Unmanned Aircraft Systems (UAS) University Innovation Showcase

Fall 2021 – Spring 2022

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Version History

Version	Description
1.0	Initial Draft
1.1	Clarification Updates to Challenges
1.2	2021 - 2022 Version

Introduction

Mission & Vision

Universities will participate, in partnership with Raytheon Technologies, in an Unmanned Aerial System (UAS) Innovation Showcase. The purpose of the UAS Innovation Showcase is for students to use their creativity and innovation to research, develop, integrate, and test UAS hardware and software components to solve existing real-world problems.

This team-oriented effort is an opportunity for university students to engage and put in practice their project-management and problem-solving skills on open-ended problems and gives them the opportunity to work in an environment similar to industry professionals. For the corporate sponsor, it provides the opportunity to evaluate and assess top graduates, promote corporate branding, and explore the latest technologies.

The showcase is currently schedule to occur April 20th – April 23rd, 2022.

Points of Contacts

The UAS Innovation Showcase is a collaboration project between Raytheon Technologies and the following Universities:

The University of Texas at Arlington
The University of Texas at Dallas
The University of Texas at El Paso
The University of Texas at Austin
Texas A&M University
Southern Methodist University

The direct participants of the Innovation Showcase will be the assigned students, while University faculty and industry mentors act as project guidance and do not work on the project itself. Judges will observe the final competition and grade based on performance and requirements met. Judges will not be student mentors.

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Schedule

The timeline for this showcase is the Fall 2021 Semester (August) through the Spring 2022 Semester (May). The Innovation Showcase will be held April 20th through April 23rd at the UTA Maverick stadium.

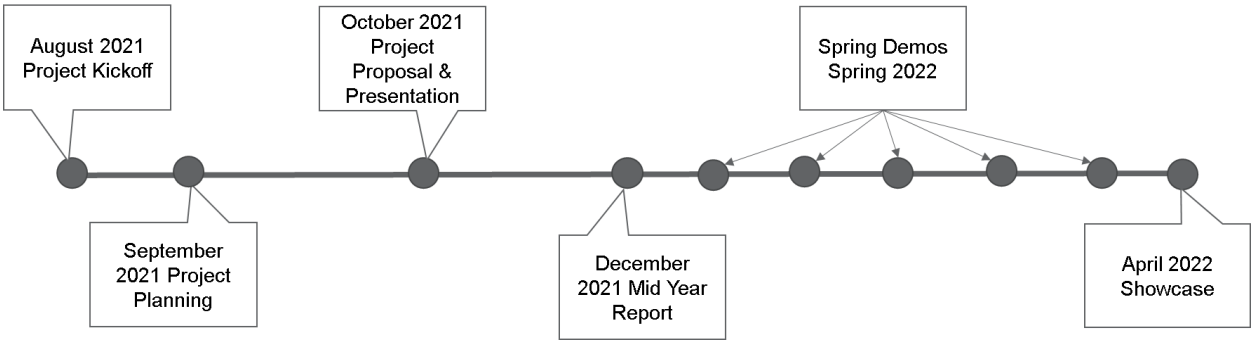
Students will follow agile development methodologies and meet with university and corporate mentors frequently (i.e. weekly) to ensure project progress.

At a high level, students will:

1. Conduct studies on existing state of the art solutions and work with stakeholders to gather all specifications and requirements for the project.
2. Create a proposal and presentation that is approved by all parties
3. Design, Implement, Test, and Demonstrate prototype solution
4. Showcase solution during the Innovation Showcase in the Spring 2021 Semester
5. Prepare any and all classroom documentation requirements (i.e. poster, presentation, final report)

Milestones

Note: this is a template, and not *required* for the project.



1. Project Kickoff (August)
    a. Requirements Review & Clarification / Q&A
2. September 2021 – Project planning (e.g. System Requirements Review)
    a. Configuration Management
    b. Project Logistics
3. October 2021 – Project Proposal & Presentation (e.g. System Design Review)
4. December 2021 – Prototype creation
    a. Mid Year report is due (e.g. Critical Design Review)
        i. PPT template can be provided if needed
    b. Prototype Demonstration(s)
5. Spring Demos (e.g. TRR's)

a. Jan Flight Functionality Demo – Drone autonomously takes off and lands at a set distance (targeting Challenge 1)
b. Feb Logo Detection Demo – Drone autonomously finds logo (targeting Challenge 2)
c. March Obstacle Avoidance Demo – Drone autonomously avoids a minimum of 2 obstacles (targeting Challenge 3)
d. March/April No GPS demo – Drone autonomously flies in a pre-determined path with no GPS (targeting Challenge 4)
e. April Scenario Checks

6. **Competition Date – Texas Drone Throw Down!**
   April 20th – April 23rd 2022
   Wednesday April 20th - Travel
   Thursday / Friday April 21st, 22nd - Open Testing, Poster Demonstration
   Saturday April 23rd - Competition

Innovation Showcase

2021 Pre-conditions:

1) New Code Baselines
2) New Drone
3) Same drone to execute all 4 challenges

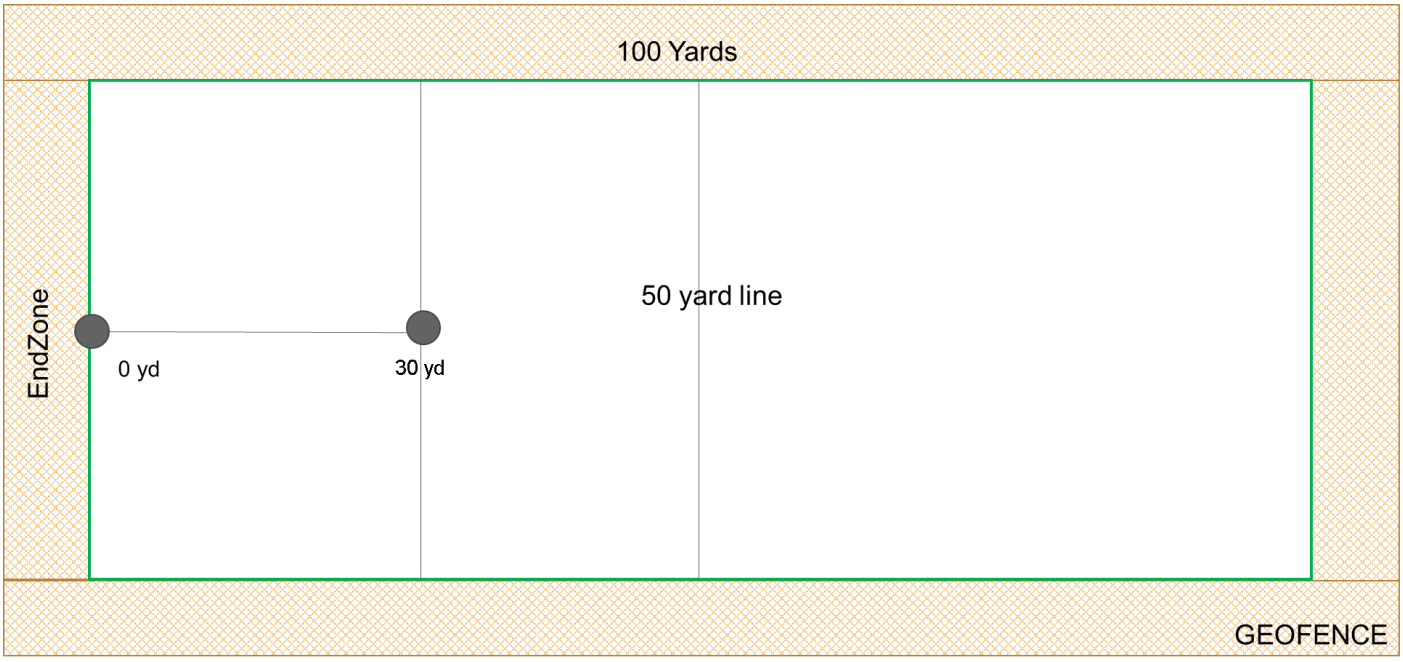
Technologies:

The Innovation Showcase challenges students with integration of various technologies such as advanced manufacturing, computer vision, cloud, edge processing, wireless technologies, command and control, system integration, chip design, avoidance, algorithms, artificial intelligence, imagery, sensing, etc.

Venue:

Currently, the UAS Innovation Showcase will occur at UT Arlington Maverick Stadium. This venue was chosen due to its proximity to the corporate sponsor and participating universities. COVID protocols will be followed per the University guidelines.

Innovation Showcase 1 – Does your drone work? (Autonomous Flight and Landing)



The purpose of the first innovation showcase is to verify basic autonomy functionality of the UAS.

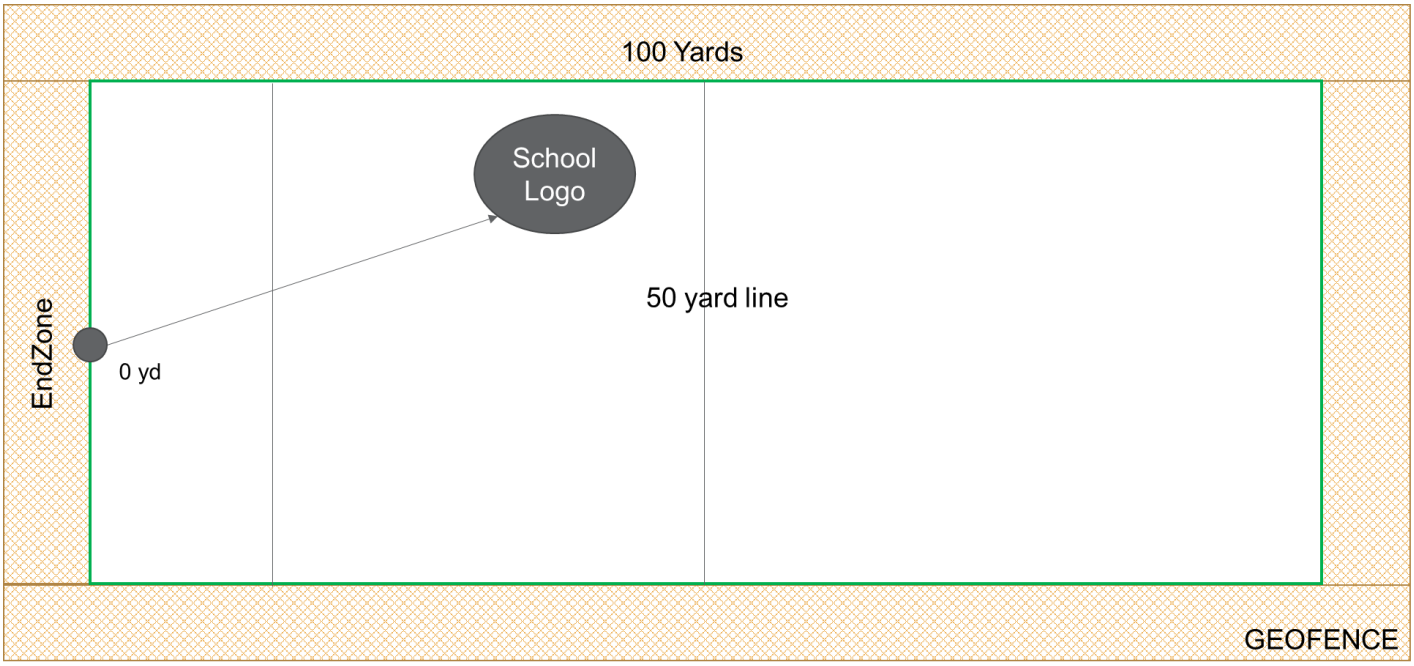
The UAS is expected to:

- Autonomously lift off at the Zero yard line on an End Zone
- Autonomously stay within a minimum of 20 feet and a maximum elevation of 30 feet
- Autonomously move across the field and land on the 30 yard line

Innovation Showcase Evaluation Criteria will be:

- How long did it take for the UAS to complete its task (timer starts on liftoff)
- Accuracy (i.e. distance) to landing spot
- Staying within elevation

Innovation Showcase 2 – Find your school logo (Autonomous Flight and Landing)



The purpose of the second Innovation Showcase is for the drone to autonomously lift off and land on a designated spot (school logo) which will be randomly placed by the corporate sponsor before the 50-yard line. Note: Other school logos may be on the field at the same time.

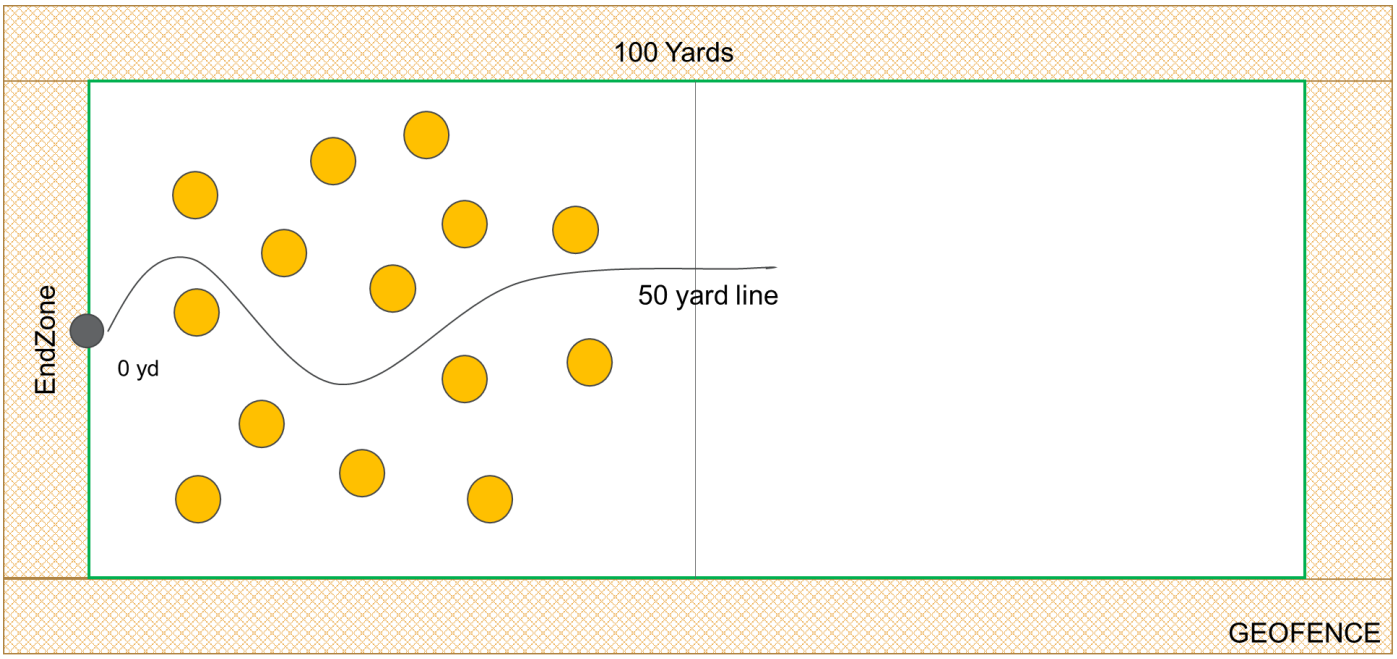
The UAS is expected to:

- Autonomously lift off at the Zero yard line on an EndZone (timer starts on liftoff)
- Autonomously stay within a minimum of 20 feet and a maximum elevation of 50 feet while searching for the logo
- Autonomously land on school logo

Innovation Showcase Evaluation Criteria will be:

- How long did it take for the UAS to complete its task (timer starts on liftoff)
- Accuracy (i.e. distance) to landing spot
- Staying within elevation
- See logo criteria in rules section for definition and constraints on the logo

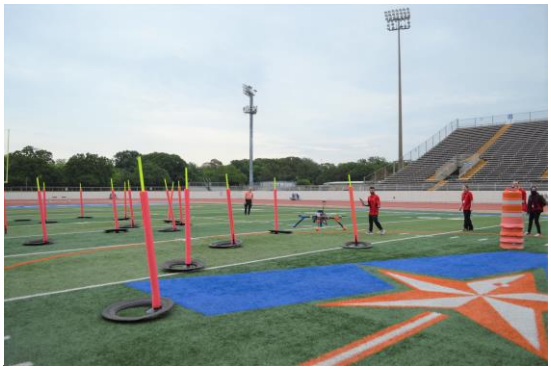
Innovation Showcase 3 – Obstacle Course (Autonomous Avoidance)



The purpose of the third Innovation Showcase is for the drone to autonomously navigate through obstacles in its path then crossing a "finish line".

The UAS is expected to:

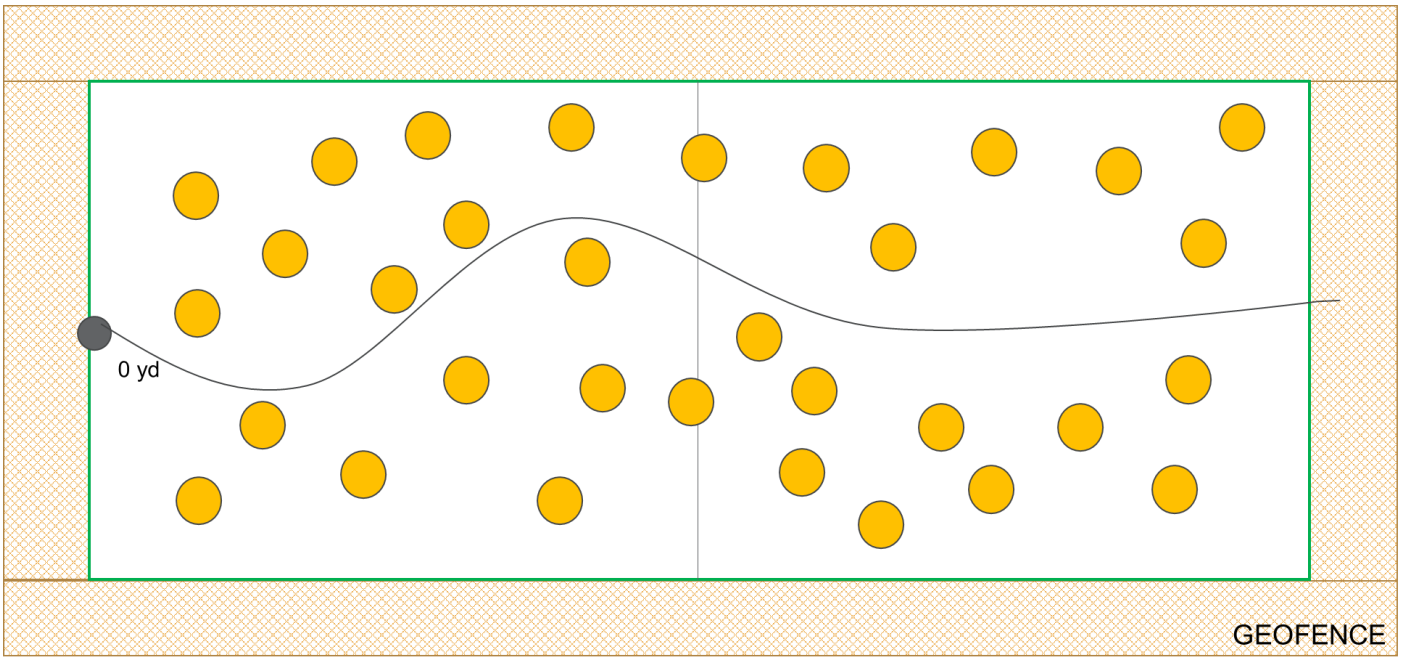
- Autonomously lift off at the Zero yard line on an EndZone (timer starts on liftoff)
- Autonomously stay within a maximum elevation of the height of stationary obstacles
    - e.g. the drone should not be able to "see" over the agility stick, and should stay slightly lower than the height of the agility stick
    - The height has been determined at approximately 5 ft
    - The obstacles will consist of soccer agility sticks covered by pool noodles (approximate width 3.5 inches)



Innovation Showcase Evaluation Criteria will be:

- How long did it take for the UAS to complete its task (timer starts on liftoff)
- Obstacle Avoidance
- Staying within elevation

Innovation Showcase 4 – Indoor collision avoidance – No GPS



This showcase is expected to take place inside a facility that has limited to no GPS signal available. The drone will need to understand its location relative to the area being flown in, and understand its mission to navigate from one point to another while avoiding obstacles at a certain height.

The UAS is expected to:

- Autonomously lift off at the "start line" of the enclosed space (timer starts on liftoff)
- Autonomously stay within a maximum elevation of the height of stationary obstacles
    - e.g. the drone should not be able to "see" over the agility stick, and should stay slightly lower than the height of the agility stick
    - The height has been determined at approximately 5 ft
    - The obstacles will consist of soccer agility sticks covered by pool noodles (approximate width 3.5 inches). These are the same obstacles as in Challenge 3

Innovation Showcase Evaluation Criteria will be:

- How long did it take for the UAS to complete its task
- Accuracy (i.e. distance) to landing spot
- Obstacle Avoidance

- Staying within elevation
- GPS Disabled

Project Management

Students are expected to manage their project using industry best practices. The following tools will be provided in order to standardize on management logistics:

Jira (Raytheon) – Project management. Jira is a tool to manage Agile methodologies. Epics will be provided.

GitHub / GitLab / BitBucket / etc.

MS Teams (School Provided)

Folder Structure will be provided by Raytheon

Weekly Team Meetings – about 1 to 2 hours per week.

Roles & Responsibilities

Project Mentor

Each university will be given a Raytheon representative as a project mentor in order to help guide the project

Judges

Judges will observe the final competition and grade based on performance and requirements met. Judges will not be project mentors

Faculty Advisor

The Faculty Advisor(s) are the professors of each respective engineering domain. Faculty advisors are typically responsible for team creation, grades, monetary logistics, and course work.

Project Manager

Students will choose a PM that will lead all the teams and be responsible for team communication, logistics, requirements verification and validation, and overall success of the project

Student Teams

Teams will consist of undergraduate students in the field of computer science and engineering disciplines. Teams from each university will be limited to no more than 15 students total.

Surprise Challenges

A surprise challenge may be executed on the day of the event. Teams will be notified of the surprise challenged approximately 1 week prior to the event.

Awards & Evaluation

Raytheon's desire is to encourage students to embrace innovation and real world experience to further both the school and the individual's experience. Independent Raytheon leadership will evaluate each teams' project based on the following categories:

- Innovation Showcase 1 Performance

- Innovation Showcase 2 Performance
- Innovation Showcase 3 Performance
- Innovation Showcase 4 Performance
- UAS Design Discriminators – for example:
    - Weight of UAS
    - Budget of UAS
    - Mechanical Design
    - Search and Landing Algorithm
    - Component Integration
    - UAS Presentation and Poster

Evaluation will result in general feedback for each category above. Students will provide posters during the showcase based on their school requirements.

Rules

General Rules:

Teams will follow the FAA Drone Requirements for Educational Users and Institutions of Higher Education. The UAS field is always evolving, so please refer to the FAA for the latest specifications and regulations.

Part 107 is the primary law for flying small drones (less than 55 lbs.) in the United States.

Institutions of Higher Education. There is also a statutory provision (PL 115-254, Section 350) that distinguishes some educational and research uses of drones by institutions of higher education as recreational in nature. The FAA intends to publish specific implementation guidance for Section 350 later this year.

- Safety is the highest priority for the participants. No careless or reckless operations and no carriage of hazardous materials.
- Students will provide body of evidence of meeting the weight specifications prior to the showcase. This can include but is not limited to photographic evidence of weight (i.e. on a scale), to onsite weighing.
- Each university will be responsible for providing an area (i.e. field) for students to access to perform development and testing. This location will conform to the rules and regulations.
- Innovation Showcase aircraft will be limited to flying within a geofence(i.e. the stadium) in order to prevent operation over any persons not participating in the operation.
- Students will have to provide a means of verification of speed, such as outputting the flight controller information to a display, or limiting via software/hardware mechanisms
- Pre-flight inspection will be performed prior to the Innovation Showcase to verify UAS is safe to fly and meets all rules and regulations.
- Students/Universities must register their drones. dronezone.faa.gov.
- At least one student will need to become an FAA Certified Drone Pilot

Logo:

The school logo (aka landing spot) will be created by the students. The only requirement is that the logo be 2 ft by 2 ft square. Students will design the logo and should consider techniques such as materials to be used, design of the logo, detection technologies, etc. The logo cannot contain internal homing beacons (i.e. Bluetooth, wifi, or GPS)

Note: All showcase challenges may be repeated multiple times depending on time and availability of resources. Schools should only have one version of their logo, but may have multiple copies available.

Budget:

- Each university will have a budget of $5,000 USD to use on this project. This budget can be used for hardware and software expenses to help the students accelerate their prototype.
- Procurement of hardware and software will be done via the university procurement process
    - Students will be asked to provide a budget breakdown prior to the Innovation Showcase
- The use of open source hardware and software is recommended

Drone Design:

- Students have the opportunity to conduct a trade study on what hardware and software configuration are necessary in order to complete the assigned tasks and will have to assess with their mentors the best path forward.
    - Items to consider are weight, speed, complexity, location of components, battery life, open source vs custom design, etc.
- For showcases that require GPS, the drone will be expected to integrate RTK. This will require the drone to have an Internet connection at all times during the challenges that require GPS.

Healthy Tips:

- Obtain Training for:
    - Project Management (PM)
    - Agile (entire Team)
    - SRR, SDR, CDR, TRR
    - Machine Learning
    - Image Recognition
    - Drone Pilot

Appendix A – References

Jira Link:

Agility Sticks Purchased from: