GAMA/Build A Plane 2017 Aviation Design Challenge

UPDATE TO 2017 INSTRUCTIONS & DUE DATE

Issue: ***Design changes made to the Cessna 172SP.acf aircraft file originally specified for the competition are not showing properly in the PlaneMaker or X-Plane 10 simulator software.***

A couple teams reported issues they experienced with design changes being made to the Cessna 172SP.scf aircraft file not showing properly in the PlaneMaker. The X-Plane developers did some troubleshooting and identified an issue with the stock 172SP.acf aircraft that comes with the new X-Plane 10 - it has a special "OBJ" paint job which PlaneMaker cannot modify. Thus, when you change the wingspan (for example) in PlaneMaker the wing *is actually* getting bigger or smaller but this change is invisible to the user (not shown on your screen). NOTE that your aircraft file has been altered and the aircraft does fly differently due to the larger wing (or any other changes you've made) but the picture on your screen does not change so this is clearly very confusing to users and has impacted all teams in the competition. We greatly apologize for the inconvenience and are therefore UPDATING the design challenge instructions and due date.

4/13/17 UPDATE: ***2017 Aviation Design Challenge Instructions***

All teams must use the GAMA Cessna 172SP.acf aircraft file provided by GAMA - distributed via email on 4/13/17 and also available from https://gama.aero/opportunities-in-ga/aviation-challenge/

Instructions: Extract/unzip the "GAMA Cessna 172SP.zip" file and copy/place the entire folder into the [Aircraft] directory within the main X-Plane 10 folder installed with the software. When properly placed in this location, from PlaneMaker and X-Plane software you can click on Open Aircraft and from the top level [Aircraft] directory select the GAMA Cessna 172SP folder and the GAMA Cessna 172SP.acf aircraft.

4/13/17 UPDATE: ***2017 Aviation Design Challenge Competition Entry Due Date***

The competition due date is being extended by 2-weeks to ensure that each team has time to work with the updated aircraft file. Please note that any design changes or tests that you have completed thus far continue to be applicable by entering your design changes into PlaneMaker using the updated GAMA Cessna 172SP.acf aircraft.

To enter the Aviation Design Challenge, each team is required to submit a completed entry form (provided with the rules document distributed to each team) along with several electronic files and documents to **STEMcompetition@gama.aero** **no later than May 5, 2017**.

QUESTIONS & ANSWERS (FAQs)

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Section I. FAQs Submitted by 2017 Teams

4/13/2017

We don't see anything instructions with regard to crew. Are we supposed to factor a pilot into the payload? If so, how heavy is that pilot supposed to be?

No, it is not necessary to factor in a pilot weight. The simulator software assumes that the pilot is included in the payload and the competition will be based on the challenge score reported by the software which takes this into account.

Can we reshape the fuselage? Not just stretch it, but move the 3D points to give it a different shape?

Yes, teams can reshape the fuselage by modifying the original Cessna 172SP fuselage. The curriculum addressed changes to the moment arm of an aircraft by making the fuselage longer/shorter so additional modifications to the shape are acceptable.

Can we add a variable sweep wing - since some of the other aircraft files have variable sweep wings?

Yes, the X-Plane software will calculate the variable lift vectors and center of mass of the aircraft and calculate the aircraft flight characteristics accordingly. However, for aircraft that perform at speeds similar to a Cessna 172 there are very limited benefits of this type of design feature and several draw backs, including decreased controllability and critical stall behavior.

4/10/17

Is there a definite maximum payload like in the years past, or is it a case of the maximum gross weight of the original 172. (I.E. the aircraft must weigh under 2558 pounds of gross weight) or can we increase the maximum gross weight of the airplane in plane maker?

No, there is no prescribed or set maximum payload. For the 2017 Aviation Design Challenge, the rules state that the total weight of the aircraft for this competition cannot exceed the maximum allowable weight prescribed by the design which can be seen in the screenshot of the "Weight & Balance & Fuel" pop-up screen (reference competition instructions and rules – Figure 2).

The empty weight of the original Cessna 172SP airplane is inherent in the design of the .acf file you load into Plane Maker and X-Plane Software. As you make certain design changes the weight of the airplane will adjust accordingly. In addition, the rules require that you must manually increase/decrease the empty weight of the airplane by 2 pounds for every square foot increase/decrease in the wing area, and 2 pounds for every increase/decrease in engine horsepower. So the maximum payload is limited by the

maximum weight that the design of the airplane can support less empty weight and less fuel weight.

4/6/17

Are you willing to provide us with the details for how the final score is calculated? We saw that it was "pounds payload for a nautical mile per pound fuel and minute used." We're not sure how the data from the test flight indicated [i.e. payload, distance, fuel burn and time] would result in the score that was given.

Reference the FAQ above for 'How does the X-Plane flight simulator software calculate the aviation challenge score?'

4/5/17

My video… is too big to email. Any suggestions?

Reference the FAQ above for 'What do I do if my video or screenshot files are too big to email?'

Section II. Aviation Design Challenge Rules and Entries

Once we have completed the Fly to Learn Curriculum, what are the instructions and rules for the 2017 Aviation Design Challenge?

To foster an exciting and competitive environment, the instructions, rules and flyoff mission for the annual GAMA Aviation Design Challenge are modified slightly each year so that each entrant has equal opportunity to apply what they've learned in new challenge. The 2017 Aviation Design Challenge instructions and rules for Plane Design & Construction and Flying the Mission will be distributed to all teams at the same time when the challenge portion of the competition begins. Please reference the GAMA website for the specific schedule and contact STEMcompetition@gama.aero if there are any questions or comments.

UPDATE 4/13/17

How do we submit an entry to the Aviation Design Challenge?

To enter the Aviation Design Challenge, each team is required to submit a completed entry form (provided with the rules document distributed to each team) along with several electronic files and documents to **STEMcompetition@gama.aero** **no later than May 5, 2017**. This includes information such as:

- The .acf file of your custom designed virtual airplane.
- A summary of the design changes your team made to the airplane.
- A screenshot of the weight & balance & fuel page prior to the challenge flight.
- A checklist that describes the steps the team took to make a successful flight.
- A screenshot of the aviation challenge score following successful completion of the challenge flight.
- A video of the students explaining what they learned and how they applied that knowledge in the competition.

What do I do if my video or screenshot files are too big to email?

Any of the required files for entry into the competition can be provided via a download link such as Googledocs, Dropbox, OneDrive or other internet resource available from

your school or public sources such as Facebook or YouTube. Please note that all videos become the property of GAMA which may be used in future promotional materials.

How will the aviation design challenge entries be judged?

A panel of judges from GAMA will evaluate the following factors to determine the winner of the GAMA/Build A Plane 2017 Aviation Design Challenge:

- summary of the design changes your team made to the airplane (20 percent)
- checklist that describes the steps the team took to make the flight (5 percent)
- aviation challenge score from the flight simulator software (65 percent)
- videos submitted throughout the competition (10 percent)

How does the X-Plane flight simulator software calculate the aviation challenge score?

X-Plane flight simulator provided with this competition includes a 'Fly to Learn - Aviation Challenge' mode under the Special Menu. This mode is encoded within the software to calculate an aviation challenge score based on the specific mission and weighting power for distance, payload, fuel and time. GAMA does not know the detailed algorithms the software uses to calculate specific score values but all valid team entries/scores use the exact same criteria. The competition instructions and rules provided to each team at the beginning of the challenge will provide the specific airport departure/arrival locations and weighting power for each criteria.

Section III. General

What is the GAMA Aviation Design Challenge?

The General Aviation Manufacturers Association (GAMA) is sponsoring the GAMA/Build A Plane 2017 Aviation Design Challenge to promote Science, Technology, Engineering and Mathematics (STEM) education through aviation in high schools across the United States. Schools interested in the competition will receive complimentary "Fly to Learn" curricula, which comes with flight simulation software powered by X-Plane. Teachers will guide students through the science of flight and airplane design, completing the curricula in approximately six weeks in the classroom or in four weeks through an accelerated program. Each high school will apply what they have learned by modifying the design of an airplane. The schools will then compete in a virtual fly-off, which will be scored on aerodynamic and performance parameters while flying a specific mission profile. Judges from GAMA will select the winning school based on that score and other factors.

What is the Prize?

The prize will include an all-expenses-paid trip for up to four high school students, one teacher, and one chaperone to experience general aviation manufacturing firsthand.

Where can I find additional information about the Aviation Design Challenge?

General information about the GAMA Aviation Design Challenge is available from the websites of the leading sponsor organizations:

- General Aviation Manufacturers Association (GAMA): https://gama.aero/opportunities-in-ga/aviation-challenge/
- Build A Plane: http://www.buildaplane.com/gamabuildaplane-design-challenge/

- Fly to Learn: http://flytolearn.com/aviation-challenge/
- Glassair Aviation: http://glasairaviation.com/

Where can I find the flytolearn curriculum and related teacher resources?

The following are available from http://flytolearn.com/resources/:

- Curriculum titled "*STEM Education Inspired by Aviation – Science of Flight and Airplane Design*"
- PowerPoint presentation slides for curriculum lessons 1 through 9
- Fly to learn Webinar lessons I through VI recorded on video

Section IV. 2016 QUESTIONS & ANSWERS

Is there a limit to the horsepower we can have?

No. You may increase engine horsepower to any level that meets your design and flight performance objectives within the capability of the Plane Maker and X-Plane software. Fuel consumption will increase proportionally with horsepower and you must adjust the airplane empty weight by two pounds for every increase/decrease in engine horsepower.

Can we change the type of engine? For example, can we change the engine to a turboprop or a diesel engine and, if so, what is the weight change?

No. You may not change the type of engine as this was not addressed as part of the curriculum. The competition mission score is based on the payload delivered divided by the time and fuel consumed by the airplane to successfully complete the flight, so it is important for the Design Challenge that all of the airplanes use the same type of engine for which the fuel calculations are based.

Can we have retractable landing gear and, if so, what is the weight change?

Yes. The curriculum discusses the impact that retractable landing gear has on airplane drag so we will allow design changes to incorporate this feature AND you must increase the airplane empty weight by 300 pounds.

Are we allowed to change the propeller?

Yes, within the capability of the Plane Maker software.

Do we need to fly on full fuel/ full mixture at cruise?

No. You may operate the airplane in any way you choose within the capability of the X-Plane software to successfully complete the mission and receive a score. You must provide a checklist that describes the steps the team took to make a successful flight, from take-off to landing, such that the judges would be able to replicate your flight using the information provided.

Is realism important in this challenge or can we just go for efficiency?

The Aviation Design Challenge rules and judging criteria provides the information that is important in this challenge. Your score from the Aviation Challenge competition mission in X-Plane takes efficiency into consideration, which counts for 60 percent of the judging criteria. There is a degree of realism, but the scope of the project is set by the rules and the capability of the Plane Maker and X-Plane software.

Are JATO rockets allowed?

No. No change to type of propulsion is permitted, as this was not addressed in the curriculum and does not fall within the guidelines of the design competition.

Is there a specific altitude to fly at or can we stay in ground effect for the flight?

No. You may operate the airplane in any way you choose within the capability of the X-Plane software to successfully complete the mission and receive a score. You must provide a checklist that describes the steps the team took to make a successful flight, from take-off to landing, such that the judges would be able to replicate your flight using the information provided.

What path are we required to take? Can we go over the mountains or must we stay above the river?

You may operate the airplane in any way you choose within the capability of the X-Plane software to successfully complete the mission and receive a score. You must provide a checklist that describes the steps the team took to make a successful flight, from take-off to landing, such that the judges would be able to replicate your flight using the information provided.

How detailed of a checklist do the judges want for them to recreate the flight?

The judges are general aviation pilots and aerospace engineers with significant experience. The level of detail you may want to consider for your checklist should relate to the level of detail of any unique or critical aircraft/engine or flight route procedures necessary to successfully complete the mission.

Is a V tail allowed?

Yes, you may make design changes to primary flight surfaces.

Is there a limit as to how big we can make the control surfaces?

No. You may make any changes to the size of control surfaces. The empty weight of the airplane must be increased/decreased by 2 pounds for every square foot increase/decrease in the wing area.

Is there a minimum payload weight?

No, there is no minimum payload weight. (NOTE: A negative payload is not permitted - I have not tried this but thought I'd put that out there in case the software responds in some way)

How much can the payload be? How much is the total weight of the plane?

The maximum payload for this competition is 4,000 pounds. The total weight of the starting point GAMA Cessna 172SP airplane is within the provided file you load into Plane Maker and X-Plane Software. As you make design changes the weight of the airplane will adjust accordingly and you must manually increase/decrease the empty weight of the airplane by 2 pounds for every square foot increase/decrease in the wing area, and 2 pounds for every increase/decrease in engine horsepower.

The current model has a fixed pitch prop. Can we change this to a constant speed? Please advise.

Yes, within the capability of the Plane Maker software.

Can we modify the aircraft to use retractable landing gear vs. the fixed gear the model has?

Yes. The curriculum discusses the impact that retractable landing gear has on airplane drag so we will allow design changes to incorporate this feature AND you must increase the airplane empty weight by 300 pounds.

Are the three videos required?

The three videos count for 10 percent of your final score. If you have not submitted either of the first two videos, you should send them via Dropbox to STEMcompetition@gama.aero as soon as possible.

Does the maximum payload limit of 4,000 pounds include the empty weight of the airplane?

No, airplane maximum payload does not include the empty weight of the airplane.

Can the students change the tail moment arm and COG moment arm?

You may change the tail moment arm and the COG moment arm, as long as you ensure the fuselage can still carry the intended passengers and payload.

Are we allowed to use a drag chute to slow us down upon descent and, if so, how much weight do we need to add?

No, you may not do so, as this was not covered in the curriculum.