# FY24 RWDC National 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 National challenge will continue the focus on Uncrewed Aircraft Systems and implementation of a UAS. This year’s mission is to develop an uncrewed aircraft support 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 a business case that includes a communications plan 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, 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 justify 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:*** *Based on the results of your initial proposal, your Company has been invited to submit a new proposal for the final round. Since the UAS must be transported by a hiker, more details on the size requirements have been included. Additional details about the ground control stations have also been provided.*

*In the United States, wildfires burn over a million acres of forests and grasslands each year with over a billion dollars being spent fighting these wildfires. Many state agencies, federal agencies, and companies are working together to develop strategies and technologies to tackle the complex problem of wildfires. Uncrewed aircraft have the potential to make a large impact on fighting wildfires by helping increase situational awareness, communications, and data gathering. Your company has been asked to develop a small uncrewed aircraft to focus on the ability to aid in fighting wildfires by providing data with more spatial and temporal resolution than current sources. Your company is to design 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 also encouraged. Successful proposals may be invited to the next round.*

***Overall Design Criteria:***

* *At least 30 min of flight time*
* *Operational/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 (see transportation below)*
* *Provide real time and accurate location information to all other aircraft in the area*
* *Local ground control (used by operator)*
  + *Rugged, small, and light weight*
  + *At least semi-autonomous controls*
  + *Record real-time data from UAS*
* *Transportation*
  + *UAS, local ground control, and any other necessary equipment must fit within single duffel bag*
  + *UAS can be assembled at deployment location, but ease and time of assembly must be considered*
  + *Maximum storage dimensions: 28 in. by 16 in. by 12 in. (71.1 cm by 40.6 cm by 30.5 cm)*

***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*

*Note: During an active fire, the real-time data from the UAS will be used by personnel at a main fire coordination location. You can assume that the main fire coordination location will either be within the 5-mile communication range of your UAS or that there will be a method to relay the data from your UAS. Your proposal will not include the design of any equipment at the fire coordination location.*

***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*** *– the cost of the components of your system. This includes the components of your aircraft and support equipment.*
* ***Communications plan****- For this element you will need to create a plan explaining how you will communicate your idea to policy-makers and one sample communications product as an example. In the plan, teams will briefly explain the importance of addressing wildfires, how their design will be a useful tool for dealing with wildfires, and what communications product(s) would be created, with one sample product included in the plan. Teams should give a compelling argument of not only the importance of the issue but also why their design should be used. The teams’ communication plan should have the following characteristics:*
  + *Audience and purpose:*
    - *Communications should be written for an appropriate audience, keeping in mind that many policy-makers have little to no technical background*
    - *There should be a compelling reason to use the proposed design*
  + *Plan for concise communication* 
    - *Teams should briefly summarize the strategy and explain the reasoning 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.*
  + *Sample communications product:* 
    - *While the communications plan may include multiple ideas about the way to best communicate your message to policy-makers, teams will create one example of a communications. More information and examples of communications products are included in the detailed background.*

## 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 National Uncrewed Aircraft System Challenge: Detailed Background
* RWDC National Engineering Design Notebook Template
* RWDC National 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 National Challenge Scoring Rubric. Teams must submit the following:

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

## Scoring

* Teams’ submissions will be evaluated based on criteria outlined in the RWDC FY24 National 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 National 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 communication plan.
* Total team score at the National/International Challenge Championship is 70% from the Engineering Design Notebook and 30% from the presentation at the National/International event.

## 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
* Best Communication Plan
* Judges Award

## Contacts

Dr. Ralph K. Coppola

Founder & Executive Director, Real World Design Challenge

Phone: 703-298-6630

Email: [rkcoppola@yahoo.com](mailto:rkcoppola@yahoo.com)

## Authors

Dr. Robert Deters

Associate Professor, Embry-Riddle Aeronautical University-Worldwide

Jeff Coppola, MBA

Deputy Director, Real World Design Challenge