



FY 23 International State/Province Level Unmanned System Challenge

Student, Coaches, and Mentors Guide Version 1.0

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I. Introduction

Welcome to the Real World Design Challenge. This handbook is designed to provide information that you will need to successfully work through the Challenge.

The Real World Design Challenge is a Science, Technology, Engineering, and Math (STEM) competition for teams of three to seven high school students. This year's Challenge focuses on unmanned aviation. High schools can enter as many teams as desired. The Challenge and additional supporting materials will be issued online and made available through the Real World Design Challenge website (<http://www.realworlddesignchallenge.org>). You will use professional software tools and have an opportunity to collaborate with mentors from industry, government, and academia.

For this Challenge your team will design an Unmanned Aircraft System (UAS) and develop a business plan in support of a specific commercial application (see RWDC challenge statement). The competition will take place in two rounds. First is the state or province level. All U.S. states and Territories are eligible to participate as well as other countries.

The champion teams from each participating state or territory or province will move on to the National/International Challenge. You will get an additional problem that builds on the State/Province Level Challenge to compete in the National/International Challenge. The top three teams from each country will be recognized with trophies, and other top teams from each country recognized with Merit Awards. Important Resources

Keep checking our website www.realworlddesignchallenge.org for updates along with the getting started page http://realworlddesignchallenge.org/RWDC_Getting_Started_Page.php.



II. Instructions

These instructions outline the basics of what you will be doing in the Real World Design Challenge. The rest of the guide will fill in the finer details.

Register

Registration is easy. Teachers register the whole team of three to seven high school students. Your team must register for this year's Challenge even if you have participated in the past.

Just go to www.realworlddesignchallenge.org and choose Sign Up. **You may register as many teams as you like!** There is no limit to the number of teams you may register. You may have students from different schools but all students must be from the same state or province.

And take a look at the *RWDC Getting Started Page* (http://realworlddesignchallenge.org/RWDC_Getting_Started_Page.php). **The Getting Started Page is the place to go!!!** You should go to the Getting Started Page daily. New material will be updated frequently.

Contact your State/Country Coordinator and Mentors

When you get started, you should contact your State Coordinator. This person is a resource about the RWDC in your state. You can find him or her by going to the Participating States or Country page on www.realworlddesignchallenge.org and selecting your state or country.

You will also need to find a mentor. Mentors may be found at universities, companies and government agencies. Find a mentor as soon as possible. Mentors will provide technical advice to your team over the course of the challenge. **It is important that you begin working with your mentors right away!** They will help you formulate your plan of action, provide content expertise and be your key resource. Do not wait until you have your ideas together. Build your relationship with your mentors now! New mentors will be added to the page so keep checking for people with whom you want to work.

Please be courteous with your mentors. If you decide that you no longer need a specific mentor, please let him or her know so that he or she can help other teams.



Getting Started

Once your team is registered, you should follow the steps outlined on the *RWDC Getting Started Page*.

What should my team do to get started?

Step 1: Register your team for the RWDC Competition

Step 2: The easiest way to get your team prepared for this Challenge is to review Challenge materials on the Getting Started Website. Be sure to review the following documents:

- FY24 RWDC State Challenge Statement
- FY24 RWDC Challenge Detailed Background
- FY24 RWDC Scoring Rubric
- FY24 RWDC Student/Teacher/Coaches Handbook

Step 3: As with previous years, a team's ability to successfully solve the Challenge is made possible largely through the active partnership with mentors. **Contact a mentor as soon as possible.**

Step 4: Download the software applications that will be used for this year's challenge

- RWDC Software Applications (<https://www.ptc.com/en/academic-program/academic-products/free-software/creo-download>)
- Please specify how many computers on which you will be installing the software.

Step 5: Participate in the RWDC Training Webinars and RWDC Courses

All teachers and students should go through the RWDC Getting Started Courses. In addition, training webinars will be scheduled regularly through the Challenge to demonstrate tools and answer your questions. Information on Training Webinars, PowerPoints and materials will be posted on the RWDC Getting Started page.

Step 6: Complete Formative Surveys

Teams will receive points in their *Engineering Design Notebook* scoring for completing Formative Survey's throughout the challenge. Surveys will be distributed through email to teams and mentors. The surveys will help assess areas where teams need help and will allow the RWDC support team to take proactive steps to help teams stay engaged, and work through technical challenges leveraging mentors, webinars, and direct feedback.



Step 7: Download and monitor RWDC Challenge Resources

New Resources are added frequently – Keep checking to see what is new!

Download the RWDC Challenge Kit. This kit is what will include all materials for the challenge. The kit contains all the necessary Mathcad worksheets and other support materials.

For general questions contact Jeff Coppola at jeffcoppola@gmail.com.

For technical questions about PTC's Creo CAD software go to:

https://support.ptc.com/apps/cs_loggers/academic/log.

If you have additional questions visit the RWDC home page at www.realworlddesignchallenge.org.

Train on the software

Now that you have the software, it is time for teachers and students to do basic training on the various software packages provided by RWDC. Going through the RWDC Courses will introduce you to the software used in the Challenge. Not only will this course provide a good foundation for the Challenge, it will also introduce you to all the applications used in the Challenge.

And if you get stuck or need some help, please send your questions to

https://support.ptc.com/apps/cs_loggers/academic/log.

Solve the problem

Once you have the software and have gone through the RWDC Courses, you're ready to tackle the Challenge. The Challenge Statement is posted on the Resources menu on www.realworlddesignchallenge.org.

Submit your solution

Once you have completed the Challenge, you will send a copy of your *Engineering Design Notebook* to your RWDC State or Country Coordinator and to Jeff Coppola at jeffcoppola@gmail.com. State Coordinators are listed on your State Page and Country Coordinators are listed on your Country Page. Additional instructions on submitting your solution will be provided by email to your team.

Teams will compete with all of the other teams in your state or province. If you are selected as the State Champions, you will be invited to compete in the National/International Championship. You will receive an additional Challenge that builds on the State Challenge. At the National/International level you will modify your *Engineering Design Notebook* to address the additional requirements and prepare a PowerPoint presentation. Both of these deliverables are due in April.



Help

If you need help with anything, we have a number of resources:

- **RWDC Courses** – These prepare you for the Challenge by providing preparation in the use of the software and an introduction to aeronautical engineering and business plan development.
- ***The Student, Coaches and Mentors Guide***—Contains the information you need to participate in the Challenge.
- **Challenge Statement** – Provides the requirements for problem to be solved.
- **Scoring Rubric**- Provides the details on how all of the Challenge requirements will be evaluated by the judges. It also is the format for the sections of the *Engineering Design Notebook*. The Engineering Design Notebook should include all the headings from the Scoring Rubric so the judges can easily identify how you address the requirements. The Scoring Rubric also provides details on what information is expected for each section along with the number of points provided for the sections.
- **Challenge Detailed Background** - Contains detailed materials to familiarize you with the technical aspects of the challenge.
- **Training Videos**—Posted on the Getting Started Page (http://realworlddesignchallenge.org/RWDC_Getting_Started_Page.php) and cover the technical skills you will need to complete the Challenge
- **Technical Support**— Submit your questions to Jeff Coppola at jeffcoppola@gmail.com.
- **Mentors**—Mentors provide content support to teams. They are not responsible for technical support.
- **State & Country Coordinators**—Participating states and countries have a Coordinator who serves as an intellectual resource for the Challenge. Find yours by going to the States or Country page, finding your state or country and going to your specific state’s or country’s page. Your coordinator’s contact information will be on the state or country page. If you are in an Independent State or Country or if your state does not have a State Coordinator and you need help contact Jeff Coppola at jeffcoppola@gmail.com or by phone at 703-965-2870.

III UAS Design Approach

There are five UAS design areas teams need to research to develop their Challenge solution. These include:

1. Sensors
2. Platforms
3. Command, Control, Communications (C3)
4. Support Equipment
5. Operators.

Each UAS design area will need to be investigated based on the mission requirements of the Challenge. The mission requirements are given in the Challenge Statement. Teams should use the Engineering Design Process to develop and refine each area of research. Each element of the five UAS design areas



of research should be detailed in the Teams' *Engineering Design Notebook*. The Engineering Design process should be used to investigate the UAS areas of research. Teams should document the Engineering Design Process in the *Engineering Design Notebook*. The UAS areas of research should be discussed in the context of using the Engineering Design Process. The Engineering Design Process is represented in the RWDC Scoring Rubric. The RWDC Scoring Rubric provides the details of what will be evaluated in the *Engineering Design Notebook*. Points are provided for each section in the RWDC Scoring Rubric. Judges will use the RWDC Scoring Rubric to evaluate the Teams' *Engineering Design Notebooks*.



IV. The Challenge

The full text of the Challenge and supporting materials are posted on the RWDC Getting Started Site (http://realworlddesignchallenge.org/RWDC_Getting_Started_Page.php) on 1 September.

FY24 RWDC State Uncrewed Aircraft System Challenge: Wildfire Monitoring and Mitigation

Background

Uncrewed Aircraft Systems (UAS) have near-term potential for numerous civil and commercial applications. The FY24 RWDC State challenge will continue the focus on Uncrewed Aircraft Systems and implementation of a UAS. This year's mission is to develop an uncrewed aircraft to help with wildfire mitigation. The teams will use concepts from Engineering Technology (i.e., application of science and engineering to support product improvement, industrial processes, and operational functions) to identify, compare, analyze, demonstrate, and defend the most appropriate component combinations, system/subsystem design, operational methods, and business case to support the challenge scenario. Through use of an inquiry-based learning approach with mentoring and coaching, the students will have an opportunity to learn (and apply) the skills and general principles associated with the challenge in a highly interactive and experiential setting. For example, the students will need to consider and understand the various Uncrewed Aircraft System elemental (subsystem) interactions, dependencies, and limitations (e.g., power available, duration, range of communications, functional achievement) as they relate to the operation, maintenance, and development to best support their proposed business case.

To support the inquiry-based learning approach, each team will perform and document the following in an engineering design notebook:

- 1) **Task Analysis** - analyze the mission/task to be performed
- 2) **Strategy and Design** - determine engineering design process, roles, theory of operation, design requirements, system design, integration testing, and design updates
- 3) **Costs** - calculate costs and anticipated capabilities associated with design and operation, including modification of the design to further support a competitive and viable business case

As you progress through the challenge, your team will incrementally be presented with background relating to the composition and operation of Uncrewed Aircraft System designs, engineering design principles, business management, and development tools. You will need to work together as a team with coaches and mentors to identify what you need to learn while pursuing the completion of this challenge. By connecting your own experience and interest, you will have an opportunity to gain further insight into the application of design concepts, better understand application of Uncrewed Aircraft System technology, and work collaboratively towards completion of a common goal.



Challenge

This year's challenge is to design Uncrewed Aircraft Systems (UAS), create a theory of operation, and develop a business and communication plan for the system based on the following scenario.

Scenario: *In the United States, wildfires burn over a million acres of forests and grasslands each year with over a billion dollars being spent to fight these wildfires. Many state agencies, federal agencies, and companies are working together to develop strategies and technologies to tackle the complex problem of wildfires. Small-uncrewed aircraft have the potential to make a large impact on fighting wildfires by providing data with more spatial and temporal resolution than current sources. Your company has been asked to develop a single aircraft platform that can provide required data before a wildfire, during an active wildfire, and after a wildfire. If necessary, payload sensors may be switched during the different missions, but cost of the overall system is a major consideration. A set of design criteria has been developed that designs and analyses must follow. Companies can consider the environmental conditions common to the western United States (forests and grasslands) as the baseline region of focus; however, considerations based on other regions (within and outside the United States) are encouraged. Successful proposals may be invited to the next round.*

Overall Design Criteria:

- *At least 30 min of flight time*
- *Operational range of at least 2 miles*
- *Communication range of at least 5 miles*
- *Small enough in size and weight for the UAS to be transported by the operator hiking to the deployment location*
- *Provide real time and accurate location information to all other aircraft in the area*

Pre-Fire Criteria:

The purpose of the sUAS is to gather data that will help monitor potential locations of wildfires and will help in enhancing prediction models to assess wildfire risk. At a minimum, the sUAS must gather the following data at a resolution better than current methods.

- *Fuel type and amount*
- *Moisture levels (ground and fuel)*
- *Air boundary layer (wind directions, height, and humidity)*
- *Thermal information (air, ground, and fuel)*

Active Fire Criteria:

The purpose of the sUAS is to provide real-time data that will aid the firefighting effort. This data will also be used to improve fire models and potentially real-time digital twins. At a minimum, the sUAS must gather the following real-time data at a resolution better than current methods and in the possible presence of dense smoke.

- *Current fire edge*
- *Thermal information*
- *Fuel type and amount*



- *Moisture levels*
- *Air boundary layer*

Post-Fire Criteria:

The purpose of the sUAS is to gather data that will help monitor areas after a wildfire and will help with post-fire models. After a wildfire, there is an increase chance of flooding due to excessive runoff from burn scars and a chance for landslides. At a minimum, the sUAS must gather the following data at a resolution better than current methods.

- *Vegetation*
- *Moisture levels*
- *Thermal information*
- *Air boundary layer*

Business case:

For this year's business case, your team will be developing a proposal to create a UAS to help combat wildfires. For the business case you will need to include the following elements

- **Operating cost** – *the cost it takes you to fly, not accounting for the cost of the aircraft and equipment. This includes fuel and personnel.*
- **Fixed costs** – *how much are the components of your system. This does include the components of your aircraft and equipment.*
- **Communications plan**- *For this element you will need to have a plan for how you will explain your idea to policy makers. Teams will need to be able to briefly explain the importance of addressing wildfires and how their design will be useful tool for dealing with wildfires. Teams should give a compelling argument of not only the importance of the issue but also why their design should be used. Teams' communication plan should have the following characteristics*
 - *Plan for concise communication (Teams need to explain their strategy in addition to showing what they plan to say to the policy maker)*
 - *Teams should explain the strategy behind their planned communications*
 - *There will be an example of what will be said to policy makers*
 - *For the communication to policy makers it is better to say less more effectively than to try to cram more information into a small amount of time.*
 - *Clear communication requiring no background in fires or aviation*
 - *It is important to explain things not only so anyone should be able to understand but so that people cannot misunderstand.*
 - *Compelling reason to use the proposed design*

Objectives

Your designs will be judged on how well they satisfy the objectives while meeting the requirements above. It will be up to your team to decide on your design and provide sound engineering arguments to justify your design decisions.

- Minimize your costs
- Maximize aircraft performance



Other Resources

- RWDC State Uncrewed Aircraft System Challenge: Detailed Background
- RWDC State Engineering Design Notebook Template
- RWDC State Challenge Scoring Rubric
- Student, Coaches, and Mentors Guide
- Challenge Statements and Detailed Backgrounds from previous RWDC competitions
- Winning Engineering Design Notebooks from previous years
- RWDC Content Webinars (schedule to be determined)
- The RWDC Support Site with FAQs, tutorials, material allowables, and other supporting materials: Getting Started section of the RWDC website (<http://www.realworlddesignchallenge.org>).
- Mentors from the aerospace and defense industry, government agencies, and higher education

Tools

- PTC Creo Computer Aided Design (CAD) software for 3D geometry design (if you have other CAD tools, you may use them)

Team Submissions

The Engineering Design Notebook submission including the business plan and appendices must be 80 pages or less. Detailed information regarding what must be documented can be found in the RWDC FY24 State Challenge Scoring Rubric. Teams must submit the following:

1. Engineering Design Notebook (refer to RWDC FY24 State Challenge Scoring Rubric)
2. CAD drawings in Engineering Design Notebook (refer to RWDC FY24 State Challenge Scoring Rubric)

Scoring

- Teams' submissions will be evaluated based on criteria outlined in the RWDC FY24 State Challenge Scoring Rubric and in reference to the example mission scenario
- Technical scoring will be based on deliverables to be incorporated in the Engineering Design Notebook
- Engineering Design Notebooks must follow the paragraph order of the RWDC FY24 State Challenge Scoring Rubric
- Judges will be looking for the ability to express comprehension and linkage between the design solutions with what students have learned. Specific recognition will be given for design viability, manufacturability, innovation, business plan development, and additional application beyond the package delivery mission



Merit Awards

Special RWDC Merit Awards will be given at the National/International Challenge Championship. Merit awards will be granted at judges' discretion to teams that do not place in the top three but are top performers overall. Only one merit award will be granted per team. Awards will be based on the team presentation and Engineering Design Notebooks.

- Innovation
- Design Viability
- Teamwork and Collaboration
- Effective Mentor Collaboration
- STEM Interest Impact
- Most Creative
- Against All Odds
- Best Business Case
- Best First Year Team
- Judges Award

Contacts

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Team Submissions

The Engineering Design Notebook submission including the business plan and appendices must be 80 pages or less. Detailed information regarding what must be documented can be found in the RWDC FY21 State Challenge Scoring Rubric. Teams must submit the following:

1. Engineering Design Notebook (refer to RWDC FY21 State Challenge Scoring Rubric)
2. CAD drawings in Engineering Design Notebook (refer to RWDC FY21 State Challenge Scoring Rubric)



Scoring

- Teams' submissions will be evaluated based on criteria outlined in the RWDC FY21 State Challenge Scoring Rubric and in reference to the example mission scenario
- Technical scoring will be based on deliverables to be incorporated in the Engineering Design Notebook
- Engineering Design Notebooks must follow the paragraph order of the RWDC FY21 State Challenge Scoring Rubric
- Judges will be looking for the ability to express comprehension and linkage between the design solutions with what students have learned. Specific recognition will be given for design viability, manufacturability, innovation, business plan development, and additional application beyond the package delivery mission

Merit Awards

Special RWDC Merit Awards will be given at the National/International Challenge Championship in Washington, DC. Merit awards will be granted at judges' discretion to teams that do not place in the top three, but are top performers overall. Only one merit award will be granted per team. Awards will be based on the team presentation and Engineering Design Notebooks.

- Innovation
- Design Viability
- Team Work and Collaboration
- Effective Mentor Collaboration
- STEM Interest Impact
- Most Creative
- Against All Odds
- Best Business Case
- Best First Year Team
- Judges Award

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V. Coaching an RWDC Team

Who can be a Coach?

An RWDC coach can be a formal classroom teacher in any school or an adult advisor to an after school or informal learning program. Although having specific expertise in engineering principles or a degree in a STEM-related field may be helpful, coaches are not required to have a technical background to participate. Coaches can be, but are not limited to: technology education teachers, science teachers, math teachers, or someone who is overseeing a math or science club or museum program.

What role does the Coach play on a team?

The coach should act as a facilitator, advisor, and educator for the team. Due to the competition's reliance on engineering software, the coach should be prepared to arrange access to computer-related resources and assist students in getting training with software.

What does a Coach do?

A coach may find it necessary to do any or all of the following:

- * Provide meeting space
- * Create a schedule of meetings
- * Attend and supervise all meetings
- * Obtain approval from school and permission from parents
- * Train or assist students in getting training in the use of PTC Creo 3D CAD software or other CAD software
- * Share the digital plane parts, training video, and other analysis tools provided to support the teams' work
- * Provide access to resources for students
- * Seek support, and encourage students to seek support, from mentors
- * Offer guidance, lessons, or suggestions on basic fundamental principles in engineering (design process), science, and math
- * Assist with defining the roles of team members
- * Assist with communication and connection between the team and its mentor(s)
- * Provide suggestions and constructive feedback on strategy and models
- * Travel with and chaperone team, if necessary, at national event and other related events



- * Oversee online secure sites for team: register team, access online forms and password-protected areas, and assist with final submission
- * Assist with final submission criteria: oversee student deadlines and ensure all submissions are made properly and timely.

Support

It is important that you have support from the key players in your community, such as administrators, teachers, and parents. Because each team must have access to resources, communicating with your Teacher/Coach, school principal, or superintendent will be essential. It is much easier if support is requested early and the approvals and permissions are arranged in advance.

Operating in Other Venues

Even if your team decides to work outside a formal school setting, it is likely that you will need to have an established educational organization to provide you with access to useful facilities. You may choose to work on the Challenge in an after-school program, such as a school club; through Boy or Girl Scouts; at a science or technology center; or through another educational program.

Contacting Mentors

One of the first things that you do when you sign up for the Real World Design Challenge is finding a mentor. Please be courteous to mentors and respect their time.

There is a list of mentors available on the Getting Started Page (http://www.realworlddesignchallenge.org/RWDC_US_Getting_Started_Page.php) under the link Find a Mentor to Help Your Team. Look through the list and find an initial mentor. As you progress through the Challenge, you can add up to three additional mentors, but start with one.

You may reach out to several mentors to find one, but once you choose one, contact the other mentors that you are not using. Let them know that you will not need their assistance.

Once you have found your first mentor, please set up a call with that person to get to know him or her and to discuss the project.

Mentor's Roles

Mentors are professional scientists and engineers who will help you with the Challenge. Each team may recruit a maximum of five mentors with expertise in science, mathematics, engineering, aviation design and business. Mentors may limit the number of teams they choose to assist and the amount of time they will devote to the mentorship process. Accordingly, mentors will be available on a first come/first served basis.

1. Mentors will present STEM concepts to your team in a fun and exciting way and give you a chance to interact with real world engineers and scientists.
2. They will help to stimulate creative thinking through assisting your team with the hands-on design of your project.



3. Mentors will provide advice to your team during the State Challenge, which will run from September through January.
4. If the Mentor's team is the State Winner, then mentors will provide advice for the winning team's National Challenge efforts through the end of the National Competition.
5. The Mentor is your subject matter expert.
6. Mentors will provide advice to you on science, math, and engineering principles and be a content resource for your team.
7. The Mentor is also the Teacher/Coach's advisor, assisting with knowledge of core principles processes, and knowledge of science, math, and engineering.
8. The Mentor should NOT solve the problem of the Challenge for the team.

VII. Software

All the software in the Real World Design Challenge is provided to you for free. You should download everything and get it working as soon as you sign up for the Challenge. To download the software applications that will be used in this year's challenge:

Download the Software. First if you are a first time user or have not already created a PTC academic account. Next check to see the [system requirements](#) then follow the steps below

- [Create an academic account](#)

PTC Creo 9.0:

- **Step 1:** Download the **PTC Creo 9.0 from the link below**
 - <https://www.ptc.com/en/academic-program/academic-products/free-software/creo-download>
 - **DOWNLOAD Note:** All downloads are Zip files and need to be extracted prior to use.
- **Step 2:** Follow the **PTC Creo 9.0 install guide listed below**
 - [Creo 9.0](#)

If you have any issues request technical support and you will receive a response on how to deal with your individual issue. For technical support contact Jeff Coppola at jeffcoppola@gmail.com phone 703-965-2870.

Instructions are also provided on the "Getting Started" page on the RWDC website www.realworlddesignchallenge.org.

There are also videos on the Getting Started Page to learn how to use the software. www.ptcschools.com is available as a free training resource in PTC Creo.

Here is a list and descriptions of the software you will be using:

PTC Creo

PTC Creo is the standard in 3D product design, featuring industry-leading productivity tools that promote best practices in design while ensuring compliance with your industry and company standards. Integrated, parametric, 3D CAD/CAM/CAE solutions allow you to design faster than ever, while maximizing innovation and quality to ultimately create exceptional products. PTC will be providing PTC



Creo for each team. If you have other CAD software that you prefer, you may use that software.

VIII. Solving the Challenge

Inquiry-based learning approach:

Through use of an inquiry based learning approach with mentoring and coaching, the students will have an opportunity to learn the skills and general principles associated with the challenge in a highly interactive and experiential setting. For example, the students will need to consider and understand the various UAS subsystem interactions, dependencies, and limitations (e.g., power available, duration, range of communications, maintenance of visual contact) as they relate to the operation, maintenance, and development to best support their proposed business case. To support the inquiry based learning approach, you will be provided with a basic framework associated with the following focus areas:

- 1) **Task Analysis** - analyze the mission/task to be performed
- 2) **Strategy and Design** - determine engineering design process, roles, theory of operation, design requirements, system design, crew resources, integration testing, and design updates
- 3) **Costs** - calculate costs and anticipated capabilities associated with design and operation, including modification of the design to further support a competitive business case

As your team progresses through the Challenge you will incrementally be presented with background relating to the composition and operation of UAS designs, basic aeronautical and engineering design principles, UAS application, and business management and development tools. You will work together as a team with fellow students, coaches, and mentors to identify what you need to learn as you move towards the completion of this Challenge. By connecting your own experience and interest you will have an opportunity to gain further insight into the application of design concepts, better understand application of UAS technology, and build those priceless experiences that will guide you on your own path to success.

Examine the Challenge and identify what needs to be done:

Now that the State Challenge is issued, determine what the goals are and what you will need to do to win. **Tip:** Look at the *RWDC Scoring Rubric* and see what the judges will be looking for and design your solution so that they conform to the *RWDC Scoring Rubric* in the order that they are provided. This helps make sure the judges will see all of your work and will not miss anything.

Determine what resources are needed to solve the problem:

You will need to figure out what resources you will need to solve the problem. These will include: (a) human resources (team members with expertise needed to do the task you identified); (b) research on what has been done to address the problem by others; and (c) tools needed to do the job.



Gather Your Resources

Each team's goal is to create the best solution to the Challenge. This will require students to develop a strategy that addresses the following topics: team expertise, mentor expertise and support, differentiated roles, collaboration, capacity, and approach. Educational materials will be available to support the development of student team strategies, melding the professional practice of research-based product design with the entertainment value of role-playing games.

Researching What Has Been Done and Gathering Information

There are resources provided to you on the *Real World Design Challenge Website*. These are just a beginning. You should start your research by exploring what others have done to address similar Challenges, research, or technology design. You may find information on the Web, in libraries, and from mentors or other experts. Researching what has already been done will be the springboard for your work. From that information you will learn what others have tried and get ideas for how you may better develop an approach to solve the Challenge.

Develop Challenge Team

Team members should be recruited to provide a variety of skills to the team. There should be distinct divisions of labor in the roles and functions of each team member. The exact set of team roles will be up to the team and may vary based on local expertise and strategy. Note that not every role needs to be filled and some team members may have multiple roles depending on available expertise and interest.

The nature of each team will determine how it functions. For instance, teams that meet after school will face a different set of needs than teams that function within a classroom. Your Teacher/Coach will help you decide which approach will work best in your community.

Not every member of the team needs to be an expert in the use of all the tools. However, at least one team member, the Project Engineer should possess a high degree of skill with the software. It is recommended that all team members have a working knowledge of these tools. The tools are provided to the teams for free.

Suggested Team Roles

Project Manager

The Project Manager will be responsible for recruiting a winning team and leading strategy design. The Project Manager is responsible for the overall success of the product or program. The Project Manager is the individual responsible for managing the project plan and deliverables, ensuring that all project team members have the necessary resources required to complete the project, and reporting status for the team, tracking timeline and milestones, and quality. Many times this individual plays additional roles in the project. The Project Manager leads the cross-functional team and is typically responsible for the development of the overall product, program or *Engineering Design Notebook*. They often monitor several interrelated sub-project activities engaged in by team members.



Design Coordinator

The Design Coordinator role arises your team is composed of members that are geographically dispersed. The role will not apply if your team is within a single class. The Design Coordinator acts as the liaison between the design partner and other internal engineering teams. The Design Coordinator is often responsible for integrating new or modified design data into the overall product design. The Design Coordinator is the primary interface with the third- party partner. The Design Coordinator coordinates partner engineering resources and is either located locally in another class at the team's school, or remotely in another school.

Systems & Test Engineer

The Systems Engineer defines the product architecture, its modules, and interfaces. He or she has ultimate responsibility for ensuring the various parts of the product will work together as a whole when finally assembled. They provide direction to the design team, manage interfaces, and participate in design reviews. The role of Test Engineer is responsible for testing prototypes of designs and pre-production products created by the design team. The Test Engineer reviews test cases generated by the design team and collaborates with the design team during the testing phase. This role is the liaison with an engineering mentor, assisting the team with the incorporation of engineering advice. This person may also be a project simulation engineer on the team.

Simulation Engineer

The Simulation Engineer is the expert in the authentic simulation and modeling tools, such as 3D CAD. The Simulation Engineer is responsible for simulation and modeling application interoperability, file compatibilities, and file transfer.

Project Scientist

The Project Scientist should have a background in physics or a related field. This role will be responsible for the scientific integrity of the approach and for translating the scientific principles into the team's engineering design. This role is the liaison with a science mentor, assisting the team with the incorporation of scientific advice.

Project Mathematician

The Project Mathematician should have a background in mathematics, with a minimum of algebra and trigonometry. This role will be responsible for the mathematical integrity of the approach and for translating the mathematical principles and applications into the team's engineering design.

Marketing Communications Specialist

The Marketing Communications Specialist integrates ideas, approaches, and applications from the design team into written documents, videos, and presentations. This role is responsible for the team's brand. This person represents the team to the media and will work with the teacher/coach to coordinate event activities.



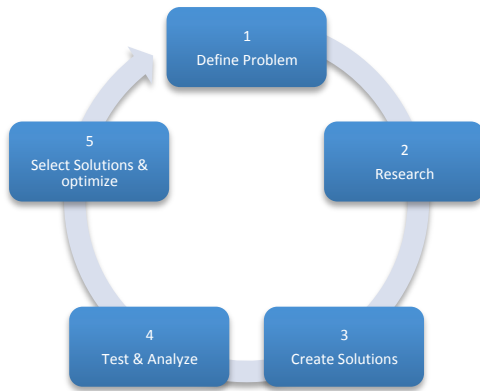
Utilize the Design Process

Engineers use a specific process to solve problems. The design process provides an effective way to learn how to develop innovative solutions in a systematic way. The process is much like the inquiry process in science. To effectively learn it you need to use it. All team members should learn and participate in the design process. Although the process has been described in a number of different ways, the basic concepts include the following:

1. Define the problem and need. We will provide the Challenge to you and that will frame the problem. You will need to define how you will solve the problem. This will provide the foundation for organizing your team and developing a work plan.
2. Research and gather important information about the problem. We will provide reference material, but we encourage you to identify additional material that will help you understand what others have done to address this type of problem. This information will help you develop an approach to the solution.
3. When you start out, you should brainstorm multiple possible solutions to the problem. Through your research you will be able to narrow and refine your potential solutions. When you identify the few you like best, design and test them.
4. Test, analyze, and gather data on the solutions. Testing the solutions will provide data on how well they worked in addressing the problem. Based on these data you will be able to modify your designs and choose the one that is the most promising.
5. Identify the solution that seems the most promising. Use your test data to modify the design and improve it.
6. Revise or redesign the best solution based on testing and analysis. This step may be done multiple times until you are satisfied with the results.
7. Develop a plan to communicate the results of your work to others. Keep in mind that your reviewers will be looking for a justification of your approach based on test data and your analyses. Also make sure that you include information about how you worked together as a team. Each member of the team should have made a contribution to the solution.

Engineering Design Process

Figure 1: Overview Engineering Design Process



The *Engineering Design Process* is used during each *Design Phase*.

Design Phases

1. **Conceptual Design** (Many designs at least eight per team member)
2. **Preliminary Design** (Narrow down to three designs per team)
3. **Detailed Design** (One design per team)

The Engineering Design Process has been represented in a number of ways but the basics are: 1. Define the problem, 2. Research the problem, 3. Create solutions, 4. Tests and analyze the solutions, 5. Select solutions and optimize them. This process is used multiple times in the context of each phase of the process: 1. In *Conceptual Design* many ideas are developed and explored; 2. In *Preliminary Design* the number of ideas are narrowed to best ones based on employing the Engineering Design Process; then in *Detailed Design* the most promising design is chosen and optimized using the Engineering Design Process. The more iterations of the process the better the design will be. The number of iterations is often determined by the amount of time available.

Develop a Design Plan

To be successful you will need to have a plan for your work. This should include the following:

- Team members with expertise to address the Challenge in fields such as science, math, and design
- Mentors to supplement the expertise of your team
- Physical resources such as a place to meet and work, computers, and software loaded on the computers
- A strategy that includes the application of the design process and mathematical and scientific principles to the Challenge
- Preparation of your Challenge Solution submission

Establish a Timeline with Milestones

A timeline with milestones is key to your success. You may need to revise this timeline as your work progresses. The Project Manager should call regular team meetings (at least once a week) to review the progress that everyone has made on their tasks:

- Key events should be noted as milestones. These milestones, such as the due date for the submission of the Challenge Solution, should drive the dates for the other tasks.
- It is easy for time to rush by so be sure to create a timeline with specific tasks for each team member.
- If problems arise, they should be dealt with efficiently and effectively, and a revised timeline should be created with the plan to resolve the problem included.

Develop and Utilize a Communication Plan

Strategize How to Communicate Your Challenge Solution

Keep in mind that a quality Challenge Solution is likely to require multiple drafts before it is polished and ready to submit. You need to plan for that part of the process. The Challenge Submission should be designed so that reviewers will see that all of the review criteria are addressed.

Link the Communication Plan to Your Timeline

Make sure that you reserve enough time for writing your Challenge Solution. Be sure that key writing tasks and milestones are included in your timeline.

Develop the Writing Team

Each team member should be part of the writing team. Assign roles for the writing process and modify the plan based on the results of testing and redesigning your Challenge Solution. You should appoint one person, perhaps your project Marketing Communication Specialist, as the lead on the writing task. This team member might be responsible for ensuring that everyone meets their writing task goals and for undertaking the editing of the final document.

Keep an Engineering Design Diary

Keeping good records is part of good science and engineering. Each team member should have an *Engineering Diary* or project journal in which they record ideas, solution options, plans, sketches of designs, references they collect, actions that need to be taken, notes from meetings, tests and plans, etc. The record archives will be helpful when you begin writing your Challenge Solution. Your *Engineering Design Diary* will contain information that you will include in Your *Engineering Design Notebook*. The *Engineering Design Notebook* is what you submit for Judging.

Submit Your Challenge Solution in the form of your Engineering Design Notebook

In the end, everything comes down to your submission. When you submit, make sure that:



- Your submission meets the guidelines
- You review the RWDC Scoring Rubric by which your submission will be judged
- Make sure your submission is as complete as you can make it.
- You submit **on time!**

IX. Submission Guidelines

The Engineering Design Notebook should detail the design process and your team's results. Review the Scoring Rubric carefully to following its paragraph order and details on what judges are looking for. The *Engineering Design Notebook* has been limited to 80 pages this year so take extra time to submit your best narrative in response to each Rubric element. Do not postpone work on your *Engineering Design Notebook*, but work on it throughout the challenge.

The narrative sections of your report need to include information allowing judges to verify your analysis and design viability. It will communicate an understanding of the mathematics supporting the results of the proposed design. The data included in the report will explain how the images in your proposed solution relate to the testing results obtained from the mathematical formulae used for analysis, and how you have modified your designs based on testing. The narrative and graphic representations of your design should clearly communicate an analysis of how the proposed design works and why it works.

In the *Engineering Design Notebook*, you capture the history of your work, how you understand the design process, and develop and test your design concepts. It is a working document containing ideas tested, approaches and ideas that worked and that did not work. The *Engineering Design Notebook* should include and represent the collaboration of your team, how team members understood the design, how mentors contributed to the solution, as well as how the design solution was tested. *The Engineering Design Notebook* will describe the strategy used to develop your solution, including the structure, roles, and responsibilities of your team members, your work plan, the mentors who guided your process, and any rules/procedures that you employed to guide the work. This document will chronicle the decisions and testing of solutions that led to the final design capturing the various iterations of the design evolution. It will include concepts explored and formulae tested that contributed to the evolution of the final design submitted, including sketches, drawings, and schematics of designs tested and modifications made.

Your *Engineering Design Notebook* should contain evidence collected over time and should be presented in the form of a report. It will be judged on the degree to which it demonstrates your team's:

- A. Winning strategy, including a description of team members' roles and a chronicle of the extent of collaboration among team members
- B. Level of innovation in addressing the Challenge process and the design solution
- C. Understanding of the engineering, science, and mathematics concepts underlying the problem and solution
- D. Demonstration of the use of the design process and skills in using design tools
- E. Evolution of the design (schematics) and decision/testing process leading to the solution proposed
- F. Teamwork and collaboration



- G. Networking and working effectively with RWDC national mentors to supplement your teams' needed expertise

Team Design Presentation is an optional activity for the **State or Province Challenge**. States or Provinces may choose to ask finalist teams to present their findings in the form of an electronic and/or in-person presentation to state judges. If your team is nominated as a finalist, you may be asked to submit with the final submission an electronic presentation consisting of no more than 20 slides that communicate the results of your design solution. The electronic presentation is a stand-alone document that captures essential elements of your RWDC experience by including a description of your winning strategy, the evolution of your design, and your team's understanding of the scientific principles that led to the design solution presented, along with the results of the design solution. Note that team presentations are an essential component of the National/International Challenge and can differentiate between two teams whose technical scores are comparable. For the National/International Challenge, the presentation will be judged on content (inclusion of elements identified) and how well the content is communicated to the audience.

Design Presentations at the National/International Challenge will be required of all State or Province Winning Teams competing in the National/International Challenge. All State or Province Winners will be required to prepare a 15-minute presentation in Microsoft PowerPoint format. Presentations will be made to the Challenge Judges. The overall top teams will again present to a panel of Blue Ribbon Judges in the evening.

Student Surveys will be conducted at the beginning and end of the State Challenge. In addition, formative surveys will be sent to teams and mentors throughout the challenge. Teams that fill out the surveys will get extra points in judging.



X. Dates and Deadlines

RWDC Key Dates

1. State Challenge issued October 2023
2. Team registration for State Challenge open now
3. Team registration for the State Challenge closed November 17, 2023
4. State Challenge Engineering Design Notebooks due January 5, 2024
5. State Winners announced by January 22, 2024
6. National Challenge Team rosters due March 17, 2024
7. National/International Challenge Engineering Design Notebooks due March 29, 2024
8. National/International Challenge Team PowerPoint presentations due April 12, 2024
9. National Challenge Competition April 20, 2024

XI. Scoring

A team of professional engineers to evaluate the quality of your design submission using the RWDC Scoring Rubric will score your *Engineering Design Notebook*. Be sure to review the Scoring Rubric carefully to ensure a high quality submission.

Engineering Design Notebook submissions are limited to 80 pages and are to follow the paragraph order of the RWDC Scoring Rubric. **Teams can lose up to 15 points if their *Engineering Design Notebook* is more than 80 pages or if their *Engineering Design Notebook* does not follow the Scoring Rubric paragraph order.** Supporting details including Creo models and analyses results should be included in the *Engineering Design Notebook*.

Scoring for the State or Province Challenge will be based on the *Engineering Design Notebook* alone. Some states may elect to incorporate presentations at their discretion. State or Country Coordinators will inform teams if this is the case in their state or Province.

Scoring for the National/International Challenge will be weighted 70% on the Engineering Design Notebook submission and 30% presentation at the National/International Championship. Technical merit scores will be based on the Technical Judge's verification of analysis results, and the design viability of the final design. The teams' presentations will be recorded. The recording of the top National Teams' presentations will be viewed by a panel of Blue-Ribbon judges, who are executives in the aviation industry who will determine the International Champion with the final ranking of the top three teams based solely on their presentation.

Judges will be briefed before scoring to improve the consistency in their evaluations. The consensus of many judges is trusted and more accurate than the scores of a few judges. Numerous team submissions require a large number of judges to provide adequate coverage in a constrained timeframe. Because of the large number of teams in the RWDC National/International competition, judges do not all have the benefit of base lining their scores against other teams.



The distribution of teams into challenge rooms for their National/International Challenge presentation will be based on teams overall pre-ranking from *Engineering Design Notebook*. There will be multiple teams presenting in each challenge room.

Both Challenge Judges (scoring the presentations), and Technical Judges (scoring the *Engineering Design Notebooks*) will weigh in to select *Merit Awards*. Merit Awards will go to top teams, with anyone team only eligible for one award.

The entire judging process is monitored by an independent expert resource to ensure fairness and equity. The decisions by judges at the State and National/International Competitions are final!

Judging feedback to teams will be collected from Challenge and Technical Judges and shared with each team. Team ranking beyond the top three will not be shared.

XII Judging

RWDC Teams go through a rigorous process of judging with the goals of evaluating academic performance and identifying the best and brightest students with the highest levels of achievement. Judges are volunteers from government, industry and higher education. The judging process has two major tiers. There is State/Province Level Judging and National/International Level Judging. All teams are judged at the State/Province Level to determine the State/Province Champions. State/Province Champions are invited to compete in the National/International Championship where a National Champion and an International Champion are chosen.

- State/Province Judges read and score the State Challenge *Engineering Design Notebooks* (80 pages). Judges use the *RWDC Scoring Rubric* to evaluate the *Engineering Design Notebooks* (the teams' solutions). The judging is done virtually. The State Coordinators determine the State Champion based on the scores and input from the State Judges.
- National/International Judges
 - Technical Judges read and score the National/International Challenge *Engineering Design Notebooks* (80 pages) two weeks before the National/International Championship begins. Judges use the *RWDC Scoring Rubric* to evaluate the *Engineering Design Notebooks* (the team's solutions).
 - Challenge Judges view team presentations at the National Championship and question the teams on their work. They also facilitate deliberation, scoring and ranking. They meet to share results and determine the top teams and Merit Award Winners.
 - Blue Ribbon Judges view the top teams' presentations and determine the International Champion.

XIII. Rules

The following are the rules and eligibility requirements for RWDC participants. In order to qualify to participate in the National/International Championship, each participant and team must meet all criteria and follow all stated rules.

A. Student Eligibility Requirements

1. Participation is limited to students living in OR enrolled in schools located in a state, territory or country that is hosting a state or province competition. Schools are defined to include public, private, or home schools.
2. To be eligible to compete as a student team member, a student must be currently enrolled in grades nine, ten, eleven, or twelve. Students enrolled in school environments with alternative grade or level designations must be engaged in a program of study equivalent to the corresponding high school grade level.
3. Student team members must have attained the age of 14 as of 1 October, of the Challenge year.
4. Student team members shall not yet have attained the age of 19 as of 1 October of the Challenge year.
5. Teams may be organized around extra-curricular organizations. Girl Scouts, Boy Scouts, science clubs, and museums programs are encouraged to participate.
6. Student team members may only participate on one team.
7. Student team members *may not* transfer from one team to another.

B. Team Composition

1. An RWDC team consists of one designated teacher/coach and *no fewer than three nor greater than seven student* members.
2. Only those team members identified on the official registration form are considered part of the team.
3. Each team may compete in only one state competition and all team members must be permanent residents of that state, territory or country OR be enrolled in a school located in that state or country.
4. Team members may be added or changed up to November 17.



C. Competition Rules

1. One teacher/coach may lead multiple teams.
2. A team teacher/coach must be at least 21 years of age by 1 October of the Challenge year
3. Coaches may be a teacher or other responsible adult.
4. All submissions shall be the original work of the students involved.
5. No team may register after 10:00 PM Eastern Time November 17.
6. All work must be submitted prior to midnight on the date of the submission deadline in local time.
7. All submissions must conform to the specifications outlined in the Challenge.
8. Teams shall only contact mentors through the means and at the times specified by the mentors.
9. Only team members registered as of November 17 will be eligible to compete in the National/International Championship.
10. A team can be represented by no fewer than three students or more than seven students at the National/International Championship.
11. Students will be required to participate in all scheduled activities at the National/International Challenge Competition.
12. The team teacher/coach must accompany the team if the team is selected to attend the activities.

XIV. Contact Information

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Appendix 1: Engineering Design Notebook, Cover Page Template & Format

Design Name

Submitted in Response to the Real World Design Challenge

Submitted by

Team Name

Team Member Names

(List team members, with age, grade, email addresses and phone numbers, and designate team leader – a table is fine to list information)

School/Organization Name

Address

Submission Date

Coach(s)/Advisor(s): Coach Name

Coach Contact Info (Address, Phone, E-mail)

Team/Coach Validating Signatures:

Participating students/team members completed Formative Surveys:

[REMOVE: Only the above statement and coach's signature are required to demonstrate surveys were completed (honor system)]



[REMOVE: An electronic signature of the coach is expected.]

[REMOVE: A visual representation of the final design is required on cover page]

[REMOVE: While the template is provided for convenience as a Word document, it is highly recommended that the report is submitted as a PDF to ensure proper formatting]

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No table of figures entries found.

In your document, select the words to include in the table of contents, and then on the Home tab, under Styles, click a heading style. Repeat for each heading that you want to include, and then insert the table of contents in your document. To manually create a table of contents, on the Document Elements tab, under Table of Contents, point to a style and then click the down arrow button. Click one of the styles under Manual Table of Contents, and then type the entries manually.

Executive Summary

[One-page Executive Summary includes brief narrative describing the design solution. Judges will be looking for a high level (less technical in style for this section) overview of how you solved the problem. This summary should be written so you give a short comprehensive description of your solution. A person reading this one-page summary will understand your solution without needing specific technical expertise nor knowing the specifics of the problem being solved. An executive summary should not contain any citations. (In the event of two teams having close scores at any level of the competition, this section will be used as a "tiebreaker." A special judges committee will use this summary to resolve any judging disputes between teams with close scores, especially at the National competition.)]

Specification Table

Criteria	Value	Met (yes/no)	Section #, page #
Aircraft			
Takeoff weight			
Wingspan (fixed-wing) or max width (other)			
Operational/communication range. At least 5 miles.			
Pre-Fire			
Method to measure fuel type and amount. Better than current methods.			
Method to measure moisture levels. Better than current methods.			
Method to measure air boundary layer. Better than current methods.			
Method to measure thermal information. Better than current methods.			
Active Fire			
Method to measure current fire edge. Better than current methods.			
Method to measure thermal information. Better than current methods.			
Method to measure fuel type and amount. Better than current methods.			
Method to measure moisture levels. Better than current methods.			
Method to measure air boundary layer. Better than current methods.			



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Measure in presence of dense smoke.			
Post-Fire			
Method to measure vegetation. Better than current methods.			
Method to measure moisture levels. Better than current methods.			
Method to measure air boundary layer. Better than current methods.			
Method to measure thermal information. Better than current methods.			
UAS Command, Control, and Communication			
Provide real time and accurate location information			
Detect and Avoid (DAA)			
Aircraft must detect static and dynamic obstacles			
Aircraft must avoid conflicts			
DAA system architecture must fit with C3 capabilities			
Lost Link Protocol			
Aircraft must have protocols in case of partial loss of communications			
Aircraft must have protocols in case of total loss of communications			

Team Engagement

1.1 Team Formation and Project Operation

[Explain the degree to which teams develop a strategy to win that includes establishing leadership in project management, science, engineering, mathematics, marketing and communications, etc. What skill set does each member bring to the team?]

1.2 Acquiring and Engaging Mentors

[Describe the degree to which your team worked aggressively to identify and leverage mentors early and throughout the challenge process.]

1.3 State the Project Goal

[Demonstrate understanding of the parts of the Challenge Statement and how they relate to the project goal. Has the team listed and demonstrated an understanding of each system element and the relationship to the design solution?]

1.4 Tool Setup/Learning/Validation

[Degree to which the team described how they overcame challenges and came up with workable solutions for technical issues: installing and operating tools (CAD), learning to use the tools, and validating that the tools are working as needed.]

1.5 Impact on STEM

[Discuss how participating in this challenge has influenced your perspectives on STEM and on your potential career paths. Also, discuss the impact the Challenge has had on STEM interest in your school.]

System Design

2.1 Engineering Design Process

[Discuss the engineering design processes you used. Include conceptual, preliminary, and detailed design phases. This section discusses the processes while the details are provided in 2.3.]

2.2 Project Plan

[Discuss the process of how your team developed a timeline to accomplish the challenge showing milestones to come up with your final solution. You must show a Gantt chart or similar type of project management chart detailing project timeline with tasks and milestones.]



2.3 Subsystems

[Discuss, in the subsequent sections, how the design process was used for each of the following subsystems (conceptual, preliminary, and detailed design phases). Discussion must include how requirements were used to generate ideas, how designs were narrowed down, and how final design fulfills requirements. These subsystems are interrelated, so include how the design of the subsystems affected each other. (Provide introduction here if desired but not required – no points given.)]

2.3.1 Air Vehicle

[Discuss design process and final design of the air vehicle (airframe configuration, power plant [propulsion], flight controls). In addition to discussion requirements provided in 2.3, include:

- Design process must include sketches of ideas during all design phases (missing sketches will result in loss of one fourth of points for this section).
- Final design must include description of components including number required.
- Clear description on how C3 and payload affected design.]

2.3.2 Command, Control, and Communications (C3) Selection

[Discuss design process and final design of C3. Discussion of the ground control station must be included in this section. In addition to discussion requirements provided in 2.3, include

- Effect of human resources (e.g., operators, monitors, pilots) on design.
- Final design must include description of components including number required. Include final selection of human resources as well including number and cost.
- Discussion of ground control station must include sketch(es).
- Description of equipment/sensors required for detect and avoid must be included in this section. Application of DAA provided in 3.3.1.
- Description of equipment required for providing real time and accurate location. Application of equipment provided in 3.3.3.]

2.3.3 Payload

[Discuss design process and final design of the payload (needed equipment for data gathering and monitoring). In addition to discussion requirements provided in 2.3, include

- Any needed communication or other equipment that is specialized for payload. If using equipment from C3, be clear here on how it is being used for the purpose of the payload.
- Be clear on which equipment is used for pre-fire, active fire, and post-fire scenarios and why.



-Final design must include description of components including number required. Include final selection of human resources as well including number and cost.]

2.4 Lessons Learned

[Discuss key lessons that were learned during design.]

2.5 Component and Complete Flight Vehicle Weight and Balance

[Provide results of the weight and center of gravity analyses. Location of the center of gravity must be provided numerically (from a datum point) and graphically. The graphical location of the center of gravity may be shown on the 3-view of the design (Section 2.6), but if on the 3-view, it must be referenced and discussed in this section.]

2.6 Final Design Drawings

[Include drawings of the final design (with dimensions) in this section. At a minimum

-3-view of the aircraft.]

[Example] The following, Figure 1, depicts the three-view of the final unmanned system design.

[ADD FIGURE-CENTERED]

Figure 1. Three-view of final unmanned system design.

Missions

3.1 Concept of Operations

[Describe how the system will be operated during the different mission phases. Keep in mind the expectations for all stakeholders. (Provide introduction here if desired but not required – no points given)]

3.1.1 Pre-Fire

[Detail the pre-fire mission.]



- Describe typical mission: preparation, steps to complete mission, post mission.
- Include what is being measured and how.
- Include how data are transmitted and stored.
- Discuss how method and data are better than current methods.
- Objective is to maximize area measured.]

3.1.2 Active Fire

[Detail the active fire mission.

- Describe typical mission: preparation, steps to complete mission, post mission.
- Include what is being measured and how.
- Include how data are transmitted and stored.
- Discuss how method and data are better than current methods.
- Objective is to maximize time in flight.]

3.1.3 Post-Fire

[Detail the post-fire mission.

- Describe typical mission: preparation, steps to complete mission, post mission.
- Include what is being measured and how.
- Include how data are transmitted and stored.
- Discuss how method and data are better than current methods.
- Objective is to maximize area measured.]

3.2 Flight Profile Analysis

[Demonstrate through analysis that your system can successfully meet the design criteria provided in the Challenge Statement. Part of this discussion will be proof that the aircraft carries enough energy (e.g., battery or fuel) to complete the full mission. Another aspect will be the communication range.]

3.3. Safety Requirements

[Describe how the system fulfills the safety requirements and ensures public safety. (Provide introduction here if desired but not required – no points given)]

3.3.1 Detect and Avoid

[Discuss design and implementation of the DAA. Include

- Reasoning behind location of decision-making process: onboard or at ground control station
- Clear discussion of how DAA fits with C3 capabilities from 2.3.2
- Clear discussion that DAA allows aircraft to sense, detect a conflict, and avoid any cooperative or non-cooperative obstacles. Must provide distances/times for detection ranges and decisions and reasons/justification for those selections. Must include communication required with DAA such as communication between aircraft and operators.
- Description of needed capabilities/technology if all tasks cannot be accomplished with current technology.]

3.3.2 Lost Link Protocol

[Describe the protocols/procedures when the aircraft experiences a partial loss of communication and a total loss of communication. In both cases, clearly describe what steps the aircraft and operator will perform.]

3.3.3 Integration with Manned Aircraft and Other Aircraft

[Describe requirements to integrate UAS successfully and safely into flight with manned and other aircraft. Note that aircraft will be flying in a high-stress situation during an active fire.]

3.3.4 Regulations and Additional Safety

[Explain any additional safety features or procedures for your design. These additional safety features are to account for possible emergency scenarios or for any other considerations your team decides is necessary. These safety features are in addition to those already discussed earlier in this report. Remember that since no pilot is onboard, methods must be used to replace all roles performed by a pilot.]

Business Case

4.1 Cost Analysis

[Teams will be assessing the costs related to the design. Teams should understand how much the fixed and variable costs are for the groups who are using the design to fight fires. Keep in mind that since



teams are selling the design to a firefighting group, they will not be accounting for the labor costs. (Provide introduction here if desired but not required – no points given)]

4.1.1 Operating Costs

[Explain what the total operating cost (variable costs) would be for your system. This year we will NOT be calculating the cost of personnel. Make sure to describe the following. (a) Give a breakdown of how much fuel or energy (battery) is used for each flight and include how much fuel or energy the aircraft can carry. (b) The cost of fuel or energy (batteries and electricity for charging) for flying one flight. (Hint: Remember variable costs are only things consumed on the mission such as fuel or energy.)]

4.1.2 Fixed Costs

[Describe what your total fixed costs (cost of equipment and the vehicles) are for your system. Give both a total fixed cost and a description of how much you are spending on all components including the Air Vehicle, payload, and C3 equipment. Explain and justify the cost of your system giving examples of why the components are necessary to complete the missions.]

4.2 Communications Plan

[The communications plan will describe how the concept will be explained to potential decision makers for this project. Teams will need to come up with a strategy to communicate what they are planning to policy makers who will decide what projects to pay for. Keep in mind that the policy makers have no technical expertise.]

4.2.1 Strategic Communications Plan

[Explain the strategy for the communications plan. (a) Describe how information was chosen to be included in the infographic and the sample communication. (b) Explain why the information in the communications plan was used to describe the importance of the design and the issue. (c) Explain how the communications plan was designed to not only be understood but not to be misunderstood.]

4.2.2 Info graphic

[Develop an Info graphic (additional information in detailed background) to use with policy makers to explain the project. The info graphic should describe the importance of wildfire prevention and how the proposed design is an important tool to help combat wildfires. (May only use one info graphic for this section, and it must not exceed one page.)]

4.2.3 Sample Communication

[Give a sample text explaining the info graphic. The description should help anyone looking at the info graphic understand what is trying to be communicated. (Maximum of 100 words.)]

Conclusion

[Provide a brief conclusion to your Engineering Design Notebook. Summarize the important aspects of your design. Why is your design the best design for this challenge (make sure to base your argument on the analysis and justification you provided in your Engineering Design Notebook)? Be sure to justify all the design choices that you made.]

References

This is where the details of any reference citations are maintained. Do not include a reference citation in the References section if it has not been directly cited in the body of this document. These references should be ordered alphabetically. If any of the references have the same author and year, place in order by the first word in the title and add an alphabetical identifier to the year (e.g., 2012a) and ensure this year and identifier is used in any in-text citations.

See the following for APA formatting of required references: <https://owl.purdue.edu/>

Writing/Format [Remove this section from Final Document]

Neat, orderly and readable, font size no smaller than 11 pt Arial throughout (except Specification Sheet) with 1.5 line spacing, except in Executive Summary, Captions, and References (single spaced allowed). Letter size paper (8.5 in. by 11 in.) with 1-in. margins; pages numbered. The Engineering Design Notebook must follow the paragraph order of the Scoring Rubric including paragraph numbering.

The Engineering Design Notebook submission is limited to 80 pages maximum including cover page and appendices. Sections past the 80-page limit will receive a score of 0. Additional points may be deducted in individual sections if content is not in correct location or hard to understand. For each individual section, up to 20% of the maximum points available for that section may be deducted for grammar.

7.1 References and Citations

Reference citations are to be used, where appropriate, to support work. Use the following research and reference guidelines in the development of your submission:



- 1) You should have references identifying the merit of your proposed research and supporting any assertions you make. As part of this process, you need to perform a basic literature review and identify supporting material as part of your proposal. Add references and citations to support why your research is worth pursuing. What is the value of performing it? What will it identify that other research has not? Provide some detail regarding any problems or issues that can be used as rationale to support why this is valuable.
- 2) Add a supporting citation to every sentence that is not entirely your own observation. It is good practice to use supporting citations as it lends credibility to what you are stating. Add citations throughout document when you state something that is not your own original thought. If you do not cite a source and it is not your original thought, it is PLAGIARISM.
- 3) When you have more than one sentence in your quote use a block quote format.
 - a. See References->Direct Quotation on the Purdue online writers lab (OWL) website for further detail: <https://owl.purdue.edu/>
 - b. See the following block quotation:

Every sentence that contains information that is not ENTIRELY your own words or thoughts needs to contain the citation for the source from which it came. Even if this means citing almost every sentence of a paragraph, it must be done. You can, however, build citations into your sentence throughout the paragraph to avoid an excess of parenthetical documentation at the end of each sentence (APA Frequently Asked Questions..., p.2).
- 4) All direct quotes need a page, section, or paragraph number reference (e.g., Terwilliger, 2012, p. 4).

7.2 Tone of Writing/Professional Appearance

Avoid an informal or narrative tone. Instead, focus on use of formal tone in academic writing as described in the following material:

- <http://writingcenter.waldenu.edu/1082.htm>



Use the following grammatical and writing guidelines in the development of your submission:

- Always spell check
- First time use should define an acronym. For example, “The use of **uncrewed aircraft systems (UAS)** has served to reduce risk to humans by removing the crew from a hazardous operating environment (U.S. GAO, 2008).” Subsequent uses through the remainder of the document should be, “UAS.”
- Paragraphs should be at least three sentences long
- Spell out numbers under 10
- Use numerals for numbers over nine
- When referring to a variable, such as population (*N*), it should be in italics
- Refrain from using contractions (e.g., don’t, can’t, didn’t, etc.)
- Avoid colloquial, superlative, or slang expressions in scientific/academic writing (e.g., on the other hand)
- Refrain from self-referencing (e.g., I, myself, me) in scientific/research writing. If you must refer to yourself, do it in the third person. For example, the researcher will...

7.3 Figures and Tables

Figure and table reference should appear in the following format (always precede the caption and image/table with an in-text reference to explain or depict the connection to the text). For example, Figure 2 depicts an example for the purposes of explaining figure use, reference, and appearance.

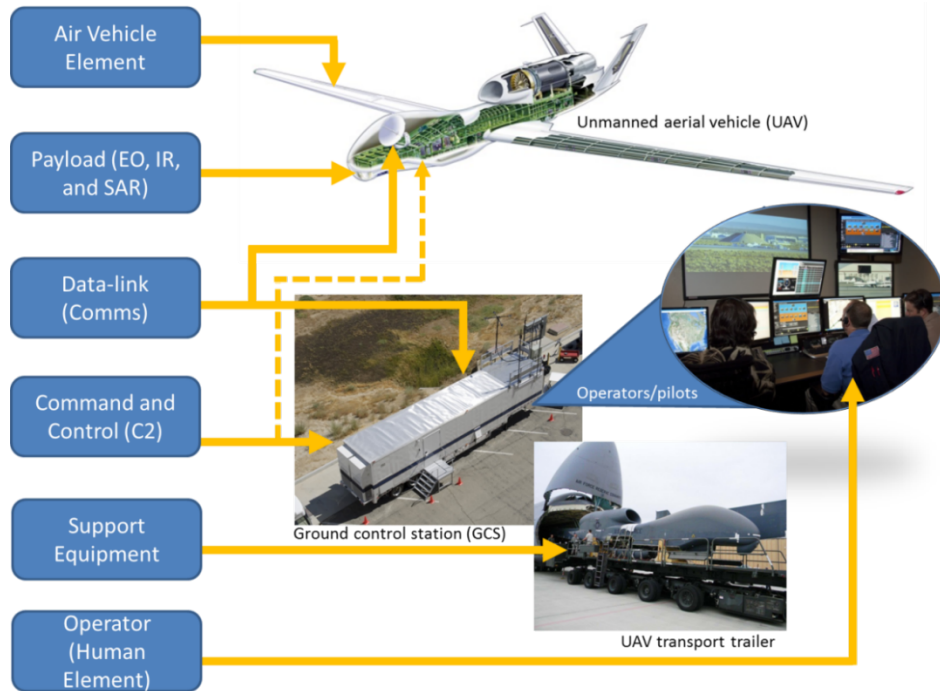


Figure 2. Description phrase to be used as title and description. [If not original] Reprinted [or adapted] from Title (page number), by Author first initial. Second initial. Surname, year, place of publication: Publisher. Copyright [Year] by the Name.