

# 2015/16 Rules and Vehicle Design

**DRAFT** Rules: 31 Aug 2015

Entry Deadline: 31 Oct 2015

***The contest rules are in DRAFT form and may be modified and updated up until the entry deadline.***

*The contest rules may be augmented/supplemented at any time during the competition through the Q&A process.*

## **Summary:**

The AIAA through the Applied Aerodynamics, Aircraft Design, Design Engineering and Flight Test Technical Committees and the AIAA Foundation invites all university students to participate in the **Cessna Aircraft Company/Raytheon Missile Systems - Student Design/Build/Fly Competition**. The contest will provide a real-world aircraft design experience for engineering students by giving them the opportunity to validate their analytic studies.

Student teams will design, fabricate, and demonstrate the flight capabilities of an unmanned, electric powered, radio controlled aircraft that can best meet the specified mission profile. The goal is a balanced design possessing good demonstrated flight handling qualities and practical and affordable manufacturing requirements while providing a high vehicle performance.

To encourage innovation and maintain a fresh design challenge for each new year, the design requirements and performance objectives will be updated for each new contest year. The changes will provide new design requirements and opportunities, while allowing for application of technology developed by the teams from prior years.

***Check the rules package carefully as items and approaches that were legal in past years may not be legal for this contest year. Only the contents of this Rules package, the 2016 FAQ, and 2016 Q&A documents hold bearing on the requirements and/or allowances for the current contest year.*** It is the responsibility of the teams to know and follow all provided rules, the FAQ, and all contest day briefings.

Cash prizes are \$2500 for 1<sup>st</sup>, \$1500 for 2<sup>nd</sup> and \$1000 for 3<sup>rd</sup> place. The winning team may be invited to present their design at an AIAA conference. The team with the best Report Score will receive a \$100 prize from the Design Engineering Technical Committee.

## **Judging:**

Students must design, document, fabricate, and demonstrate the aircraft they determine to be capable of achieving the highest score on the specified mission profile(s). Flight scores will be based on the demonstrated mission performance obtained during the contest.

Each team must also submit a written Design Report. A maximum of 100 points will be awarded for the team design report. The overall team score is a combination of the Design Report score, Flight score and Rated Aircraft Cost (RAC). The team with the highest overall team score will be declared the winner. Scores will be FINAL 7 working days after the completion of the contest. This period will allow for review of the scores in a timely fashion following the contest.

All submitted reports are the property of AIAA, Cessna and Raytheon and may be published or reproduced at their discretion.

### **Contest Site:**

Host for the competition will be Textron Aviation (Previously known as Cessna Aircraft Co.). The fly-off is planned to be held at the Cessna field in Wichita, KS. Details on the contest site and schedule will be sent to registered teams early in the fly-off calendar year. You can check on historical weather conditions at [www.weatherbase.com](http://www.weatherbase.com) or [www.weatherunderground.com](http://www.weatherunderground.com).

Teams are advised to check with their airlines on what materials they will be allowed to bring both to and from the contest site. Hazmat items like paints, thinners and glues may need to be purchased locally and PROPERLY disposed of following the contest.

### **Team Requirements:**

All team members (except for a non-student pilot) must be full time students at an accredited University or College and student members of the AIAA. At least **1/3** of the team members must consist of freshman, sophomores or juniors (Below senior year, for non-four year programs). The pilot must be an AMA (Academy of Model Aeronautics) member. Teams may use a non-university member for the pilot if desired. We will provide qualified pilots at the contest on an as-available basis to assist teams who are unable to have their pilot attend.

There is no set requirement for the number of students that must attend the flyoff. It is preferred, but not required, for the team advisor or responsible faculty member to attend.

Team members may be updated/changed at any time during the contest but must always comply with the **1/3** rule. Following the initial team postings at the contest beginning we will make a "One Time" update to the team member lists posted on the website. We will notify teams when the website update change information may be sent, normally in February. Teams wishing a team member list update at that time must submit an updated

copy of the contest entry form with all fields fully filled (but only the team member information may be changed).

**Each educational institution may submit one (1) team entry. The team members may be changed during the contest period, so schools may use an internal selection process to determine their final design and team members prior to the written report submission and fly-off. For schools with multiple campuses in different cities each campus will be considered as a separate entity.**

- **Two or more schools may combine to submit a single entry.**
- **Schools which already have an entry may not have additional students from their school participate as members of a team from a different (shadow) school.**

*There is no entry limit this year.*

## **Past Year Reports:**

Winning team design reports from prior contest years are posted on the contest website as examples. Note that the formatting and content has evolved from one year to the next. Only the rules noted in this document apply for the current year. The top scoring report(s) from this year's contest will be placed on the contest web site for the next year's competition.

## **Sponsorship:**

Teams may solicit and accept sponsorship in the form of funds or materials and components from commercial organizations. All **design, analysis and fabrication** of the contest entry is the sole responsibility of the **student** team members.

## **Schedule:**

**Entries:** The entry period **OPENS** 15 October 2015 at 8am US East Coast Time. No entries will be accepted before that time. A completed electronic entry must be **RECEIVED** by 5pm US East Coast Time on **31 October 2015**. Entries will not be accepted before 15 October 2015.

- There is a new entry process this year
- At the beginning of the entry period, the link to the entry web page will be posted on the website. Data will be entered directly to the site.
- After the deadline has passed, the website will no longer accept entries and no further teams will be allowed to compete. There is no allowance for computer, internet, or power outage, or any other type of error beyond the control of the Organizing Committee.
- The DBF entry form is different from the ones used for other AIAA student competitions. The DBF entry link can be found on the contest web site.
  - Be sure to include **ALL** information requested in the form. We will use the first (valid) entry received so be sure all supplied information is correct the first time.

- If AIAA membership has been applied for, but a member number has not been issued, use "pending" for the member number in the entry form. The data must then be updated when the team roster update occurs in early 2016.
- **Incomplete entry forms will not be accepted.**
- It is the team's responsibility to make sure the e-mail contact addresses they supply remain active during the entire period from entry to the close of the competition, as e-mail will be the primary means to provide information and updates. Do not use an internal team correspondence e-mail list server as your point of contact e-mail address.
- **Note: The AIAA mail servers will not send e-mail to @hotmail.com addresses. Do NOT use a Hotmail address for any of your team contacts or e-mail.**

**Proposal:** A new requirement this year is to submit a proposal. A Link to submit the proposal will be posted on the website. The proposal must be submitted by 5 pm US East coast time on **14 December 2015**.

Teams with compliant proposals will be invited to submit reports and become eligible for the fly-off. In the event that the number of entries received exceeds the capacity of the flyoff venue, then the proposal will be used as a factor in determining whether a team will receive a flyoff invitation. The criteria for acceptance, if needed, will be posted shortly after the entry deadline.

**Design Report:** A Link to submit the design report will be posted on the website. The design report must be submitted by 5 pm US East coast time on **22 February 2016**.

- Proposals and Reports submitted by email will not be accepted.
- Proposals and Reports will be judged "as received"; no corrections/additions/changes will be made by the organizers so check your reports carefully before sending them.
- ***Once a Proposal or Report is submitted, no changes are allowed.***

***Submission of Proposals and Reports is electronic only (no hard copy required). The details for the electronic format and submission, including a new requirement for a separate 3-view, are at the end of the report section in this rules document.***

**Contest Flyoff:** The contest flyoff is scheduled for **15-17 April 2016** and is anticipated to run from 8AM to 6PM on Friday, 7AM to 6PM on Saturday and 7AM to 5PM Sunday. Awards will be presented at 5:30PM on Sunday. All teams should plan their travel so that they may stay for the awards presentations on Sunday. A final contest schedule will be e-mailed to the teams prior to the contest date.

Tech inspections will begin on Friday and will continue as required on Saturday and Sunday.

To help streamline the contest flow and maximize opportunities for each team to get their flights in, the Tech inspections will be conducted in the same order as the flight rotation (which is based on report scores) so that the first teams inspected will be the first teams in the flight queue. Teams may use the sequence to help estimate when they need to arrive

at the contest site to make sure they do not miss their slot in the first tech inspection rotation.

**PLEASE NOTE: All schedule deadlines are strictly enforced.**

- **All deadlines are based on when an entry or submission is Received by Contest officials.**
- **Late entries will NOT be accepted.**
- **Late report submissions will be disqualified.**
- **There is no allowance for computer, internet, or power outages by the submitter, or any other type of error beyond the control of the DBF Organizing Committee.**
- **Teams which do not submit the required electronic report and 3-view will NOT be allowed to fly.**
- **It is the team's responsibility to assure that all deadlines are known, understood and met.**

## **Communications:**

The contest administration will maintain a World Wide Web site containing the latest information regarding the contest schedules, rules, and participating teams. The contest web site is located at:

<http://www.aiaadbf.org>

Questions regarding the contest, schedules, or rules interpretation may be sent to the contest administrator by e-mail at:

[director@aiaadbf.org](mailto:director@aiaadbf.org)

Questions received prior to the official entry submission date will not be answered directly. Select questions "may" be answered in the FAQ prior to the entry submission date. Official questions and answers received following the entry submission date will be posted on the website.

**The DBF Organizing Committee will utilize Facebook as an additional means of communicating with the teams during the contest weekend only.** This will NOT be a means of communicating rules, FAQ's, protests, etc., but only used in case of emergencies, weather delays or contest weekend schedule updates. Additional information will be included in a contest site/ schedule email to be sent out to the registered teams prior to the fly-off.

## **Aircraft Requirements - General**

- The aircraft may be of any configuration except rotary wing or lighter-than-air.
- No structure/components may be dropped from the aircraft during flight.
- No form of externally assisted take-off is allowed. All energy for take-off must come from the on-board propulsion battery pack(s).
- Must be propeller driven and electric powered with an unmodified over-the-counter model electric motor. May use multiple motors and/or propellers. May be direct drive or with gear or belt reduction.
- Motors may be any commercial brush or brushless electric motor.
- For safety, each aircraft will use commercially produced propeller/blades. Must use a commercially available propeller hub/pitch mechanism. Teams may modify the propeller diameter by clipping the tip and may paint the blades to balance the propeller. No other modifications to the propeller are allowed. Commercial ducted fan units are allowed.
- You can change the propeller diameter/pitch for each flight attempt.
- Motors and batteries may be limited in current draw by means of a **fuse** in the line from the positive battery terminal to the motor controller. **There is no set limit on the fuse rating.** If used, it is the responsibility of each team to properly size the fuse to protect the battery, motor, and controller against overcurrent from any source.
  - Fuse(s) must be located such that no propulsion system component: motor; motor controller; or battery may see more current than the stated limit (fuse value).
  - Fuse must be placed in the positive (+) lead from the battery, and should be as close to the battery(s) as feasible.
- Must use over the counter NiCad or NiMH batteries. **LiPo batteries are not allowed.** For safety, battery packs must have shrink-wrap or other protection over all electrical contact points. The individual cells must be commercially available and the manufacturers label must be readable/documented (i.e. clear shrink wrap preferred). All battery disconnects must be "fully insulated" style connectors.
- **There is no limit to battery pack weight this year.** The propulsion battery pack must power propulsion systems only. Radio Rx and servos **MUST** be on a separate battery pack. Batteries may not be changed or charged during a flight mission attempt.
- Aircraft and pilot must be AMA legal. This means that the aircraft TOGW (take-off gross weight with payload) must be less than 55-lb, and the pilot must be a member of the AMA.
- Since this is an AMA sanctioned event, the team must submit proof that the aircraft has been flown prior to the contest date (in flight photo) to the technical inspection team. We will provide qualified pilots at the contest on an as-available basis to assist teams who are unable to have their pilot attend.
- **The aircraft must remain substantially the same as documented in the report (for example you cannot change a flying wing design to a conventional tail design). You may make small modifications to the design to improve flight performance after the report submission (one example would be**

**changing a control surface size). The three-view drawing supplied in pdf form as described below in the electronic report section will be used to verify the flight article during tech inspection.**

## **Aircraft Requirements - Safety**

All vehicles will undergo a safety inspection by a designated contest safety inspector prior to being allowed to make any competition flight. **All decisions of the safety inspector are final.**

To speed the tech inspection process each team must present a signed *Pre-Tech and First-Flight Certification* when called to begin their on-site tech inspection. Teams may not begin the on-site tech inspection without a completed certification. The *Pre-Tech and First-Flight Certification* sheet is available on the contest website.

The Pre-Tech must be conducted by, and signed off by, a non-team member RC pilot or the team faculty advisor. The Pre-Tech will cover the same safety of flight requirements as the on-site tech inspection and will assist teams in making sure they are ready and able to pass the on-site tech inspection the first time. An expanded First-Flight requirement, which also must be signed off by a non-team member RC pilot or the team faculty advisor, requires demonstration of a complete flight including take-off, flying a minimum flight pattern, and landing in a pre-designated location without damage to the aircraft. The non team member RC pilot who signs the inspection and flight certifications may be the same as a team's non-student contest pilot.

Safety inspections will include the following as a minimum:

- Physical inspection of vehicle to insure structural integrity.
  1. Verify all components adequately secured to vehicle. Verify all fasteners tight and have either safety wire, Loctite (fluid) or nylock nuts. Clevises on flight controls must have an appropriate safety device to prevent their disengaging in flight.
  2. Verify propeller structural and attachment integrity.
  3. Visual inspection of all electronic wiring to assure adequate wire gauges and connectors in use.
  4. Radio range check, motor off and motor on.
  5. Verify all controls move in the proper sense.
  6. Check general integrity of the payload system.
- Structural verification.
  - All aircraft will be lifted with one lift point at each wing tip to verify adequate wing strength (this is "roughly" equivalent to a 2.5g load case) and to check for vehicle cg location. Teams must mark the expected empty and loaded cg locations on the exterior of the aircraft. Special provisions will be made at the time of the contest for aircraft whose cg does not fall



within the wing tip chord. This test will be made with the aircraft filled to its *maximum payload capacity*.

- Radio fail-safe check. All aircraft radios must have a fail-safe mode that is automatically selected during loss of transmit signal. The fail-safe will be demonstrated on the ground by switching off the transmit radio. During failsafe the aircraft receiver must select:

Throttle closed  
Full up elevator  
Full right rudder  
Full right aileron  
Full Flaps down

For aircraft not equipped with a particular control, then the safety inspector must be satisfied that the intended function of the fail-safe system will be carried out.

**The radio Fail Safe provisions will be strictly enforced.**

- All aircraft must have a mechanical motor arming system separate from the onboard radio Rx switch. This may be the contest specified "blade" style **fuse**. Or, an **arming plug** such as [http://wsdeans.com/products/plugs/ultra\\_plug.html](http://wsdeans.com/products/plugs/ultra_plug.html) may be used. This device must be located so it is accessible by a crewmember standing **ahead** of the propeller(s) for pusher aircraft, and standing **behind** the propeller(s) for tractor aircraft (i.e. the crew member must not reach across the propeller plane to access the arming system). The "Safety Arming Device" will be in "Safe" mode for all payload changes. The aircraft Rx should always be powered on and the throttle verified to be "closed" before activating the motor arming switch. The arming system **MUST be mounted on the outside the aircraft** (they cannot be behind an access panel or door) and **MUST** act as the "safeing" device.

Note: The aircraft must be "safed" (arming fuse/plug removed) any time the aircraft is being manually moved, or while loading/unloading payload during the mission. The arming fuse must be removed anytime the aircraft is in the hanger area.

**Scoring:**

*In the event that, due to time or facility limitations, it is not possible to allow all teams to have the maximum number of flight attempts, the contest committee reserves the right to ration and/or schedule flights. The exact determination of how to ration flights will be made on the contest day based on the number of entries, weather, and field conditions. In the event of a tie, Report Score will take precedence over Flight Score as a tie-breaker.*

Each team's overall score will be computed from their **Written Report Score**, **Total Mission Score** and **Rated Aircraft Cost** using the formula:



$$\text{SCORE} = \text{Written Report Score} * \text{Total Mission Score} / \text{RAC}$$

The **Total Mission Score** is the product of the individual Mission Scores:

$$\text{Total Mission Score} = \text{MF1} * \text{MF2} * \text{PF} + \text{Bonus}$$

PF – Score for the **Production** Aircraft flight

MF1, MF2 – Score for the **Manufacturing Support** Aircraft flights

Bonus – **Bonus** Task Score

The RAC is a function of empty weight, battery weight and the number of sub-assemblies for transport:

$$\text{RAC} = \text{EW1} * \text{Wt\_Battery1} * \text{N\_Components} + \text{EW2} * \text{Wt\_Battery2}$$

EW1 = Weight of the **Production** Aircraft ready to fly but without payload.

Wt\_Battery1 – Battery weight for **Production** Aircraft

N\_Components – Number of sub-assemblies the **Production** Aircraft is broken into for the delivery flight(s)

EW2 = Weight of the **Manufacturing Support** Aircraft ready to fly but without payload

Wt\_Battery2 – Battery weight for **Manufacturing Support** Aircraft

## Mission Task Matrix:

# Distributed Manufacturing

The objective for this year is to design an aircraft optimized for distributed manufacturing (**Production Aircraft**) and an aircraft optimized for moving the production aircraft sub-assemblies from remote manufacturing locations to a centralized assembly location (**Manufacturing Support Aircraft**). Teams must design the **Production Aircraft** to meet the specified payload capability. Teams will optimize the joint design of the **Production Aircraft** and the **Manufacturing Support Aircraft** to minimize the number of flights required to transport all of the sub-assemblies from their “Manufacturing” location to a central “Final Assembly” location. Teams will determine the number, size and composition of each sub-assembly and the groupings of sub-assemblies for each transport flight.

## General:

- Design payload for the **Production** Aircraft is a single 32 oz. Gatorade bottle (factory sealed, full, any flavor).
  - The Production aircraft will be broken into sub-assemblies for transport
  - **Any** portion of the airplane which is disconnected or moved from its position required for flight will add to the number of sub-assemblies. For example, an airplane which the left and right wings separately detach or fold from the body, and the tail detaches in one piece, N\_Components = 4.

- Sub-assemblies breakout must be reversible so the aircraft can be reassembled
  - Breakdown/reassembly must be capable of being repeated multiple times
- Breakdown must not include cutting or de-bonding
- Reassembly must not include gluing / bonding
- Design payload for the **Manufacturing Support** Aircraft is the **Production** Aircraft, broken into multiple sub-assemblies and groupings.
  - All sub-assemblies must be carried internally
- All payloads must be secured sufficiently to assure safe flight without possible variation of aircraft cg outside of design limits during flight.
- Support frames to hold the **Production** Aircraft sub-assemblies together for loading and flight in the **Mission Support** Aircraft are allowed.
  - Supports are not included in the RAC
- Missions / flight line crew is limited to pilot, observer and 1 ground crew.
- *There is no limit on battery weight this year.*

### Mission Sequence:

- **The Flight Missions must be flown in order.**
  - **A new mission cannot be flown until the team has obtained a successful score for the preceding mission.**
- **Aircraft must be designed to be capable of performing all required missions.**
  - **Aircraft must pass the wing tip load test with the largest payload loading intended to fly.**
  - **The maximum load demonstrated will be recorded and cannot be altered after completing tech inspection.**
- Only the assembly crew member, pilot and pilot assistant may go to and enter the staging box.
  - After aircraft pre-flight checkout is complete the assembly crew member may be swapped for a different flight line crew member if desired.
- Aircraft will use ground rolling take-off and landing
  - Takeoff field length will be limited to **100 ft.**
- The initial upwind turn on the first lap of each mission will occur after passing the turn judge (signaled by raising a flag). The aircraft must remain in unaided visual control distance of the pilot at all times. The **Flight Line Judge** may require turns to be made to remain in a safe visual control range at his discretion.
- Aircraft must complete a successful landing at the end of each mission for the mission to receive a score.
  - A successful landing is outlined in the general mission specification section below.

### Tech Inspection

- Both the **Production** Aircraft and the **Mission Support** Aircraft will enter Tech Inspection fully assembled and flight ready
- The **Production** Aircraft will undergo the wing tip lift test with the design payload installed

- During the tech inspection the team will dis-assemble the **Production** Aircraft into the team determined sub-assembly payloads.
  - All sub-assembly payload groupings (with any restraints or supports) will be weighed and the heaviest group will be used for the wing tip lift test for the **Manufacturing Support** Aircraft

### Flight Missions:

- **Mission 1: Manufacturing Support Aircraft Arrival Flight**
  - The **Manufacturing Support** Aircraft will be used for this mission
  - There is no payload for the arrival flight
  - Takeoff within the prescribed field length.
  - Fly three laps within a total 5 minute window
  - Time starts when the throttle is advanced for the (first) take-off (or attempt).
  - A lap is complete when the aircraft passes over the start/finish line in the air.
  - Must complete a successful landing to get a score.
  - Scoring:
    - MF1 = 2.0 – Aircraft completes the mission
    - MF1 = 0.1 – Aircraft does not attempt or complete a successful flight
- **Mission 2: Manufacturing Support Aircraft Delivery Flight**
  - The **Manufacturing Support** Aircraft will be used for this mission
  - There will be a 10 minute window for this mission
  - The mission will begin with the first sub-assembly installed
    - All sub-assemblies must be carried internally
  - Takeoff within the prescribed field length
  - Fly one lap, return and land.
  - After each lap the aircraft will taxi to the designated payload change area where:
    - The ground crew will “safe” the aircraft propulsion system
    - Remove the installed sub-assembly group
    - Install and secure the next sub-assembly group
    - Re-enable the aircraft propulsion system
    - The aircraft will taxi to a location before the Start Line and take-off for the next lap
  - Time ends when the aircraft passes the start line in the air at the end of the final flight
  - Aircraft must complete a successful landing on each flight to obtain a score
  - **Production** Aircraft sub-assemblies do not include the **Production** Aircraft flight battery **or payload**.
  - Scoring:
    - MF2 = 4.0 – Aircraft completes all sub-assembly group transport flights successfully within the time window
    - MF2 = 1.0 - Aircraft completes less than all the sub-assembly flights within the designated time allowance but at least 1 group is successfully transported
    - MF2 = 0.1 – Aircraft does not attempt or complete a successful flight

- **Production Aircraft Flight**

- The **Production** Aircraft will be used for this mission
- Payload is a single 32 oz. Gatorade bottle (See example below - factory sealed, full, any flavor)
  - **Approximate specifications: Height 8.2", Max Circumference 3.7", Weight 2 lb. 3.9 oz.**
- **The payload must be carried internally**
- Takeoff within the prescribed field length.
- Fly three laps within a total 5 minute window
- Time starts when the throttle is advanced for the (first) take-off (or attempt).
- A lap is complete when the aircraft passes over the start/finish line in the air.
- **Must complete a successful landing to get a score.**
- Scoring:
  - PF = 2.0 – Aircraft completes the required flight within the time period carrying the full payload
  - PF = 1.0 - Aircraft completes less than the required laps or exceeds the time period
  - PF = 0.1 – Aircraft does not attempt or complete a successful flight



- **Bonus Mission (Ground Only)**

- After completing all the above missions successfully for a score the team may attempt the bonus mission
- Bonus mission will be completed in an area separate from the flight area. Immediately after the final flight the team will bring all **Production** Aircraft sub-assembly groups flown to the designated area.
- The ground crew must assemble the **Production** Aircraft from the sub-assemblies within **2** minutes, including re-installing the payload (the payload will not be flown by the Manufacturing Support aircraft during its mission)
- The completed aircraft must pass the wing tip lift test and a controls system check.
- Scoring:

- Bonus = 2.0 – Aircraft assembled in specified time and passes wing tip lift test
- Bonus = 0.0 – Any other result

## Flight Line Order:

- A **flight order** list will be generated and **emailed to the teams on the Wednesday prior to the fly-off weekend**. Teams will always rotate in this order. The flight order will be repeated continuously.
  - The flight order list will carry over from Friday to Saturday and Saturday to Sunday at whatever spot in the rotation it leaves off.
  - Each team's position in the flight order will be determined from their written report score, highest report score goes first.
  - Report scores will be available following the pilot briefing at the start of the contest (they will not be included with the rotation sequence e-mail).
- There will be four **staging box** positions near the flight line.
- If you are not ready to enter a **staging box** when your rotation number comes up you will miss your opportunity for that rotation.

**Note:** It is each team's responsibility to monitor the notifications from the scoring table in order to respond if ready. A contest official will be available to help teams enter the **staging box**.

- If you choose to leave the **staging box** for any reason you may not attempt a flight until your turn comes up again in the rotation order.

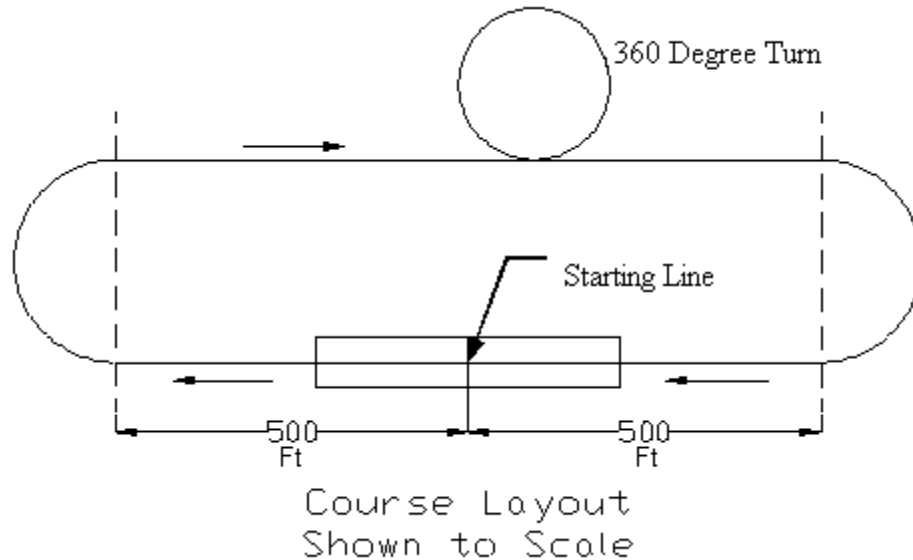
## General Mission Specification and Notes:

- The aircraft propulsion system(s) must be "safed" (fuse or arming plug removed) during any time when crew members are preparing/handling the aircraft.
- Maximum flight support crew is: **pilot, observer, and ground crew**.
- Observer and all ground crew must be students. **Only the pilot may be a non-student**.
- The upwind turn will be made after passing the upwind marker. The downwind turn will be made after passing the downwind marker. Upwind and downwind markers will be 500 ft. from the starting line. Aircraft must be "straight and level" when passing the turn marker before initiating a turn.
- Aircraft must land on the paved portion of the runway. Aircraft may "run-off" the runway during roll-out. Aircraft may not "bounce" off the runway.
- *Aircraft obtaining "significant" damage during landing will not receive a score for that flight. Determination of "significant" is solely at the discretion of the Flight Line Judge.*
- Flight altitude must be sufficient for safe terrain clearance and low enough to maintain good visual contact with the aircraft. Decisions on safe flight altitude will be at the discretion of the Flight Line Judge and all rulings will be final.

Additional information is included in the [FAQ](#) (Frequently Asked Questions).

### Flight Course:

The orientation (direction) of the flight course will be adjusted based on the prevailing winds as determined by the Flight Line Judge. The flight course will be positioned to maintain the greatest possible safety to personnel and facilities. The nominal flight course is shown in the Figure below.



### Protest Procedure:

Submitting a protest is a serious matter and will be treated as such. Teams may submit a protest to the Contest Administration at any time during the competition. Protests may not be submitted after the conclusion of the competition. Protests must be submitted in writing and signed by the team advisor, designees are not allowed for protest submissions. If the team advisor is not present, he may FAX or email a signed protest to the team for them to present. Remotely submitted protests must be on hard copy (printed by the team) and have the advisors signature. A phone number where the advisor may be contacted must be provided. Protests may be posted for review at the decision of the administration.

Protests and penalties (up to disqualification from the contest for deliberate attempts to misinform officials, violate the contest rules, or safety infractions) will be decided by the Contest Administration. **Protests submitted but not upheld by the judges *may be given a penalty of the loss of one flight score to the team submitting the protest.*** The decision of the Contest Administration is final.

### Proposal:

Each team will submit a proposal as outlined below and in the **SCHEDULE** section above. Teams with compliant proposals will be invited to submit reports and become eligible for the fly-off.

**Note: Proposals must strictly adhere to the following requirements. Failure to meet requirements will result in the proposal being rejected and elimination from the contest.**

- Proposals must have the University name on the cover page.  
*Proposals missing this identification information will not be accepted.*
- Absolute maximum page count for the proposal is **5 pages**, the PDF reader "pages" value will be used as the official page count.  
*Reports exceeding the maximum page count will not be accepted.*
- Proposal PDF must be formatted as 8.5 x 11" pages.

- Proposals will be reviewed for full compliance to the requirements outlined below.
- All proposals must be one and one half line spacing, 10-pt Arial font. Tables and figures should be clear and readable. **The proposals will be judged on format and readability.**
- **ALL** items below shall be present, easy to locate and identify, well documented and in the correct section for full compliance.

## **Proposal Requirements**

1. Cover Page
  - Must include University name
2. Executive Summary
  - Objective Statement
  - Planned approach to achieve all objectives
3. Management Summary
  - Describe the organization, the roles of each team and individual skill sets required
  - Organization chart (by team/function, individual names are not required for the proposal)
  - Schedule / Milestone chart
4. Conceptual Design
  - Describe the mission requirements (problem statement)
  - Translate the mission requirements into preliminary design requirements
5. Preliminary Design Status
  - Results of Trade Studies to date
  - Preliminary design / sizing results
6. Conceptual Aircraft Views
  - Include a 3D view(s) or 3-view of the conceptual design
7. Manufacturing Plan
  - Preliminary manufacturing flow
  - Bill of Materials



- Describe critical processes or technologies required
8. Summary

## Proposal Electronic Submission

Each team must provide an electronic copy of their proposal as outlined below.

- Electronic copy must be submitted on the link provided at [www.aiaadbf.org](http://www.aiaadbf.org) by 5PM US East Coast time on **14 December 2015**.
- Electronic proposal must be named: “**2016DBF**\_*[university]*\_PROPOSAL.pdf”
- Electronic proposal must be a single file with all figures/drawings included in the proper sequence in PDF format.  
(Free PDF file conversion programs are available on the Internet, such as [www.pdf995.com](http://www.pdf995.com).)
- Electronic proposals should have all figures compressed to print resolution to minimize file size.
- Electronic proposals must be less than **20 MB** in size (including encoding for e-mail transmission).

**Proposals not following the name format or exceeding the file size will be rejected.**

## Design Report:

Each team will submit a judged design report as outlined below and in the **SCHEDULE** section above.

**Note: Reports must strictly adhere to the following requirements. Failure to meet requirements will result in penalties that range from score reduction to elimination from the contest.**

- Reports must have the University name on the cover page.  
*Reports missing this identification information will not be scored.*
- Absolute maximum page count for the report is **60 pages**, the PDF reader "pages" value will be used as the official page count.  
*Reports exceeding the maximum page count will be given a **10 point penalty** for each additional page.*
- Report PDF must be formatted as 8.5 x 11" pages.
  - May use 11x17" pages for the drawing package.
- A separate stand-alone three view drawing must be submitted along with the report file. See description below in the electronic submission section.

- Reports will be scored on a 100 point basis following the guidelines outlined below.  
All information used for scoring **must be in the outlined sections, content that is**

out of sequence, including the drawing package, will be treated as missing and scored accordingly.

- All reports must be one and one half line spacing, 10-pt Arial font. Tables and figures should be clear and readable for the judges. The reports will be judged on format and readability.
- **ALL** items requested below should be present, easy to locate and identify, well documented and in the correct section for full scoring.
- Examples of winning team design reports from prior contest years are posted on the contest website. Note that the formatting and content has changed from one year to the next. Prior year reports may not reflect or meet the rules listed for the current year.

## **Design Report Scoring Rubric**

*All section scores include format, completeness and readability*

1. Executive Summary (10 Points)
  - Maximum of 2 pages. If exceeded, score as 0 points
  - Summary description of selected design and why it best meets the mission
  - Describe key mission requirements and associated design features
  - Document the performance/capabilities of your system solution
  - Format, completeness, readability
2. Management Summary (5 Points)
  - Describe the organization of the design team
  - Chart of design personnel and assignments areas
  - Milestone chart showing planned and actual timing of major elements
  - Format, Completeness, Readability
3. Conceptual Design (15 Points)
  - Describes mission requirements (problem statement)
  - Translate mission requirements into design requirements
  - Review solution concepts/configurations considered
  - Describe concept weighting and selection process and results
  - Format, Completeness, Readability
4. Preliminary Design (20 Points)
  - Describe design/analysis methodology
  - Document design/sizing trades
  - Describe/document mission model (capabilities and uncertainties)
  - Provide estimates of the aircraft lift, drag and stability characteristics
  - Provide estimates of the aircraft mission performance
  - Format, Completeness, Readability
5. Detail Design (15 Points + 15 Points for Drawing Package)
  - Document dimensional parameters of final design
  - Document structural characteristics/capabilities of final design
  - Document systems and sub-systems selection/integration/architecture
  - Document Weight and Balance for final design
  - Must include Weight & Balance table empty and with each possible payload

- Document flight performance parameters for final design
  - Document Rated Aircraft Cost
  - Document mission performance for final design
  - Format, Completeness, Readability
  - Drawing package:
    - 3-View drawing with dimensions
    - Structural arrangement drawing
    - Systems layout/location drawing
    - Payload(s) accommodation drawing(s)
6. Manufacturing Plan (5 Points)
- Document the process selected for major component manufacture
  - Manufacturing processes investigated and selection process and results
  - Manufacturing milestones chart: plan and actual
  - Format, Completeness, Readability
7. Testing Plan (5 points)
- Test Objectives and schedule
  - Test and flight check lists
  - Format, Completeness, Readability
8. Performance Results (10 Points)
- Describe the demonstrated performance of key subsystems
  - Compare to predictions and explain any differences and improvements made
  - Describe the demonstrated performance of your complete aircraft solution
  - Compare to predictions and explain any differences and improvements made
  - Format, Completeness, Readability

## **Design Report Electronic Submission**

Each team must provide an electronic copy of their final design report for the report judging as outlined below.

- Electronic copy must be uploaded to the link provided at [www.aiaadbf.org](http://www.aiaadbf.org) by 5PM US East Coast time on 22 February 2016.
- Electronic report files must be named: **“2016DBF [university]\_DESIGN\_REPORT.pdf”**.
- Electronic report must be a single file with all figures/drawings included in the proper report sequence in PDF format.  
(Free PDF file conversion programs are available on the Internet, such as [www.pdf995.com](http://www.pdf995.com).)
- Electronic reports should have all figures compressed to print resolution to minimize file size.
- Electronic reports must be less than **20 MB** in size (including encoding for e-mail transmission).

Stand Alone 3-view requirements:

- A separate file with a one page 3-view drawing formatted to fit 8.5" x 11" paper **must be submitted** with the report for confirmation of the basic configuration. Note that this page does not count toward the report total.
- The 3-view file shall be named as per above:  
“2016DBF [*university*]***THREE\_VIEW***.pdf”.
- The university and team names shall be clearly shown on the drawing.
- The 3-view file is limited to **2 MB** in size.

**Reports and three-views not following the name format or exceeding the file size will be rejected.**

## Frequently Asked Questions (FAQ)

**Please check the FAQ often during the competition. Please note that rules interpretation questions are not answered by e-mail until after the entry date (when all participant e-mail address are known), so that all teams will have equal access to all rules information.**

**\*\*\* All Rulings In This FAQ Supplement The Official Rules! \*\*\***

### General Notes:

- 2.4 GHz band radios are recommend for the contest. We will accept an email request to use a 72 MHz style radio from teams with accepted entries following the close of the entry submission period.
- Li-Poly batteries are NOT legal for use either as propulsion or RC batteries.

### Flight / Mission Questions

1. Question: Do we have to fly all of the different missions to get a score?  
Answer: You will get a score for each mission you successfully complete. The flights must be completed in the order specified to obtain a score.
2. Question: If the airplane is damaged on a flight can we use another copy of the aircraft which has the same design?  
Answer: No, you must repair the original aircraft.
3. Question: Can we tailor the configuration of the aircraft differently for the different missions? For example, could we use different sized propulsion systems for each flight?  
Answer: You cannot change the hardware configuration of the aircraft for the different missions.
4. Question: What constitutes a successful landing?  
Answer: The aircraft must touch down ON the runway. It may roll/slide, not bounce, off the runway after touchdown.
5. Question: Is there a minimum altitude for flying the course?  
Answer: No. Altitude must be high enough for safe flight as set by the discretion of the Contest Director.
6. Question: What would constitute “non-critical” versus “significant damage” on landing as described in the rules?  
Answer: The decision will be at the discretion of the flight line judges. In general, “non-critical” damage would allow the aircraft to be easily returned to safe flight status. A couple of examples of “non-critical” damage would be a broken propeller, bent landing gear, sheared nylon bolts or minor scratches to the finish. If any component is structurally damaged and would be considered a hazard to safe flight then it will be considered as “significant damage”.
7. Question: At what wind speed will the contest be called.  
Answer: It will be up to each team to determine whether they want to fly or not. The

contest director will determine if it becomes unsafe for teams to fly. Wind speed is not the only factor that may be considered.

## **Aircraft Configuration Questions**

1. Question: Can there be thrust vectoring via rotating the engine, nozzles, blown surfaces etc.?  
Answer: Yes. Any of the above options is allowed, and may be varied during flight. However, "rotary wing" vehicles are not allowed, so you may need to consult the judges with your specific design doesn't cross over the line into vertical flight capability.
2. Question: Can we change the aircraft geometry, such as wing sweep or span, for different missions?  
Answer: Variable geometry is allowed provided it is controlled remotely through the RC control system. You may not "swap out" parts for different missions.
3. Question: Do the external fuse accessibility requirements (from behind if tractor, from the front if pusher) exclude the use of a pusher-puller type multi-engine configuration?  
Answer: You may use a push-pull configuration but must locate the fuse(s) such that they can be accessed by the crew member without having to reach over or around either propeller or being in the propeller disk plane of either propeller.

## **General Questions**

1. Question: Is it safe to assume that if the rules do not explicitly forbid something, it is allowed?  
Answer: The rules are intentionally designed to not impose too many limitations while allowing each team an equal chance. If something adheres to the "spirit" of the rules it is likely to be allowed. If you have any specific questions you would like clarified they may be addressed in a private e-mail to the contest administrator. Ideas will not be disclosed to other teams if they represent a legal and innovative approach. If it is deemed to be not legal, it may be added to this FAQ or posted to the other teams at the administrator's discretion.
2. Question: Do all of the team members need to be student members of AIAA?  
Answer: Since the DBF is part of the AIAA competitions sanctioned by the Student Activities Committee and the AIAA Foundation, all team members should be student members of the AIAA.
3. Question: What is the maximum number of people that can make-up a team?  
Answer: There is no specific limit on team size. It is up to the team itself to determine a size sufficient to meet the required tasks and small enough to remain manageable.
4. Question: Is it necessary to list all team members on the entry.  
Answer: Yes, we need to know all the team members to verify that at least 1/3 of the team members are Freshmen, Sophomores or Juniors. Team members may be updated/changed at any time during the contest but must always comply with the 1/3 rule.

5. Question: Can we change team members during the contest year?  
Answer: You may change team members anytime during the contest year as long as you continue to meet the team composition rules.
6. Question: Is it allowed to have/declare more than 1 pilot in a team (in case one of them cannot go to the contest, or simply have a back-up pilot)?  
Answer: Yes, teams may register multiple pilots as long as each meets the requirements listed in the rules.
7. Question: Can we have corporate sponsors? If so, can we put their logo on the aircraft at any place that pleases them?  
Answer: Teams may solicit and accept sponsorship in the form of funds or materials and components from commercial organizations. All design, analysis and fabrication of the contest entry is the sole responsibility of the team members. Sponsor and university decals or logos may be placed as desired.



## **Q&A #2 (Proposal Requirements) - 12/04/2015**

*(Addressing proposal related questions received between 11/6/2015 and 12/3/2015)*

Q. We don't know what to do with the "bill of materials" which is required for the proposal. we don't have a final prices for the materials we use, also the motors and batteries are not selected yet, so we want to know what exactly will we write for the "bill of materials" ?

A. The term "Bill of Materials" refers to a listing of components and materials you plan to use. If actual prices are not available yet, then use your best estimate. Documentation of pricing is not required.

Q. We have registered for AIAA DBF 2016 and have following doubts regarding the proposal.

- 1) Is the manufacturing flow supposed to be a flow chart or a gannt/milestone chart?
- 2) Does the manufacturing flow have to include design stages or only construction stages?
- 3) Does the bill of materials need to be added along side the 3D view of the aircraft or is to be added separately?

A. These types of details are left to the discretion of your team based on the current stage of the design process.

Q. We would like to know if the airplane described in the proposal has to be the exactly the same one of the final report or if we can modify it.

A. The basic design of either or both airplanes may change between the proposal and final report.

Q. Since our team has 2 designs for the production plane, and we would like to ask if it is okay to include the two designs in the proposal? We are currently doing tests on the two designs, and we have not yet decided on which design we would use in the competition. Therefore, we would like to know if we can put the two designs in the proposal.

A. Yes, this would be considered a trade study and may be included.

Q. Does the proposal require 3-view drawings for both production aircraft and manufacturing aircraft?

A. A conceptual sketch or 3-view of both airplanes would be expected at this stage of your design

Q. The rules stress "format and readability" as the metric for judging. Due to our semester schedule, our team is at the critical design review stage and therefore has completed some fairly comprehensive engineering studies spanning dozens of pages - should we stress format and readability over quality of content?

A. Both content and readability are important. You are not required to fully document your design at this stage.

Q. The rules state that the proposal must be written in 10 pt Arial font. This rule was clarified in the Q&A saying that the University name on the cover page may be larger than 10 pt ft. Are there any other instances where teams may use a font size larger than 10 pt?

A. The 10pt font rule should be considered a minimum size. Larger fonts may be used when

appropriate.

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## **Proposal Requirements and Evaluation Procedures - 11/23/2015**

*The proposal schedule and requirements are detailed in the rules. Be sure to review them*

The number of entries has exceeded the capacity of the flyoff venue. Therefore the proposals will be evaluated and the **top 90 teams with compliant proposals** will be selected to continue on to the final report phase.

### **Evaluation Process:**

- All elements of the proposal must be present to be compliant. For example if a conceptual sketch or three view is absent then the proposal will be considered non-compliant and that team will not be allowed to continue.
- The proposal requirements are detailed in the rules. Be sure to review them.
- All compliant proposals will then be scored. Each section will be given a score based on how well the section is completed.
- Every proposal will be scored by multiple representatives from the DBF Organizing Committee.
- The scores will be totaled and proposals ranked. The top 90 teams (and ties) will continue on.
- Teams will be notified December 21, 2015 of their status.
- Compliance and scoring results will be available to teams after notification.

### **Other Notes:**

- All proposals received within the entry period and prior to the deadline will be reviewed.
- The University Name on the cover page may be larger than 10pt font.
- The cover page may include other parts of the proposal in addition to the University Name.
- The cover page is included in the 5 page limit.
- The sketch or three-view is included in the proposal and is not a separate file.
- Pages may be portrait or landscape orientation.
- Beyond the specifications in the rules, teams are free to present material in a manner of their choosing based on the current stage of the design process.

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## **DBF Q&A #1 - 11/11/2015**

(Addressing questions received between 10/31/2015 and 11/6/2015)

## "Sub-Assemblies" and "Components"

Q. If we detach the propeller, does that count as a sub-assembly?

A. This is addressed in the rules. Yes, it counts as a sub-assembly.

Q. Is a retractable landing gear of the Production Aircraft counted as subassembly? Of course the gear has to be moved for transport, but the gear is also moved during flight of the aircraft.

A. This is addressed in the rules. Yes, each moving gear leg that is moved for the purpose of loading into the Manufacturing Support Airplane counts as a sub-assembly regardless of whether it is servo-actuated or manual. If the gear is left in the down position then it does not constitute another sub-assembly.

Q. Is there any limitation for the number of sub-assemblies? Is it allowed to transport the Production Aircraft on the whole or is there a minimum of 2 sub-assemblies?

A. The lower limit on the number of sub-assemblies is 1. There is no upper limit.

Q. We are considering using a folding propeller in order to improve our aircraft's glide efficiency in case of a motor failure. The aircraft will fly with the propeller both folded and extended during each flight, so it is technically in its flying condition both when folded and extended since it will transition on its own with power application during each flight. The propeller will neither be removed from the Production Aircraft nor secured in the folded or extended condition when placed inside of the Mission Support Aircraft. It will extend by centripetal force when the motor begins turning upon power application. Will a commercially available folding propeller be considered a separate sub-assembly?

A. This is addressed in the rules. Folding propellers are specifically excluded for the Production Airplane.

Q. In terms of production aircraft sub assemblies, what constitutes the number of sub assemblies? Say made it so the tail could separate from the fuselage but also had it so that we could fold it to make it smaller in size, would that count as 1 sub assembly or 2?

A. This is addressed in the rules. Folding the component would add to the sub-assembly count.

Q. Do the current rules prohibit landing gear and or control surfaces from being retracted for storage in the Manufacturing Support Aircraft using servos controlled by the RC control system?

A. This is addressed in the rules:

- Landing gear that is retracted or removed to fit inside the manufacturing support airplane will count as a sub-assembly.
- Movable control surfaces that remain in their flight installed position for transport do not count as additional sub-assemblies

Q. We want to know if the production aircraft sub-assemblies can be grouped together for transporting in the manufacturing support aircraft. For example, if the right and left wings are detached for transportation, then that would count as 2 sub-assemblies. Can this two be grouped together for the same flight in the manufacturing support aircraft such that 2 sub-assemblies = 1

grouping = 1 manufacturing support aircraft flight?

A. The number of Sub-assemblies (N\_Components) is defined as the "Number of sub-assemblies the Production Aircraft is broken into for the delivery flight(s)". So the total number of different components factors into your score. This is different from the number of assemblies loaded into the Manufacturing Support Aircraft for any given flight. The number of sub-assemblies carried at any one time, and the number of flights required to complete the mission are left up to the team to optimize and does not factor directly into the score as long as the mission is completed within the allotted time as described in the rules.

Q. If a wing is taken off of the production plane and folded it counts as 2 sub-assemblies. However, if that folded wing is still one continuous piece, does it need to be flown around the track multiple times? Or if it is carried all internally could it be 1 lap?

A. Only one lap is required for each flight within Mission 2, regardless of the number of sub-assemblies carried.

Q. We were wondering if we are allowed to place multiple sub-assemblies in our Manufacturing Support Aircraft, then count that lap for all of the sub-assemblies in the plane (i.e. If we had 4 sub-assemblies and we can fit 2 sub-assemblies in our plane per flight, then do we need to fly 4 laps, or can we fly 2 laps?)

A. Any number of sub-assemblies may be flown at a time. In your case, you would fly two sub-assemblies for the first flight for one lap. Then land, taxi to the loading area, load the second two sub-assemblies and fly one lap.

## **Internal Carriage of Sub-Assemblies**

Q. My team has a question about the rules for the AIAA DBF competition. Under the description of Mission 2, it says:

- All sub-assemblies must be carried internally

My team was wondering if this means that the sub-assemblies of the production airplane can also be carried inside of the manufacturing aircraft's wing as well, and not just the fuselage. We were thinking of placing the production aircraft's wing inside of the manufacturing aircraft's wing, and we wanted to know if this was legal.

A. Internal means completely covered by the Manufacturing Support Aircraft skin. Areas other than the fuselage may be used.

## **Flexible Structures and Fuselage Shells**

Q. For the production plane, would a flexible (non rigid) skin count as a subcomponent if the skin could be in any position during flight? For example, an inflatable fuselage. If the production plane could fly regardless of whether the fuselage was deflated, partially inflated, or completely inflated, would the fuselage be considered an additional component?

Q. If the wing deforms due to the external volume it is contained in (ie, no servos involved or manual disassembly, and removing the external volume will automatically cause the wing to

regain its ready to fly state) while remaining permanently attached to the fuselage, will the wing and the fuselage count as separate components?

Q. If we have a movable/ flexible skin over the Gatorade bottle that is securely attached to the plane but bulges out when the Gatorade bottle is inserted, would that count as a subassembly since it is a moving part?

A. The intent of the mission suite for this contest is to simulate a real world distributed manufacturing system. Flexible structures in this context are not used. Therefore all structures for both aircraft must be rigid in the sense that neither aircraft shape can change in order for the production aircraft sub-assemblies to fit within the manufacturing support airplane. Also, the structure of the production airplane may not deform to load the Gatorade bottle. The airplanes may have a hatch that moves mechanically

### **Autonomous Taxi (or any other Operation)**

Q. In mission 2 the manufacturing plane will land and "taxi" to a payload change area. Does this mean that the plane will need to drive autonomously from one area to another? Or will human interaction be allowed?

A. Autonomous operation, whether in taxi or in flight, is specifically prohibited. Manual control is required at all times.

### **Propulsion Changes between Mission 1 and 2**

Q. What aspects of the propulsion system can be changed between missions one and two? Propellers can be changed between the missions, but do motor and battery packs need to remain the same?

A. Propellers and battery packs may be changed. Motors may not (see FAQ).

### **Loading Method for Manufacturing Support Aircraft**

Q. Can we disassemble the plane between missions 1 and 2 in order to accommodate the sub-assemblies from the production a/c? Is there a limit on the number of pieces we can take apart and put back together? (assuming the final product is the same).

A. The method of loading is left up to the team. Portions may be disassembled or hatches may be used. A movable hatch on the production airplane does not count as a sub-assembly.

### **Final Report Page Limits**

Q. The absolute maximum page for the design report is 60. This year, each team has to document about the design of two different airplanes, which may or may not be similar in terms of configuration. Just for the CAD drawings, this will mean at least 4 other separate pages guaranteed. I believe that it will be quite difficult to fit all the contents within 60 pages and at the same time, present the material in a profound manner that will increase the chance of obtaining a high score. Hence, will the absolute number of pages be reconsidered?

A. The final report page limit remains at 60 pages. Teams must document both airplanes as best possible within that limit.

## Taxi Questions

Q. For Flight Mission 2, the Manufacturing Aircraft is required to taxi to a designated payload area after landing if there's more than one sub-assembly to be carried. Wichita is known to have really strong winds, which are easily capable of blowing the airplane off the runway while taxiing. Say for instance that we have multiple sub-assemblies, will the team be allowed to carry the airplane to the designated payload area if the wind is too strong? Or, is this a factor that the team has to take into consideration when coming up with the design and strategy?

A. This will be left to the discretion of the Flight Line Director. If needed, "wing walkers" may be allowed to keep control of the airplane. They will not be allowed to "carry" the airplane, and they will not be allowed to compensate for poor ground handling characteristics.

Q. If the production plane is only one component, are we required to taxi to the special area to load the plane?

A. Yes, you will need to taxi the airplane to the loading area at least once.