburn.edu, (334) 663-0511
- [2] Jennifer Spencer, Assistant Director of the Southeastern Center of Robotics Education (SCORE), jennifer.spencer@auburn.edu, (334) 844-8125
- [3] Jeff Gray, Professor at University of Alabama in Computer Science, gray@cs.ua.edu

Project References

- [4] "The University of Alabama." Alabama Robotics Competition, <https://outreach.cs.ua.edu/robotics-contest/>.
- [5] "Home - VEX Robotics." Home - VEX Robotics, <https://www.vexrobotics.com/>.
- [6] "Pololu - Zumo 32U4 OLED Robot (Assembled with 50:1 Hp Motors)." Pololu Robotics & Electronics, <https://www.pololu.com/product/4991>.
- [7] J. Ruiz-del-Solar, "Robotics-Centered Outreach Activities: An Integrated Approach," in IEEE Transactions on Education, vol. 53, no. 1, pp. 38-45, Feb. 2010, doi: 10.1109/TE.2009.2022946.
- [8] J. Grimes and J. Seng, "Robotics competition: Providing structure, flexibility, and an extensive learning experience," 2008 38th Annual Frontiers in Education Conference, Saratoga Springs, NY, USA, 2008, pp. F4C-9-F4C-13, doi: 10.1109/FIE.2008.4720494.
- [9] Chatzis, Dimitris & Kavallieratou, Ergina. (2022). Design and Implementation of a Robotic Competition. 1-5. 10.1145/3549737.3549758.
- [10] You, Hyesun & Chacko, Sonia & Rajguru, Sheila & Kapila, Vikram. (2019). Designing Robotics-based Science Lessons Aligned with the Three Dimensions of NGSS-plus-5E Model: A Content Analysis (Fundamental). 10.18260/1-2--32622.
- [11] "Guidance on the Application of Human Factors to Consumer Products." Guidance on the Application of Human Factors to Consumer Products, United States Consumer Product Safety Commission , 6 Mar. 2020, https://www.cpsc.gov/s3fs-public/Human-Factors-Standard-Practice-Documents-Final-ENGLISH-Feb032020_0.pdf?wAUEehL.VtEkpYpx8aLvYrTKqa9w0UMz.