The Race of Doom

DESIGN DOCUMENT

Team #44
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Team Members/Roles -- Zechariah Mundy, Vincent Quattrone, Simon Aguilar, Taylor Moore, Chris Agyare, Jaxon Dennis
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Executive Summary

Development Standards & Practices Used

IEEE 829	Software Test Documentation
IEEE 1028	Standard for Software Reviews and Audits
IEEE 1074	Software Development Life Cycle
IEEE 1547	Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces
IEEE 2050	RTOS for embedded systems standard
IEEE C37.2040	Standard Cybersecurity Requirements for Substation Automation, Protection, and Control Systems
IEEE 260	Standard Letter Symbols for Units of Measurement

Summary of Requirements

- Design an autonomous vehicle capable of navigating a track while avoiding traps and competing with other vehicles.
- Ensure the vehicle can respond to remote control for speed adjustments.
- Implement onboard sensors for autonomous steering.
- Address potential hacking attempts on the control system that could lead to crashes.

Applicable Courses from Iowa State University Curriculum

CprE 288

EE 230
EE 201
CprE 437x
CprE 185
CprE 186
CprE 381

New Skills/Knowledge acquired that was not taught in courses

Professional Communication
Safety Training for Machine Shop
Woodworking
3D modeling
Money management

Table of Contents

List of figures/tables/symbols/definitions (This should be the similar to the project plan)

Table 4 – Areas of Responsibility

1 Team, Problem Statement, Requirements, and Engineering Standards

1.1 Team Members

Zechariah Mundy, Vincent Quattrone, Simon Aguilar, Taylor Moore, Chris Agyare, Jaxon Dennis

1.2 Required Skill Sets for Your Project

Professional Communication
Safety Training for Machine Shop
Woodworking
3D modeling
Money management
Wiring
Programing

1.3 Skill Sets covered by the Team

Taylor – I have experience with power tools, woodworking, metalworking, and welding, in addition to experience in project management.
Chris - I have experience with understanding circuit components and when to use them. In addition, I have the knowledge of programming Arduinos for any device we need.
Jaxon - I have experience with Arduinos, circuit design, CNC machining, programming: C, and soldering.
Vince – I have experience in wireless cybersecurity systems such as RF and Bluetooth. Experience in cryptography, and network intrusion. I also have experience in the following languages: C/Embedded C, Java, Python, and C++.

Zech – I have experience with the programming languages: Java, C, Python, and Assembly. My skills also include my experience with soldering, power tools and modeling software. I'm also familiar with wireless communication technologies including both Wi-Fi and Bluetooth
Simon – I bring my knowledge of programming acquired at DMACC and ISU languages: C, C++, Java, Laber, HTML, MySQL, Swift, Mango DB, and JavaScript. Also, my skills in woodworking, soldering, and wiring.

1.4 Project Management Style Adopted by the team

Modified Agile

1.5 Initial Project Management Roles

Team organization: Taylor
Team Representative/client interaction: Taylor
Testing: Chris / Vince
Component Design: Zech/Jaxon

1.1 Problem Statement

The project aims to enhance the excitement and challenge of RC racing by introducing innovative traps on the track. It provides an engaging and dynamic environment for RC enthusiasts, offering a unique and entertaining experience.

In terms of feasibility, the project could be suitable for a class or future implementation with careful planning and collaboration. The combination of physical traps and cybersecurity elements adds a multidimensional aspect to the RC track. It not only tests the participants' skills in creating autonomous cars, but also introduces elements of strategy and adaptability, making it a compelling project for educational purposes or recreational events. The integration of electronic components and cybersecurity features may require technical expertise, making it ideal for a senior design project or an advanced class with appropriate resources and support. With proper guidance and resources, the implementation of such a project can offer valuable hands-on experience in electronics, cybersecurity, and creative design.

1.2 Requirements & Constraints

As we create a racetrack for two RC cars, there are many factors that must be considered. The materials used to physically create the track must be durable enough to allow for multiple rounds of testing, as well as multiple attempts for each car team to perform the race. The largest consideration for this project is likely the creation and implementation of the traps. Each trap, be it software or hardware based, must be tested to ensure that it will slow the cars as they progress through the race while still allowing them to complete it. Special attention is given to the traps' compliance with legal standards, ensuring that RF signals employed for hacking or jamming purposes are weak enough not to cause disturbances. Furthermore, the integration of a timing system is vital for determining race winners, and the applied science complex parking lot 104 provides an ideal real-world testing environment for the track. The final consideration lies in collaboration with the teams in charge of creating the cars.

1.3 Engineering Standards

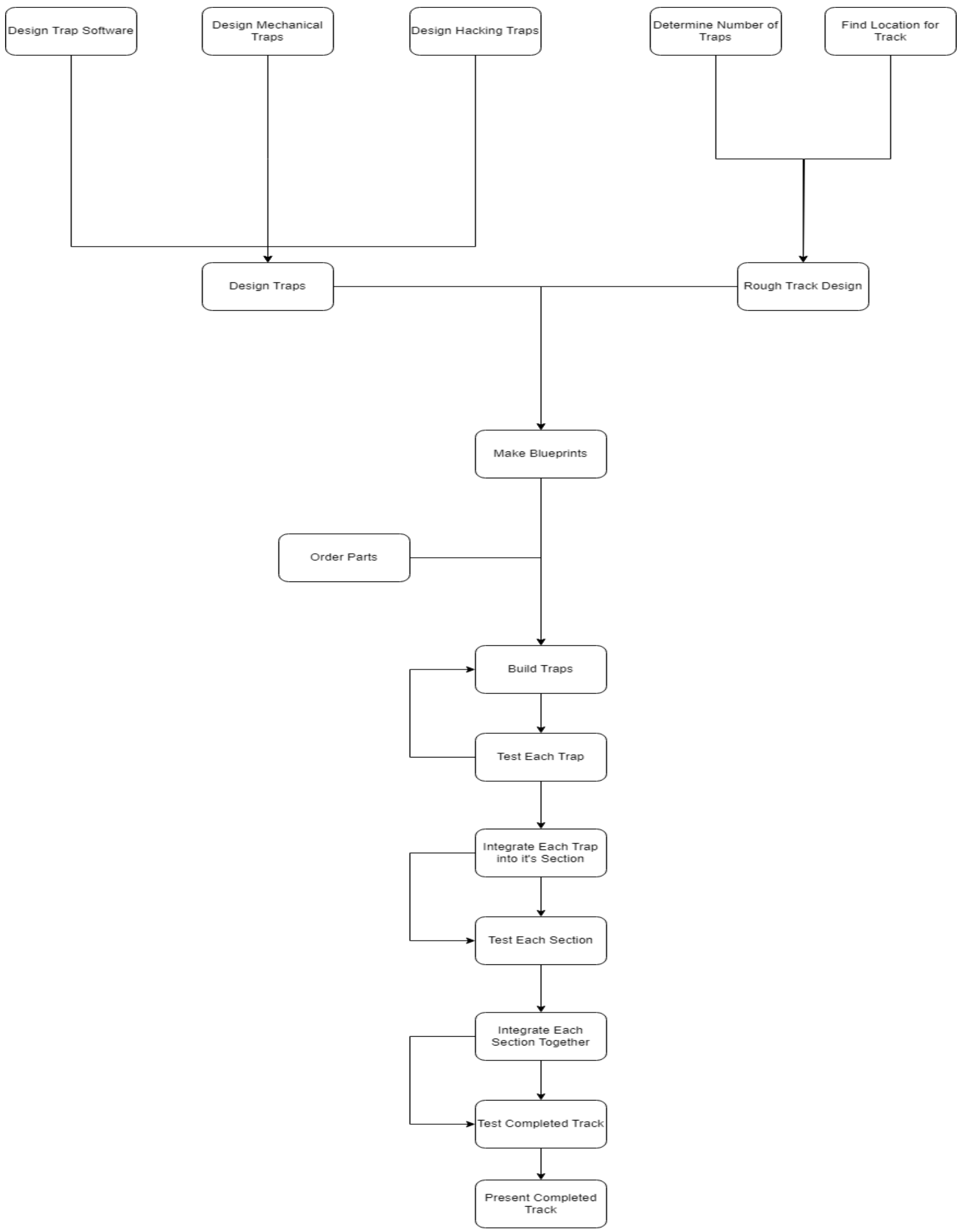
IEEE 829	Software Test Documentation
IEEE 1028	Standard for Software Reviews and Audits
IEEE 1074	Software Development Life Cycle
IEEE 1547	Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces
IEEE 2050	RTOS for embedded systems standard
IEEE C37.2040	Standard Cybersecurity Requirements for Substation Automation, Protection, and Control Systems
IEEE 260	Standard Letter Symbols for Units of Measurement

1.4 Intended Users and Uses

The racetrack functions as a focal point for the local community, uniting individuals around common interests and activities. It can evolve into a hub that enhances community connections. Beyond being a communal gathering space, racetracks also offer enjoyable and educational pursuits, such as RC car racing, engaging young people in a positive hobby that fosters connections with their peers.

2 Project Plan

2.1 Task Decomposition



(Figure 1)

Design traps software: The Software we will be using to tell the traps how they should behave will be Arduino programming language, which is a variant of C++. The purpose of designing and creating trap software is to allow the trap's parts to work together and allow all the traps to function predictably.

Design mechanical traps: The mechanical traps will be designed using various components ordered in advance from the ETG. The traps' purpose is to slow or stop cars on the track. The design will be using motors, switches, sensors, and other components.

Design hacking traps: When designing hacking/cybersecurity traps, we took some inspiration from our previous classes. Vincent took a wireless security class last semester and suggested that we should attempt to disrupt the radio signals that were being sent to the car from the controller. We found that the best way to complete this was by using a faraday cage. Another way that this could be completed was by taking over the radio signal that the RC car was using. This can be done by scanning to see which signal is being affected and using our own programmable remote to attempt to hijack the signal with a stronger strength.

Determine number of traps: We decided that we will be using 3 hardware and 3 software traps for our final track design. We have determined the type of traps and the planned general functionality for the final trap designs. We have yet to begin assembling the hardware components because of the lack of parts on hand. Parts are being ordered and we will begin building the traps as the parts come in.

Finding location of track: While finding the location of the final track, we are in the process of exhausting all our options. So far, we have emailed the TLA to see if it would be possible to rent out sections that would allow us to complete this project indoors during the cold winter months. This did not progress as we had found it too costly and will be busy during dead week of the next semester. Our next option is to rent out a room at the memorial union, but we are still awaiting a response email. Lastly, we are looking into renting out a park pavilion. While this will be outside, it will be under some shelter so it will allow for us to complete the race even if it were to rain

Rough track design: When designing the rough draft for our track design, we had to visualize the space of 25x50ft, so we had marked out an area of the TLA to help us visualize it. We also took some inspiration from a classic oval track like those found in Nascar, and found that it would be good to place some traps on the straight aways to prevent them from gaining too much speed, as well as some traps on the curves to see how their cars can handle autonomously turning in rough terrain

Design traps: When we complete the initial brainstorming and final draft of the traps we commit to using for our race, we will need to begin designing the traps, keeping in mind what materials we will need and how easily and compatible they will be with our complete track design.

Make blueprint: We need blueprints to make sure the traps are reproducible by others and to know exactly what needs to be ordered to be able to build the trap.

Order parts: To order the parts for our track a bill of materials was created to show ETG which components were needed and the cost of them. Additional descriptions were provided about each product relating to their function and need.

Build traps: When we receive our parts for our traps construction of them will start. Each trap will be built from our components with a majority of them being some form of moving barrier, elevation change, or a rotating obstacle. Many of these will be controlled by sensors and programmed with microcontrollers to take action when cars approach them.

Test each trap: When we complete the process of building the traps, we will need to start testing. To start testing we can do this in several ways including both the hardware and the software components of each. For the software testing section, we will need to use programs like the Arduino IDE to debug software mistakes and to better tune our traps to be more effective.

Integrate each trap into its section, test the section: Since our track will be broken into separate sections that will make transporting the track easier, we need to make sure that each section of the trap is working before implementing it with another section. This will be done by testing all of the traps within the section, as well as running a test RC car between each trap within the section.

Integrate each trap together, then test: After each trap is tested individually, we will have to make sure that it is possible for a car to complete the traps. This will require us to run the track multiple times from different positions around the track, and make sure that it can be completed by the test car to make sure that the other teams have a fun, but challenging race.

Present completed track: The final track will be presented as part of our second semester senior design project presentation as well as presented to our client in a one-on-one setting as this was what was requested. This one-on-one setting for the final track presentation will allow us to hide some of the trap positions from the other car teams which will provide a unique experience during the race day.

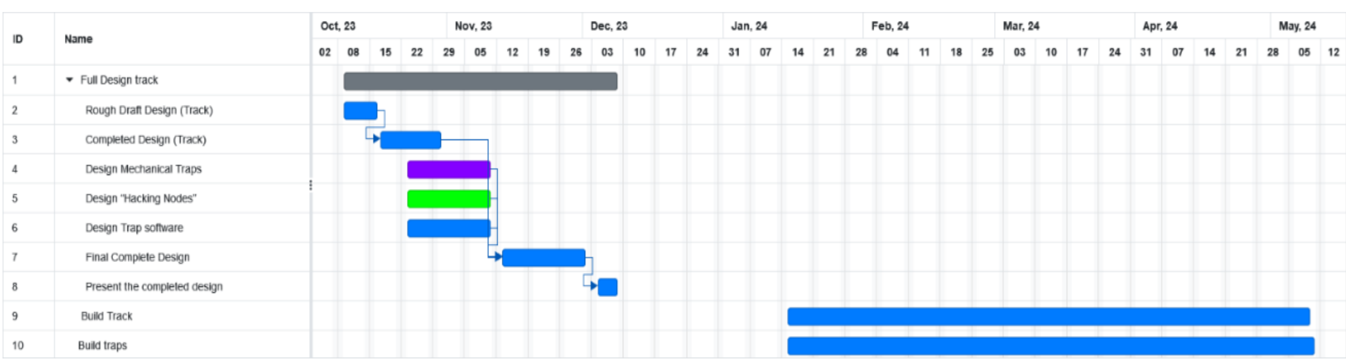
2.2 Project Management/Tracking Procedures

In our agile project workflow, we will be using Gitlab as our central hub for project management and documentation. Gitlab will serve as a comprehensive platform for tracking our project progress and maintaining a record of our tasks. This will allow us to have seamless collaboration among our team and enable us to contribute to the project and document our work efficiently. Additionally, we will also be using a Trello board to enhance task management. Tasks will be organized on the Trello board, allowing us to easily monitor their status and transition them through different stages of the development process. By combing these two software's, we aim to streamline our agile development process, and ensure efficiency throughout the project lifecycle.

2.3 Project Proposed Milestones, Metrics, and Evaluation Criteria

By setting a milestone and deadline, our team aims to make progression our project. By October 20th we successfully identified and selected traps for our intended purpose. Following this, we will have our rough draft ready and completed by October 27th. Subsequently, our ideas and translating them into a comprehensive blueprint, achieving this milestone by November 16th. With those blueprints, we will have until November 17th to finalize the design details. Our plan is to present the completed design to our faculty advisor on December 7th, ensuring that we stay on track. We seek evaluation based on our comprehensive efforts throughout the project and meticulous attention to the more intricate details. For our metrics, we will have three traps that are software based and three that are hardware based. We also plan to have the timing of the cars be within milliseconds to record a viable time for each of the times.

2.4 Project Timeline/Schedule



(Figure 2)

There were four important milestones in our project. First was a rough draft of our design completed by October 27th or earlier. About a month later, by November 29th, a blueprint for the track and a completed design of our track were needed. Lastly this design will be presented on December 7th to our faculty advisor, Dr. Bigelow.

2.5 Risks And Risk Management/Mitigation

One of the largest risks in this project will be running out of materials or damaging them where we would need to procure more.
This can be mitigated through good planning, having a small buffer of supplies, continuous monitoring, and having adequate storage for the material
Potential getting electrocuted by low voltage.
Prevent this by making sure everything is grounded properly and is dry and wearing proper protective gear.
The construction will have an inherited risk because of power tools.

- Follow safety rules of power tool use: do not wear loose clothing; wear eye, hearing, and hand protection.

2.6 Personnel Effort Requirements

	Team Members	Start Date	End Date	Estimated Hours
Rough Draft Design (Track)	Taylor, Chris, Jaxon	10/9	10/16	3
Completed Design (Track)	Taylor, Chris, Jaxon	10/16	10/27	4
List of Traps	All	10/9	10/23	6
Design Mechanical Traps	Taylor, Chris, Jaxon	10/23	11/10	30
Design “Hacking Nodes”	Vince, Zech	10/23	11/10	30
Design Trap software	Simon, Vince	10/23	11/10	30
Final Complete Design	All	11/10	12/3	10

(Table 1)

2.7 Other Resource Requirements

Materials:
Wood
A large magnet/electromagnet

PVC pipe
Pipe covers
Tarp
Fasteners
Hinges
Metal rods
Access to wood/metal shop
RC car for testing
PLC (like Arduino)
Wires
Electric actuator for wall trap
Motion detector

4 Design

4.1 Design Content

Hacking/Cybersecurity Traps: These traps would likely involve electronic components such as sensors. Microcontrollers, and modification of communication systems. The design content for these traps would include:
Sensor Jamming Zones: This involves creating zones on the track that would jam or disrupt the electronic sensors on the RC cars, leading to a temporary loss of sensor data. The design includes a selection of sensors, jamming mechanism, and strategies to execute sensor jamming scenarios.
Light/Shadow Challenges: These challenges would introduce scenarios on the track where light and shadows will be manipulated, possibly causing interference of the control to the RC car. Depending on what type of sensors the RC car uses, the RC car may react differently to the different lighting scenarios. The design content covers the implementation of light and shadow sensors, control algorithms that respond to the varying light conditions, and a track design that could maximize the effect of these challenges.
Control Takeover: This would involve creating situations where we can temporarily take over control of the RC cars. Design content for this challenge would include incorporating communication systems (radio signals) and protocols that allow us to take over RC car operations.
Electronically Complex Traps: These traps would introduce physically moving elements on the track that are controlled electronically. The design content for these traps would include:
Mechanical Design: development of the physical components of the moving parts, such as rotating barriers, elevating platforms, or sliding obstacles. This would require the use and knowledge of CAD design as well as electrical engineering principals
Electronic Control Systems: Integration of sensors and microcontrollers to that would be used to control the behavior of the moving parts. This involves designing control algorithms that would respond to the RC car’s presence or other specific triggers.

Power Management: Designing power systems that ensure the moving parts receive the necessary electrical supply. This would include battery management or wired connections for each of the components.
Physical Traps: This aspect of the project would involve the creation of physical obstacles or traps on the track that would challenge the RC car teams. The design content would include:
Terrain Design: Design the track layout and surface materials, which may include sand, gravel, or other obstacles like ramps.
Safety Measures: As per the requirements of the car teams, we will need to make sure that none of these physical traps flip the car over in any way. We will also need to make sure that these traps are designed with safety in mind to prevent damage to the RC cars or harm to any of the participants.
Environmental Safety: We will consider factors like weather resistance as the final track will take place outdoors.

4.2 Design Complexity

The building of the track requires an understanding of constriction with wood. As part of the track, we need to add traps and a way to time the racers. The traps will require an understanding of multiple engineering disciplines and technologies. The traps will require programming, wiring, mechanical design, and an understanding of Arduino.

4.3 Modern Engineering Tools

Arduino is our control of the traps and for timing the racecars. To program Arduino, we will use the IDE that Arduino provides and store the code on GitHub provided by I.S.U for ease of retrieval.
AutoCAD electrical to make the 2D model of the circuitry of the traps.

Breadboards will be used to make and test the electrical circuits for the traps.

We will be using AutoCAD, or something similar, for the design of the tracks and physical parts of the traps.

4.4 Design Context

Area	**Description**	
Public health, safety, and welfare	How does your project affect the general well-being of various stakeholder groups? These groups may be direct users or may be indirectly affected (e.g., solution is implemented in their communities)	When it comes to enhancing our well-being, racing RC cars involve various skills, such as hand-eye coordination, problem-solving, and technical knowledge. These skills can have educational and developmental benefits for participants, particularly for younger individuals.

Global, cultural, and social	How well does your project reflect the values, practices, and aims of the cultural groups it affects? Groups may include but are not limited to specific communities, nations, professions, workplaces, and ethnic cultures.	The racetrack can serve as a hub for the local community, bringing people together for shared interests and activities. It can become a central meeting point that strengthens community bonds. In addition to providing communities with a gathering place, racetracks also provide a fun and educational activity like RC car racing and engage young people in a positive hobby, keeping them active and connected to their peers.
Environmenta l	What environmental impact might your project have? This can include indirect effects, such as deforestation or unsustainable practices related to materials manufacture or procurement.	Electric-powered RC cars are cleaner and quieter than their gas-powered counterparts. Encouraging or mandating the use of electric RC cars can help reduce air and noise pollution in the surrounding area.
Economic	What economic impact might your project have? This can include the financial viability of your product within your team or company, cost to consumers, or broader economic effects on communities, markets, nations, and other groups.	The construction and operation of the RC car racetrack can create job opportunities, from track staff and maintenance personnel to event coordinators and marketing professionals

(Table 2)

4.5 Prior Work/Solutions

This open-ended project has never been attempted before. A similar project that we found is something called the micromouse competition. To be brief, this project involves motorized robots the size of mice navigating a maze. Designs involving navigation could be similar as cars for our track will have to navigate to stay on the track and to avoid obstacles similar to these micromouse bots navigating through a maze. As previously mentioned, this is the first iteration of this project and will be completely original with no previous work to reference.

Our project has the possibility to use market products such as RC cars. However, modifications to make the cars semi-autonomous will drastically change their performance. The track will be built from scratch to accommodate modifications on the RC cars so that they are compatible. A list of pros and cons compared to other similar designs is provided below.

Site cite: https://www.wikihow.com/Build-an-RC-Track

https://clutchrc.com/rc-track-ideas/

How the racetrack should work. https://blayze.io/blog/karting/how-to-get-started-in-racing https://www.wikihow.com/Build-an-RC-Track

Working on the servo motors:

https://learn.adafruit.com/make-it-move-with-crickit/standard-servo-motors

4.6 Design Decisions

Software-

- Control Software for Traps
- Cybersecurity Framework
- Simulation and Testing Software
- Microcontroller Platform Selection (Arduino IDE)

Hardware-

- Sensor Selection
- Microcontroller and Communicaton Hardware Selection
- Safety Systems (Power Supply for Motors)
- Physical Trap Layout on Track
- Track Construction Materials

4.7 Proposed Design

At this point in the project, we have worked with the other two teams to set regulations on various specifications such as rules for the track (the track shouldn't damage the cars), the size of the cars, and various regulations regarding how the cars can be hacked. We have also determined the general shape of the track, designed some of the traps, and have created two different track designs for indoor and outdoor use.

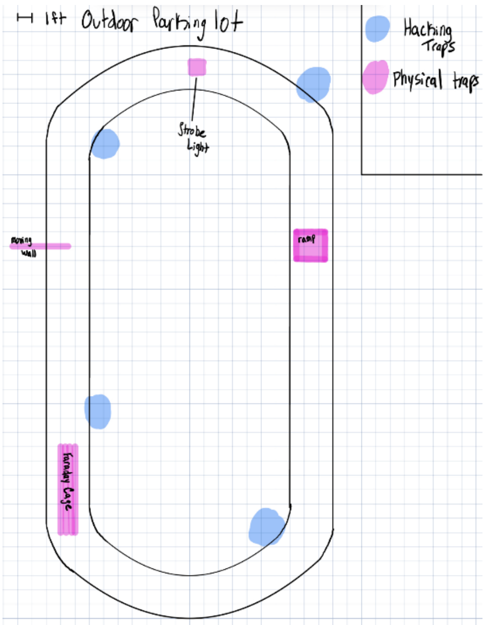
4.7.1 Design 0 (Initial Design)

The visuals below show two variations of our track design. The first is for if the race is done outdoors in the parking lot of Applied Sciences Complex (lot 104) and the second is for if the race is done indoors in the TLA at Coover Hall. Both of the two designs implement the same traps. In the current design, there are four physical traps that the cars will have to evade as well as four hacking traps where the cybersecurity of the cars will be tested. The current physical traps are a ramp, a moving wall, a faraday cage, and a strobe light.

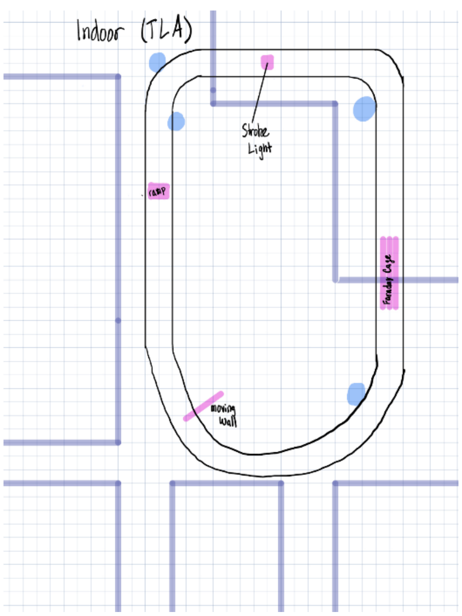
Strobe light- visibility during races, especially in low-light conditions

Moving walls Ramp- The purpose of this obstacle is to hinder the race car but

Faraday cage- to be able to have a station to hack the car within the track.



(Figure 2)



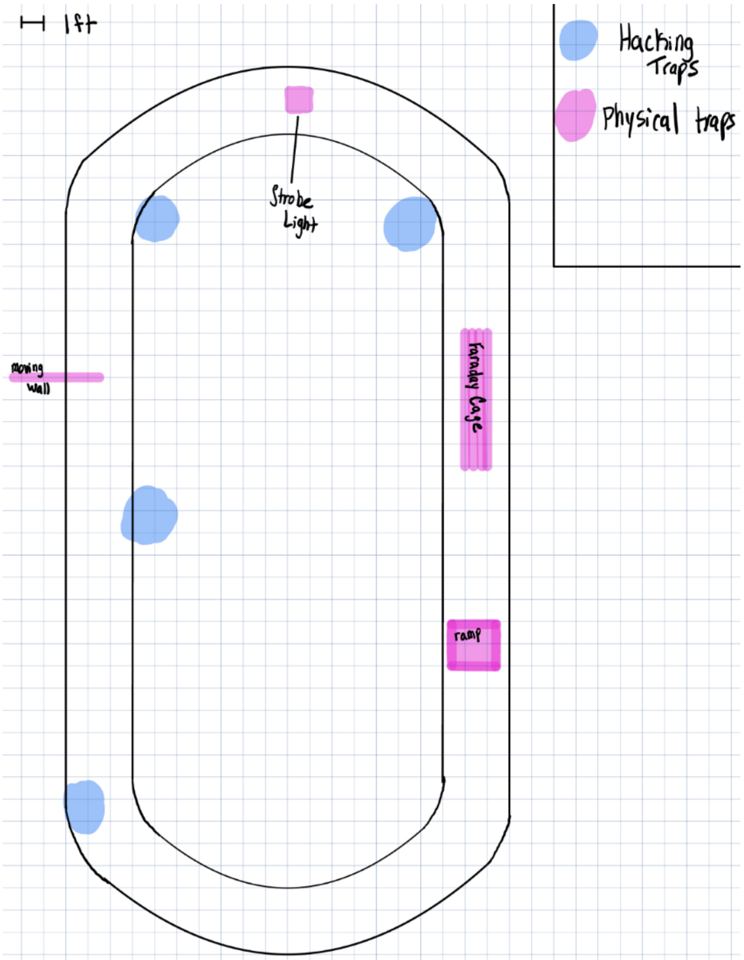
(Figure 3)

Functionality

The cars will start at a designated starting line, and the amount of time it takes them to complete the track will be recorded. Whichever car has the fastest time will be the winner.

Each of the traps depicted below is reusable and should not cause physical damage to the cars. None of these traps should eliminate the ability to finish the race.

4.7.2 Design 1 (Design Iteration)



(Figure 4)

The largest change between these design iterations is the removal of the TLA as an option for the location of the race. In addition to this, the placement of the traps was adjusted.

4.8 Technology Considerations

Potential modifications to our design may involve adjusting the positioning of the traps to increase the distance from the RC cars. Additionally, we are considering alterations to the track's shape, aiming to enhance the overall challenge for competing teams. These potential changes would contribute to refining and optimizing our project.

Pros	Cons
• Semi-autonomous • Track tailored towards cars • Adjustable traps and car configurations	• Not fully controlled movements • Small budget could limit design and prototypes

(Table 3)

4.9 Design Analysis

– Did your proposed design from 4.7 work? Why or why not?

Our design has still not been implemented and a conclusion of whether it works cannot be properly drawn. We are currently waiting on electrical components to create some traps. Potential issues could be trap placements and shapes, as well as possible minor compatibility issues with other teams.

– What are your observations, thoughts, and ideas to modify or iterate further over the design?

Different types of traps could be implemented and tested out to further challenge other racing teams. More complex components or further debugging could be effective in improving the speed and precision of traps.

5 Testing

5.1 Unit Testing

The Stopwatch will be tested by activating the stopwatch by breaking the laser connection to start the Stopwatch at the same time a timer will be started for 2 minutes. When the timer ends the laser connection will be broken again to stop the Stopwatch. The time on the Stopwatch will be compared to the 2-minutes time to see how close it is, and this test will be done serval times to make sure the results are consistent.

We also have the retainment walls as a unit and the Stopwatch to keep track of the racers' time as a unit. The retainment walls will be tested by using an RC car with the same dimensions as the ones used by the race teams to run into the wall and make the track wide enough for the RC car to pass.

For our project, we are considering each trap as a unit. We have the following types of tracks: Physical Traps, Cybersecurity Traps, and Electronically Complex Traps. Our method for testing will include both functional and stress testing of each trap. This will be completed to ensure that each unit performs as intended and is also able to be passed by the RC cars created by the other teams. This testing will involve simulated hacking attempts against the cars (jamming), stress testing of the moving parts, and validation of physical trap mechanisms. As for the tools that will be used to perform these tests, we will be using a multimeter to ensure everything is functioning properly when it comes to anything electrical, and hardware based.

5.2 Interface Testing

The interfaces in our design are between the traps and the RC cars, the track and the RC car, and the track and the traps. These interfaces will be rigorously tested to guarantee seamless communication between each unit. For instance, the interaction between the RC car and the faraday cage must affect the car enough to where it can still drive forward and not stop the car completely. To complete these tests, we will have to work with one of the RC car teams to borrow their cars and make sure that the cars can pass each trap.

5.3 Integration Testing

Electromechanical Trap Integration:

- Components: Moving walls, Ramps, Trap Doors
- Criticality: Proper synchronization of these physical elements is crucial for the track's functionality and safety
- Testing: Use of sensors to ensure the precise timing and coordination of the traps. Real life simulation using a test RC car

Cybersecurity Trap Integration:

- Components: Light sensor jamming zones, Faraday cage, radio wave hijacking zone
- Criticality: Coordination between our electronic systems to implement these measures without hindering the overall performance of the trap system
- Testing: Conduct controlled tests to validate the functionality of the faraday cage and radio wave hijacking

Control System Integration:

- Components: Central control unit managing for all traps and communication between them
- Criticality: Coordinated control of physical and cybersecurity elements is vital for a challenging and well-connected track
- Testing: Implement comprehensive testing scenarios including stress tests, and failure simulations

Safety System Integration:

- Components: Emergency shut-off mechanism, safety sensors
- Criticality: Prioritizing safety in case of malfunctions or other unexpected events is crucial
- Testing: Implement and test emergency shutdown procedures. Use sensors and safety testing tools to ensure a quick and reliable response to potential safety risks

5.4 System Testing

Traps in the system will work towards a common goal without interacting with each other directly. Each trap will act as its own autonomous system in the total track system. The trap systems will trigger using separate timers attempting to stop oncoming RC cars. Visual cues and IDE’s will be used to confirm systems and their code is running smoothly. In addition, a multimeter will be used on electrical components to test that they are working.

5.5 Regression Testing

Each of the traps is independent of the other. Each component of the traps will not be reliant on others. To make sure that new components do not destroy the functionality of the unit, we would either:

- Make sure that we finalize every component within the trap to ensure that we do not have to add any more additions.
- We would have to take the whole unit apart from the track and add the new additions. To make sure the functionality is not interrupted.

5.6 Acceptance Testing

Acceptance testing will be a comprehensive process, ensuring the fulfillment of both functional and non-functional requirements. To showcase the effectiveness of the traps, we will conduct live demonstrations of each trap type, emphasizing their seamless integration into the track environment. The accuracy of the stopwatch will be verified through time trials, assessing how well the system captures and records the RC cars' performance. Additionally, overall track performance will be evaluated, considering factors such as reliability, responsiveness, and the effectiveness of our control systems.

Involving our client in the acceptance tests is integral to aligning our design with his expectations. We will promote client participation by providing a structed walkthrough of the entire system, explaining the design rationale for each section and trap, and demonstrating the key features. This will likely be done using virtual communication via email, as well as providing videos for our client. The approach ensures that the client not only gains confidence in the system's functionality, but also has a hands-on role in validating that the design aligns with his vision and requirements.

5.7 Results

We are currently working on building the traps so that we can begin testing them. The physical traps specifically aren't able to be tested until they are built, while the hacking traps likely won't be able to be tested at all until the arrival of our test RC car. Designs have been created for each of the physical traps and they will be built as soon as materials are received.

6 Implementation

Currently our plan for next semester is to split into two smaller groups, one to focus on hardware-based traps and the other to focus on software-based traps. As materials have already been ordered, we hope to have everything we need to begin building as soon as the semester starts.

7 Professionalism

This discussion is with respect to the paper titled "Contextualizing Professionalism in Capstone Projects Using the IDEALS Professional Responsibility Assessment", *International Journal of Engineering Education* Vol. 28, No. 2, pp. 416–424, 2012

7.1 Areas of Responsibility

Pick one of IEEE, ACM, or SE code of ethics. Add a column to Table 1 from the paper corresponding to the society-specific code of ethics selected above. State how it addresses each of the areas of seven professional responsibilities in the table. Briefly describe each entry added to the table in your own words. How does the IEEE, ACM, or SE code of ethics differ from the NSPE version for each area?

Area of Responsibility	Definition	NSPE Canon	IEEE Code of Ethics
Work Competence	Perform work of high quality, integrity, timeliness, and professional competence.	Perform services only in areas of their competence; Avoid deceptive acts.	It emphasizes the importance of competency in various ways like To Avoid Harm, To Accept Responsibility and To Improve the Understanding of Technology
Financial Responsibility	Deliver products and services of realizable value and at reasonable costs	Act for each employer or client as faithful agents or trustees	The IEEE Code of Ethics does not explicitly address financial responsibility but, financial conduct is inherent in the broader ethical framework
Communication Honesty	Report work truthfully, without deception, and understandable to stakeholders.	Issue public statements only in an objective and truthful manner; Avoid deceptive acts.	The IEEE Code of Ethics states that communication should be honest, realistic, and accurate in all professional interactions
Health, Safety, Well-Being	Minimize risks to safety, health, and well-being of stakeholders.	Hold paramount the safety, health, and welfare of the public	IEEE develops and publishes standards and guidelines that cover a wide range of technological areas. Some of these standards are directly related to health and safety, ensuring that technologies meet certain safety criteria. For example, there are standards for medical devices, safety in the use of electrical equipment, and guidelines for the ethical use of technology.
Property Ownership	Respect property, ideas, and information of clients and others.	Act for each employer or client as faithful agents or trustees.	IEEE states that's respect for proprietary rights of others, including

			employers and clients is expected.
Sustainability	Protect environment and natural resources locally and globally	N/A	Strive to be environmentally responsible and to design and develop products that minimize adverse environmental impact
Social Responsibility	Produce products and services that benefit society and communities	Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.	Use technology for the benefit of society, and promote the public understanding of technology as a whole

(Table 4)

IEEE and NSPE are professional organizations with different scopes and focuses. IEEE primarily caters to individuals in electrical engineering, electronics, computer science, and related fields on a global scale. It has its own specific IEEE Code of Ethics tailored to these technical areas. In contrast, NSPE represents the interests of all licensed professional engineers across various engineering disciplines within the United States. The NSPE Code of Ethics is more general and applies to engineers' specific field of expertise. While IEEE is globally oriented, involved in setting international standards and organizing global conferences, NSPE's primary focus is on professional development, and ethical considerations for engineers in the United States.

7.2 Project Specific Professional Responsibility Areas

For each of the professional responsibility areas in Table 1, discuss whether it applies in your project's professional context. Why yes or why not? How well is your team performing (High, Medium, Low, N/A) in each of the seven areas of professional responsibility, again in the context of your project. Justify.

Work Competence (Medium) - Our team has demonstrated competency in both the technical and collaborative aspects of this project. Further collaboration may help enhance the overall project, but we are still on track of completing the project by the deadline.

Financial Responsibility (Medium) - Our team was effective in our budget planning and resource allocation. This allowed us to minimize unnecessary expenses and stay without our budget constraints

Communication Honesty (High)- Our team has maintained transparent and open communication, which fostered a positive and cooperative environment. This is crucial for an integrative project. We also had weekly meetings with our team which allowed for strengthened communication. Our team representative met with the other representatives as well as the client and kept us informed.

Health, Safety, Well-Being (Low) - This would apply to our project later as safety measures are planned to be implemented but have not been yet.

Property Ownership (N/A) - Property ownership considerations involve responsible use and handling of equipment and materials. Since this project doesn't involve long-term property ownership or significant assets, we do not believe that it is a relevant factor for evaluation.

Sustainability (High)- We want to have all our materials to be suitable for the environment. We would also not want to have the location that we will be having our project in tarnished in any way because of us.

Social Responsibility (Low) - We would want everyone in our community of expertise to come and enjoy the finished product that we have created.

7.3 Most Applicable Professional Responsibility Area

We believe that Communication Honesty is the most applicable to us.

8 Closing Material

8.1 Discussion

Assuming the current design plans are sufficient, the product will meet all given requirements. A final track design and layout is complete, as well as designs for six traps. One trap is finished, with a timing mechanism to be completed within a week. Materials have also been ordered to continue building traps at the start of the next semester.

8.2 Conclusion

Throughout this semester, we have achieved many things from design work to discussion. When we were first presented with this project, there were truly no specifications or requirements given. It was all to be decided by the collective seventeen students involved in this project. Through weekly meetings of representatives from each of the three teams, all specifications and requirements have been discussed and most have been decided. In addition to this work, the traps have been decided and designed, and the track layout has also been designed.

8.3 References

"How to Get Started in Racing: A Guide to Getting on the Track This Weekend."*DataMix*, blayze.io/blog/karting/how-to-get-started-in-racing. Accessed 27 Oct. 2023.

"wikiHow". (2020, April 1). *Simple Ways to Build an RC Track: 11 Steps (with Pictures)*. https://www.wikihow.com/Build-an-RC-Track

Wells, T. (2023, March 21). *DIY RC Track Ideas: Tips and Tricks for Building Your Dream Course | Clutch RC*. Clutch RC. https://clutchrc.com/rc-track-ideas/

Barela, A. (2018, July 4). *Make it Move with Crickit*. Adafruit Learning System. https://learn.adafruit.com/make-it-move-with-crickit/standard-servo-motors

8.4 Appendices

8.4.1 Team Contract

Team Members:

1) Taylor Moore 2) Jaxon Dennis

3) Christopher Agyare 4) Vincent Quattrone

5) Simon Aguilar 6) Zechariah Mundy

Team Procedures

1. Day, time, and location (face-to-face or virtual) for regular team meetings:
    a. Fridays 5:30 PM Coover Hall (unless agreed upon otherwise)
2. Preferred method of communication updates, reminders, issues, and scheduling (e.g., e-mail, phone, app, face-to-face):
    a. Texts
3. Decision-making policy (e.g.,Consensus, majority vote):
    a. Consensus
4. Procedures for record keeping (i.e., who will keep meeting minutes, how will minutes be shared/archived):
    a. Jaxon will take meeting notes and share with the group

Participation Expectations

1. Expected individual attendance, punctuality, and participation at all team meetings:
    a. Attendance is expected at all meetings when possible. If someone is late or doesn't show up they should send a text to the group. All members should participate.
2. Expected level of responsibility for fulfilling team assignments, timelines, and deadlines:
    a. Hard deadlines by professor are expected to be followed. Deadlines made by the team are slightly more flexible and can accommodate the needs of the team.
3. Expected level of communication with other consensus team members:
    a. Answer communications within 24 hours unless you have a valid excuse.
4. Expected level of commitment to team decisions and tasks:
    a. All team members should respond in regards to important or time sensitive decisions in a timely fashion.

Leadership

1. Leadership roles for each team member (e.g., team organization, client interaction, individual component design, testing, etc.):
    a. Team organization: Taylor
    b. Team Representative/client interaction: Taylor and Simon (depending on schedules)
    c. Testing: Chris / Vince
    d. Component Design: Zech/Jaxon
2. Strategies for supporting and guiding the work of all team members:
    a. If a team member is struggling with a task assigned to them, the rest of the team will support them in completing the task.
3. Strategies for recognizing the contributions of all team members:
    a. A PowerPoint will be made highlighting the contributions of each team member.

Collaboration and Inclusion

1. Describe the skills, expertise, and unique perspectives each team member brings to the team.
    a. Taylor – I have experience with power tools, woodworking, metalworking, and welding, in addition to experience in project management.
    b. Chris - I have experience with understanding circuit components and when to use them. In addition, I have the knowledge of programming Audinos for any device we need.
    c. Jaxon - I have experience with Arduinos, circuit design, CNC machining, programming: C, and soldering.
    d. Vince – I have experience in wireless cybersecurity systems such as RF and Bluetooth. Experience in cryptography, and network intrusion. I also have experience in the following languages: C/Embedded C, Java, Python, and C++.
    e. Zech – I have experience with the programming languages: Java, C, Python, and Assembly. My skills also include my experience with soldering, power tools and modeling software. I'm also familiar with wireless communication technologies including both Wi-Fi and Bluetooth
    f. Simon – I bring my knowledge of programming acquired at DMACC and ISU languages: C, C++, Java, Laber, HTML, MySQL, Swift, Mango DB, and JavaScript. Also, my skills in woodworking, soldering, and wiring.
2. Strategies for encouraging and support contributions and ideas from all team members:
    a. No idea will be ignored. Every idea and contribution by any team member will be considered and discussed among the group.

3. Procedures for identifying and resolving collaboration or inclusion issues (e.g., how will a team member inform the team that the team environment is obstructing their opportunity or ability to contribute?)
    a. It is the hope that we as a team become a group of friends who can feel comfortable discussing these issues.

Goal-Setting, Planning, and Execution

1. Team goals for this semester:
    a. Our goal this semester is to create a design that is under our given budget that is replicable without interpretation.
2. Strategies for planning and assigning individual and team work:
    a. As tasks are assigned, the requirements will be evaluated and the task will be given to the most qualified team member(s).
3. Strategies for keeping on task:
    a. As a group, if we find that we are getting off task, effort should be made to resume working. Anything that is not completed in group work time should be completed by the team member responsible on their own time.

Consequences for Not Adhering to Team Contract

1. How will you handle infractions of any of the obligations of this team contract?
    a. First have a verbal warring for the infraction.
    b. Second time the same infraction happens we will let the TA know

2. What will your team do if the infractions continue?
    a. If issues continue, the team will meet with the faculty advisor to discuss options, and if needed will also meet with the professor of the 491 class.

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a) *I participated in formulating the standards, roles, and procedures as stated in this contract.*

b) *I understand that I am obligated to abide by these terms and conditions.*

c) *I understand that if I do not abide by these terms and conditions, I will suffer the consequences as stated in this contract.*

1) Taylor Moore DATE 9/8/2023

2) Vincent Quattrone DATE 9/8/2023

3) Simon Aguilar DATE 9/8/2023

4) Zechariah Mundy DATE 9/10/2023

5) Christopher Agyare DATE 9/10/2023

6) Jaxon Dennis DATE 9/10/2023