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AA/INDE 470 - Paper 3

Specification - AIAA DBF

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Contents

1 Scope

These specifications cover the electrical, mechanical, and structural design and construction of the aircraft. The requirements from the 2013-2014 rules are outlined in this document. These requirements cover the design, construction, testing, documentation and performance of the aircraft. All quantitative specifications and requirements are derived from the 2013-2014 rules. The only exceptions are a few cost estimates and the funding and performance goals. This document does not give any other quantitative requirements for design, construction or budget.

2 Applicable Documents

The **2013-2014 Rules and Vehicle Design** document is be the primary resource for the contest specifications. It contains the entire ruleset for the contest. These requirements cover the team, the schedule, the aircraft, safety, mission definitions, the formatting of the report and the final competition.

The **2013-2014 FAQ and Q&A Document** web pages must be watched closely by the Project Management Team, likely to be updated. Current versions must be sent out to the team leads on a weekly basis. Each document must be clearly marked with the look-up date and changes must be highlighted using colored font.

As the pilot of the airplane must be a member of the Academy of Model Aeronautics (AMA), all flight operations and requirements for the aircraft must adhere to the **Academy of Model Aeronautics National Model Aircraft Safety Code**. The safety-relevant parts of the aircraft such as the motor, the batteries, the fuses, the propellers and the radio controllers must be installed and operated according to their **Safety and User Documents**. The team must consider these directions during design, construction and testing to ensure that the aircraft passes all necessary safety inspections.

Before and during the competition, the team must pay attention to the additional **Documents published during the competition**. This includes the **safety checklist**, as the one published in the Rules and Vehicle Design may not be exhaustive. Additionally, one person on the contest team must monitor the **contest flight order** for general time management.

3 Requirements

3.1 System Definition

The following sections provide a high-level overview of the aircraft's operational, maintenance and functional concepts.

3.1.1 General Description

This project's primary product is a remote controlled scale-model plane. It must perform three flight missions and a taxi demonstration. The flight missions are a 'ferry flight' mission, a 'cargo flight' mission, and an 'Emergency medical flight' mission. Each mission is designed to evaluate the speed, maximum cargo capacity, and versatility of the plane design. The taxi demonstration simulates 'rough field taxi' conditions and evaluates the maneuverability, structural strength, and ground clearance of the plane.

3.1.2 Operation Requirements

This system's primary purpose is to perform the assigned missions well enough to outscore the other teams in the competition. In particular, the system (including the plane, control equipment and support materials) must perform several flights in a variety of loading configurations during the competition. Additional information on the missions is available in the DBF Rules. Furthermore, the plane must also serve as the test bed for the final design. No engineering models or final prototypes are expected. The System is expected to be kept by the university and the team; except for travel to test flight facilities and the competition, no distribution of the final product is anticipated. Documentation produced during the project must be distributed as outlined in the competition rules. The project's lifespan is approximately 9 to 12 months long. At the end of the project, the system may either be disposed of and/or saved for display or recruitment purposes.

3.1.3 Maintenance Concept

Because of competition requirements, the system must emphasize component modularity and easy access to internal compartments. The plane must be serviceable by a single person with basic skills in electronics and mechanics.

3.1.4 Functional Analysis and System Definition

The system contains 3 major subsystems: electrical, mechanical, and structural. These subsystems can be further decomposed into specific functional groups as described in Tables 3.1 and 3.2.

3.1.5 Allocation of Requirements

The major requirements of the project have been assigned to each of the functional groups as indicated in Tables 3.1 and 3.2.

Tab. 3.1: Functional groups

Major Subsystem	Functional Group	Description	Interfaces	Allocated reqs.
Electrical	Energetics	Supplies electrical energy (power) to all electrical components of the system	Electrical Wiring: Power Plants, Radio Control; Mechanical Connection: Interior, Fuselage	*2.1.III, 2.4.I, 2.8.I, 2.4.I, 2.5.I, 3.2.I, 3.2.II, 3.2.III, 3.3.I, 3.5.I*
	Power plants	Comprises the motor controller(s) and motor(s) which provide thrust	Wiring: Energetics, Radio Control; Mechanical Connection: Wings, Propellers	*2.1.II, 2.1.IV, 2.2.II, 2.5.I*
	Radio Control	Transmits and receives pilot commands and translates those directives into mechanical actuations and throttle instructions	Wiring: Energetics, Power Plants; Mechanical Linkage: Control Surfaces; Mechanical Connection: Interiors	*2.1.II, 2.4.IV, 2.11.II, 2.11.III*
Mechanical	Control surfaces	Allows adjustment of plane aerodynamics to change flight characteristics and plane attitude	Mechanical Linkage: Radio Control, Wings, Tail Surfaces	*2.11.I, 2.6.I, 3.6.I, 3.6.II, 3.7.1, 3.7.II*
	Landing Gear	Allows the plane to taxi, take off, and land safely; Increases the ground clearance of the plane	Mechanical Connection: Fuselage	*2.3.II, 2.4.II, 3.6.I, 3.6.II*
	Propellers	Transforms the power plant's torque into thrust	Mechanical Connection: Power Plant	*2.2.II, 2.5.I, 3.6.I, 3.6.II*
Structural	Fuselage	Maximizes aircraft performance by reducing drag; provides the space to carry and transport loads; is a structural support and attachment point for wings, tail surfaces, and landing gear	Mechanical Connection: Interiors, Wings, Tail Surfaces, landing gear, energetics, radio control Mechanical Linkage: Control surfaces	*2.2.I, 2.2.III, 2.4.III, 2.5.II, 3.7.1, 3.7.II*
	Interior	Positions and secures internal components to properly balance the plane and allow for rapid reconfiguration of the aircraft	Mechanical Connection: Energetics, Radio control, Fuselage	*2.1.V, 2.5.I, 3.7.1, 3.7.II*

Tab. 3.2: Functional groups cont.

Major Subsystem	Functional Group	Description	Interfaces	Allocated reqs.
Structural	Wings	Generates lift and improves flight performance; supports the power plants; provides a mounting point for control surfaces	Mechanical Connection: Fuselage, Radio control, Power plants; Mechanical Linkage: control surfaces	*2.1.IV, 2.2.I, 2.2III, 2.4.III, 2.6.I, 3.6.I, 3.6.II, 3.7.1, 3.7.II*
	Tail Surfaces	Provides a mounting point for control surfaces; aids in plane stability	Mechanical Connection: Fuselage; Mechanical Linkage: Control surfaces	*2.5.II, 2.6.I, 3.6.I, 3.6.II, 3.7.1, 3.7.II*

3.1.6 Functional Interfaces and Criteria

The interfaces between functional groups are listed in Tables 3.1 and 3.2. These interfaces can be classified as one of several types defined below:

- Electrical wiring: Pairs of wires carrying power and signals between groups.
- Mechanical linkage: A connection though a controlling rod or hinged mechanism where one component's movement and position is determined by the movement of the other.
- Mechanical connection: Two components that are physically connected together, acting as one piece. Force is transmitted directly from one component to the other.

3.2 System Characteristics

The following sections specify the system characteristics of the 2013-2014 DBF aircraft.

3.2.1 Performance Characteristics

The aircraft take-off gross weight with payload must not be over 55 *lb (Req 2.1.I)*. Motors and batteries must not draw more than 15 A of current *(Req 2.1.II)*. This must be ensured by using a 15 A fuse in series between the positive battery terminal and the motor controller.

The battery packs must weigh no more than 1.5 *lb (Req 2.1.III)*. The motor/plane configuration must be able to take-off within 40 ft of field length *(Req 2.1.IV)*. The aircraft must be able to be loaded with at least one 6” x 6” x 6” wooden block, ballasted to 1 *lb*, as well as with two wooden blocks 9” long, 4” wide, 2” high weighing 0.5 *lb* and two wooden blocks 6” tall, 2” wide, 4” long in the configuration shown in the 2013-2014 Rules *(Req 2.1.V)*.

3.2.2 Physical Characteristics

The aircraft may be of any configuration except rotary wing or lighter-than-air *(Req 2.2.I)*. It must be propeller driven and electric powered with an unmodified over-the-counter model brushed or brushless electric motor *(Req 2.2.II)*. It may use multiple motors and/or multiple commercially produced propeller blades, which may be modified by clipping the tips or painting the blades. It must use a commercially available propeller hub/pitch mechanism. The ground clearance under each wing, no further than half span from the centerline, must be over 3.5” *(Req 2.2.III)*.

3.2.3 Effectiveness Requirements

The aircraft must be built to perform all three flight missions and the taxi mission well enough to achieve a score in the upper 20% of the field *(Req 2.3.I)*. The thrust/weight ratio must be chosen to maximize the aircraft’s speed for all loadings and missions. The landing gear must be able to cross the fiberglass roofing panel taxiway with corrugation spacing of 3” and 0.625” height *(Req 2.3.II)*.

3.2.4 Reliability

The range and battery capacity must be sufficient to complete a flight period without changing the batteries *(Req 2.4.I)*. The landing gear must endure the landing process of the three missions without an incident *(Req 2.4.II)*, as defined in the 2013-2014 DBF Rules. The wings and fuselage must be designed and built to withstand the safety check lift-up as well as predicted loads during flight, including high-wind scenarios *(Req 2.4.III)*. All components must be adequately secured to the vehicle. It will be necessary to tighten fasteners and use safety wire, locktite or nylock nuts. The radios must have a fail-safe mode (as specified in the 2013-2014 Rules) in case of loss of signal *(Req 2.4.IV)*.

3.2.5 Maintainability

Changes to the plane's flight configuration must be performable in less than 4 minutes *(Req 2.5.I)*. The aircraft must be built in a modular approach *(Req 2.5.II)* so it can be repaired in the estimated flight round turnaround time. This especially applies to components prone to damage or outage including, but not limited to, the landing gear, propellers, control surfaces with servos, electronics and safety fuses. The aircraft must be built and designed to be repaired by the the ground crew with tools and parts available at the contest site. The ground crew must be trained to perform all maintenance actions as efficiently as possible.

3.2.6 Usability

The aircraft must be designed to be easily maneuverable to ensure a successful flight even by a pilot unacquainted with the aircraft *(Req 2.6.I)*. It should withstand nothing more than minor damage due to rough landings, wind gusts and contingent incidents of minor magnitude.

3.2.7 Supportability

The plane must be designed in a way to ensure that time and budget constraints allow for enough spare parts to be provided before the contest date *(Req 2.7.I)*. This includes manufacturing time as well as processing time for raw materials and commercial parts. Parts must be catalogued properly to ensure quick access to the inventory information during the contest. Materials that can't be brought along must be purchased in a timely manner at the contest site.

3.2.8 Transportability / Mobility

The packaging and transport design must be conducted in conjuncture with the aircraft design and closely follow changes in the major dimensions. The Transport Team must order properly-sized boxes and equip them to ensure safe transport of the aircraft and spare parts to the contest. A modular approach in construction should be used, as a disassembled and properly packaged aircraft is less prone to damage. The Transport Team must also prevent the entrainment of hazmat material in the transport boxes during airborne transport *(Req 2.8.I)*.

3.2.9 Flexibility

The aircraft only needs to perform the 3 missions plus the taxi demonstration specified in the 2013-2014 Rules, so there is only a limited flexibility demand.

3.2.10 Sustainability

As the aircraft is a small-scale model, there shouldn't be any sustainability issues beyond basic disposal and recycling procedures.

3.2.11 Security

The aircraft must complete the Pre-Tech and First-Flight Certification *(Req 2.11.I)*. To conform with the safety inspection, the aircraft must pass the following requirements: structural integrity (adequately secured components, propeller structural and attachment integrity), radio range and fail safe check including a fail-safe mode *(Req 2.11.II)*, and a mechanical motor arming system consisting of the specified ”blade” style fuse *(Req 2.11.III)*. The fuse must be located so that crew members need not reach across the propeller's rotational plane for access.

3.3 Design and Construction

Specifications outlined in this section must be met by the aircraft's design. General specifications for the aircraft require it to be of any design other than lighter than air or rotary wing. The energy for take-off must come from the on board battery pack specified later in this section. The plane must not weigh more than 55 *lb*.

3.3.1 CAD/CAM Requirements

Shared CAD/CAM documents must all be SolidWorks compatible files, and created using the latest version of SolidWorks, available in the Guggenheim computer lab. When creating documents, all names must include the date last modified and version designation.

3.3.2 Materials, Processes, and Parts

All the parts and components must stay on the aircraft during flight. The aircraft must be propelled by electrical powered propellers. The electrical motor must be unmodified and commercially available 'over-the-counter.' It may be either brushed or brushless. The propellers and pitch mechanisms must also be commercially sourced. The propellers must only be modified by clipping the tips or painting the blades for balance. The power to the motors must be limited in current draw by a 15 *A* fuse. The fuse must be inline from the battery to the motor controller. The fuse must be located such that no propulsion system component can draw more than 15 *A* of current. The batteries used must be commercially available NiCad or NiMH batteries *(Req 3.2.I)*. The power to the propulsion system must come from a battery that is less than the maximum allowed weight of 1.5 *lb (Req 3.2.II)*. This battery must only power the propulsion system *(Req 3.2.III)*. As such, the radio control and servos must have their own battery pack. The batteries must have enough power to fly the aircraft over several sorties. All materials must be commercially available or fabricated in-house.

3.3.3 Mounting and Labeling

The manufacturers labeling must be visible on all batteries *(Req 3.3.I)*. Key switches and access points must be clearly labeled. The aircraft's center of gravity must be marked.

3.3.4 Electromagnetic Radiation

There are no requirements in the DBF rules concerning the electromagnetic radiation of the aircraft. Given the size of the aircraft and the fact that all electronics must be 'off-the-shelf', the total electromagnetic radiation will be negligible.

3.3.5 Safety

All of the electrical contact points on the batteries must be protected by shrink wrap or some other method. The contacts must be fully insulated *(Req 3.5.I)*.

3.3.6 Interchangeability

Mission-essential parts must be easily replaceable should they break during testing or transport *(Req 3.6.I)*. Additionally, all expendable parts, such as batteries, must be replaceable with less than 2 minutes of work and no major deconstruction of the aircraft *(Req 3.6.II)*

3.3.7 Workmanship

There must be no additional drag due to poor workmanship in the production of the aircraft *(Req 3.7.I)*. All parts must fit snugly together *(Req 3.7.II)*. To ensure these standards are met, all individuals must be certified to use the machine shop. The building team lead must be someone who has experience with using wood and machining metal.

3.3.8 Testability

The team must prove the aircraft has been flown in a test prior to the competition *(Req 3.8.I)*. A test flight photo is acceptable proof. In addition, the design must account for common parts failing during testing. Exposed parts must be easily interchangeable.

3.3.9 Economic Feasibility

The aircraft's design must not use more than 40% of the budget in construction materials *(Req 3.9.I)*.

3.4 Documentation / Data

All documents must be kept updated throughout the duration of the project. All documents published internally or externally must be uploaded to the Google Drive account.

3.4.1 Design Documentation

Each major component and subsystem must be documented. For each part or component made or assembled in-house, a 3-view drawing must be made. Each subsystem must also have a structural arrangement drawing indicating the relative location of pieces in the subsystem and the location of external interfaces. All electrical systems, must have a labeled schematic of the circuitry. Additionally, the following drawings and diagrams must be produced:

- A System Layout Drawing indicating the layout and location of major subsystem components and their interfaces.
- A Payload Layout Drawing indicating the layout schemes for the expected payloads.
- A Basic Configuration Drawing, formatted to fit an 8.5" x 11" sheet of paper and showing the basic configuration of the plane.

3.4.2 Materials and Parts List

A master list of materials and parts must be kept to track the parts used during construction and test of the plane. It must include information regarding the type of part, part number, manufacturer, unit cost, number of parts used, and the owning component or system. This information must be kept in an Excel-style spreadsheet. Additional parts lists for functional groups may also be produced, following the same outline as the master list.

3.4.3 Analysis and Reports

Final reports submitted to the DBF committee must be published in a PDF format. Informal analyses and reports must be presented in either an MS Word or PDF format. Presentations must be presented in a PowerPoint or similar slideshow format. Design decisions will be published in an associated report and must be documented in a decision tracking spreadsheet. An updated copy of this document must be kept on Google Drive and made available to all team members.

3.5 Logistics

The plane will require support from multiple sources in order to complete the competition.

3.5.1 Maintenance Requirements

The plane's battery must be recharged after every flight by the crew using a car battery and an appropriate charger. Additionally, per the rules, the plane's propeller may be changed between flights. After every test flight, a crewmember must inspect the plane for damage. If damage is found, testing must end for that day. The plane must be returned to the workshop and the construction team must proceed to make the necessary repairs as soon as possible. The pilot must also record the plane's battery life over the course of the test flights. If he/she should find that the plane's battery capacity has dropped to a period too low to fulfill its mission, the battery must be replaced. After testing has concluded, the operations team must do an analysis of the battery's degradation. If the odds of the battery having insufficient life to complete the competition are greater than 5%, the battery must be replaced by the construction team in the workshop before the competition.

3.5.2 Supply Support

The number of spares for a part must be based on the quantity and price of the part in question. For parts costing less than \$5, the number of spares must either be no less than two or no less than 25% of the number of parts in the plane, whichever is larger. For parts costing between \$5 and \$50, the team must buy or build no less than one spare. For parts costing more than \$50, the team should purchase or build one spare, provided that the overall cost of spares does not exceed 25% of the cost of the plane. If one spare cannot be purchased for each part over \$50, the spares purchased must be prioritized based on likelihood of failure and difficulty in quickly acquiring a replacement in case of failure. The construction team must keep an inventory of all spares and must purchase new spares if any quantity should drop below the amount stipulated above.

3.5.3 Test and Support Equipment

During the design process, there are be three basic types of test equipment needed. Structural testing requires weights, fasteners, and scales in order to apply and measure forces on parts. Wing testing requires use of the University of Washington's 3x3 Wind Tunnel. Electronics testing requires access to a computer and/or digital multimeter to test the outputs from the controller and other electronics. Additionally, standard construction tools such as screwdrivers, electric drills, hacksaws, and machine shop equipment are be required to build the necessary prototypes.

After construction, most tests are be all-up tests. Other than preliminary verification of the plane's design in the Kirsten Wind Tunnel, the plane spends most of its testing time in the air in a public field designated for use by model aircraft. Its behavior must be monitored by the test pilots to aid in optimization and characterization, and their post-flight analyses of the plane's condition determines the plane's reliability. Any necessary maintenance and modifications and maintenance must be performed in the team's workshop using standard construction tools.

3.5.4 Personnel and Training

The construction team must be responsible for maintenance of the aircraft. Many of them should be familiar with the aircraft's maintenance needs from their experience in building it, but complete aircraft document is still required. They must send this documentation to all members of the team and clearly label and organize the workshop storage areas for tools and spares. This will assure that maintenance can be performed by other personnel in case of an emergency.

Pilots must either have or gain knowledge of operating model aircraft. They must demonstrate their abilities to the Systems Engineer on a personal radio-controlled (RC) aircraft. If no one volunteers, the team must purchase an RC aircraft costing no more than $100 and find volunteers to practice on said aircraft until the Systems Engineer is satisfied that they can operate the DBF aircraft. After proving their skills, the pilots must register with the Academy of Model Aeronautics if they have not done so already. Finally, the construction team must brief the pilots on the plane's design and maintenance requirements. The pilots may then be allowed to operate the plane.

3.5.5 Facilities and Equipment

The project must have a workshop for prototyping, plane construction, and storage of tools and parts. This facility must receive the electricity, heating, and Wi-Fi connectivity needed to facilitate comfortable and efficient work. The workshop should include a sink. Additionally, the room must have a lock to protect the resources stored inside.

Additionally, the team may need to use some other facilities for short periods. Since the team may need tools that it cannot purchase or store, some members of the team must pursue certification in the ME Machine Shop, thus allowing them access to its tools. Furthermore, time must be reserved in the 3x3 Wind Tunnel and Kirsten Wind Tunnel for testing. The project manager and team leads must reserve conference rooms for team meetings. Finally, one or more public fields that allow the use of motorized model aircraft must be located for test flights of the vehicle.

3.5.6 Packaging, Handling, Storage and Transport

The plane must be packaged by the construction and operations teams. Furthermore, these teams must understand how to package it without breaking it. It must be stored in a box and temporarily tied down in order to prevent it from being jostled around. Additionally, it must be surrounded by packing peanuts to prevent any impacts from damaging the plane. The plane must be transported to and from the test flight area by automobile, and it should be transported to and from the competition in the same manner. However, if this is not feasible, it must be sent to a designated location near the competition by overnight mail. It must then be transported the remaining distance to the competition by automobile. Its return to the UW must likewise be by either automobile or overnight mail.

3.5.7 Computer Resources (Software)

This is a fairly small project with limited funds for purchasing computer resources. Hence, logistics must be handled with easily-available software. Inventory must be handled using a spreadsheet on Google Drive, allowing the construction team to keep the other teams up-to-date on the project's current resources. Google Calendar must be used to supplement this system, as it provides an easy way to record and keep track of package arrivals. Finally, a second spreadsheet must be used to keep track of maintenance issues reported by the testing and operations teams. The construction team must quickly respond to issues listed on the spreadsheet and update it with maintenance results immediately after resolution of the listed issue.

3.5.8 Technical Data / Information

The design team must provide the plans for the aircraft. This will serve as the foundation for the plane's manual, which must be written by the construction team. Furthermore, as mentioned previously, the construction team must also provide a manual detailing how to perform maintenance on the plane. The ultimate goal must be for the aforementioned documents to be sufficiently informative to teach new team members how to operate and fix the airplane.

3.5.9 Customer Services

Since the team is its own customer, there is no customer service in the usual sense on this project. Still, there are internal supplier-customer relationships, with the testing and operations teams effectively acting as customers to the construction team and the construction team, in turn, acting as a customer to the design team. Each team has to provide "customer service" to its customer team(s). However, in this case the customer service has to be proactive in addition to reactive, not only answering questions but also observing and commenting on the customer's usage of the product throughout its lifecycle. Everyone, after all, is on the same team, and no sub-team can allow the project to fail through their own inaction.

3.6 Producibility

All aircraft parts must be produced by the team members, or purchased commercial over-the counter available parts. The production must account for the limited manufacturing skills of the students. The aircraft design must be produceable using the tooling available from the departments within the University of Washington College of Engineering.

3.7 Disposability

The disposability of the plane's parts is largely dependent on the material used. The structural parts of the plane should be made from wood. Wood is not easily recycled, and the wooden parts are likely be too small and oddly-shaped to reuse. Hence, this part of the plane must be disposed of in a landfill. Still, wood is a renewable resource, so its usage is still preferable to alternatives such as carbon fiber or petroleum-based foam.

The plane's printed circuit boards can be recycled or reused for other projects, as can its metal parts and its battery. Any remaining parts must be made from plastic, and these parts can similarly be recycled at the end of their life. Hence, while the disposal method is not perfectly "green", this project still practices environmental responsibility by exclusively using renewable and recyclable materials.

3.8 Affordability

Construction materials must not account for more than 40% of the total budget. Travel expenses must not account for more than 30% of the budget. Operational expenses must cost no more than 20% of the total budget. Meals and other expenses must account for no more than 10% of the budget.

4 Test and Evaluation

The Test and Evaluation Matrix is listed in Tables 4.1 and 4.2.

Tab. 4.1: Test and Evaluation Matrix

Para No.	**Requirement Description**	**Compliance**	**Method of compliance**	**Reference Document**	**Comments**	**Results**
2.1.I	Take-off gross weight (payload included) $\leq 55\ lbs$		A, DT, AT	DBF rules		
2.1.II	Electronics may not draw $> 15\ A$ each		A, AT	DBF rules		
2.1.IV	Maximum take-off distance $\leq 40\ ft$		A, QT	DBF rules		
2.2.III	Minimum wing clearance is 3.5 in		D, AT	DBF rules		
2.4.II	Landing gear robust enough to survive repeated landings		QT	DBF rules		
2.4.I	Batteries provide at least 4 minutes of power		D, A, QT	DBF rules		
2.3.I	Complete the ferry flight mission		AT	DBF rules		
2.3.I	Complete the Medical Emergency mission		AT	DBF rules		
2.3.II	Complete the Taxi mission		AT	DBF rules		
2.3.I	Complete the Maximum load mission		AT			
2.4.IV	Radio fail-safe mode works as prescribed			DBF Rules		

Tab. 4.2: Test and Evaluation Matrix cont.

Para No.	**Requirement Description**	**Compliance**	**Method of compliance**	**Reference Document**	**Comments**	**Results**
2.4.III	Wing structures can support aircraft under 2.5 G load		D, A, QT	DBF rules		
2.4.III	Plane's CG (empty & loaded) falls within wing chords		AT	DBF rules		
2.1.III	Propulsion battery pack $\leq 1.5\ lbs$		A, AT	DBF rules		
2.1.V	Plane can carry load of in excess of 2 lbs		A, DT, AT	DBF rules		
2.5.1	Plane is reconfigurable within 4 minutes		DT			
2.6.1	Plane handels smoothly and responds to pilot controls well		AT			
2.1.V	Plane has internal volume to carry mission payloads		D, DT	DBF rules		
2.8.I	Planeand transport boxes do not contain hazardous materials		D			
2.5.II	Successful completion of a maiden flight		DT	maidne flight checklist		
2.5.II	Successful completion of a maiden flight		DT	maiden flight checklist		
2.5.II	Successful completion of a final test flight		DT	final test flight checklist		
2.5.I	Verification of prototype design		DT	Preliminary Design Report		

5 Quality Assurance Provisions

To ensure that the design and construction of the product meets both the standards of the 2013-2014 DBF rules and the objectives of the University, it is necessary to perform interviews from past contenders, trade studies, prototyping, and several tests must. The DBF team must consult with past team members and documents saved from past competitions. The team must refer to the Design Reports from previous winners in addition to those from the University of Washington to aid their pursuit of quality in the preliminary analysis stage.

The current team must also do trade studies before the first Preliminary Design Review. The PDR tests the quality of their aircraft by examining the teams estimates for thrust to weight ratio, likely size and lift to drag ratio. The quality should be measured by comparing to past reviews. The PDR must verify that the requirements are met and that the aircraft's quality of design is comparable to previous winners *(Req 5.I)*.

Prototyping, testing and error correction must be performed before the aircraft's maiden flight in order to meet quality objectives. The maiden flight, safety check, and final flight test must be enacted as checks on the quality of the product as well *(Req 5.II)*. The maiden flight tests the capabilities of the product as well as if it can accomplish all of the missions.

The safety check tests whether the product meets the relevant safety requirements. After necessary revisions are made to the plane, the final test flight tests how the plane's performance compares to the performance of winning planes from previous years. These tests indicate whether the objectives and requirements set forth by the 2013-2014 DBF rules as well as the team objectives and requirements have been met, all before the competition begins. In addition, random testing must be instated after integration of the constructed parts of the aircraft has been completed. This random testing verifies that the team is practicing and testing for high quality standards throughout the project.

The team must also participate in a full closing meeting after the competition where they must document a lessons learned for the project. This document and the Design Report for the competition may be used as references for future teams to ensure that the University of Washington keeps producing a quality product for the Design Build Fly competition.

6 Distribution and Customer Service

Since one aircraft is made for each university that competes in the competition, and competition rules are changed upon each new year, there is no anticipation of distribution of the final product. The aircraft must not be copied and replicated for future competitions.

However, the aircraft must be ready for a Public Display before the competition. As sponsors and supporters like to see how the aircraft may do in competition, as well as where their funding has been going, the current team must have a fully-functional aircraft to show the public before the competition. The team must give updates to all donors and the University itself. These updates must be done throughout the production period, during the competition, and during closeout. They must include how the aircraft placed at the competition. The aircraft must also be presented at any closeout meeting or party after the competition. This is for the purpose of thanking donors and supporters, as well as showcasing the current team to attract future participants.

7 Retirement and Material Recycling/ Disposal

Needless to say, there will be scraps left over from construction of the vehicle. Scrap metal, wood and excess electronic parts must be kept until the end of the project in case they are needed. If they are not needed by that time, any scraps that may prove useful for the following year's project must be put into storage for eventual reuse. Any remaining scraps must be offered to other groups for reuse. Any scraps that remain unclaimed one week after the project's end must be disposed of in the appropriate manner; metal, plastic and electronic parts appropriately must be recycled and wooden parts must be sent to a landfill.

After completion of the contest, the plane must be retired, as it will have no other immediate practical uses. The plane's battery must be recycled or put to reuse after retirement, as it is the part most-likely to damage the whole system if left unattended for years. However, the plane must not be immediately disposed of, as it will have value as a promotional tool for future projects. Furthermore, if it does well at the competition, it may have historical value to the school, thus guaranteeing it the resources necessary for long-term storage. However, if the plane is no longer needed, it must be disassembled to separate its recyclable and non-recyclable parts. Any parts likely to be useful to the upcoming year's DBF project must be saved for reuse. The remaining parts must be offered for reuse to other projects in the department the day after the plane's disassembly. Any parts that remain unclaimed one week later must be disposed of in the proper manner, as per the disposal of the scraps.

8 Lessons Learned

Acting on our lessons learned from the first paper, the team worked more efficiently in creating this second group effort. Improvements were made in both communication and meeting supplementary deadlines.

Our greatest improvement in group efficiency resulted from creating a more detailed work schedule with supplementary deadlines. At group meetings we would determine what work all members needed to deliver by the next meeting time. Backwards planning was used to ensure these deadlines would create a finished product by the final deadline of November 20^{th}.

Communication improvements were also made, facilitating a more productive group effort. All produced work was promptly sent out to all individuals on the team. As a team, this allowed additional group members to act on creating common parts such as reference tables. It also allowed members to use their available free time to edit and proofread more of the document. Additional proof reading helped us create a more polished document. However, as always, there is still room for improvement in our communication.

Throughout the project the team has had issues with email communication. One main issue was email conversation threads shifting topics. Shifts in topic between two group members would cause additional members of the group to filter out the whole email conversation. They would then miss out on key pieces of information, while other group members assumed all involved were still actively reading the conversation. To address this, new email threads will be created for each new topic. The second key issue with email communication revolved around replying to only one group member rather than using the 'reply all' function. To address this, all members will check each email they send goes to all of the other four group members. Additionally, when receiving an email, each individual will check that it went to all other group members as well. Hopefully, implementing these improvements will smooth out future communication and continue to improve the group's functionality.