FEEG2001: Quadcopter Design Challenge FAQ

Contents

General Module Questions

Q. Do I need to attend the workshop or design studio every week?

A. Attendance is not compulsory, in fact some of you may experience clashes with labs for other modules and it is realised that early in the design process you may wish to meet in a dedicated computer room, the library or elsewhere. However, it is highly recommended that you use your timetabled time in these facilities. During these three hours you will have access to your project supervisor and PGRA assistants to ask for advice and clarification. It's much quicker to ask in person than to send an email and wait for a response. Later in the year these three hours represent your dedicated build time, no other groups will be allowed to use the facilities unless there is space.

Q. Can we source sponsorship for our build?

A. Yes. Please talk to your project supervisor before agreeing to anything with a company.

Q. We are having an issue with a group member's contribution what can we do?

A. Firstly remind the member of your group that this is a team exercise and that everyone is expected to do their fair share and peer review plays a part in determining every student's final mark. If there is persistently little effort please contact your academic supervisor ASAP (djjt@soton.ac.uk). There is nothing that can be done if problems within teams go unaddressed until the final week of the semester. It's also worth noting that in the past students have been awarded fewer marks than their group, or indeed failed altogether, for a lack of contribution.

Q. Should we be taking a formal log for FEEG2001 activities?

A. It is always good practice to keep some form of log of your design/research activities. While there is no facility on the FEEG2001 Blackboard page for you to create a log this does not mean that you should not be doing so. Notes taken during any meetings, tests and various design activities will help with the writing of your report and help you track your decision making processes. You may be required to produce a blog/log as part of the associated management module and students may be asked for evidence of their work throughout the semester if there is some dispute regarding their contribution. As a group it is recommended that you maintain a set of PowerPoint slides with 1-2 slides capturing each students contribution each week. Formal minutes and actions should always be taken during group meetings.

Q. When should we start working on the final report?

A. ASAP. The final report should not be left to the last minute and a working copy should be prepared and contributed to by **all** team members throughout the semester. Come the final week of term the only sections which should be incomplete are the reflection on the tests and the improvements to future designs. Do not leave the report to the last minute!

Q. Should our group have a project lead/manager?

A. Yes it is always wise to appoint a project lead to manage the contributions of each team member in a coherent manner. This person should ensure that tasks are delivered on time.

Q. What else should a project lean/manager do?

A. The project manager within each team is also expect to contribute technically to the project. Managing should not be their only role!

Design Questions

Q. What loads should we consider for our landing gear/struts?

A. Consider the worst case scenario for your aircraft. This may be being dropped from a height onto the ground or, if the autopilot incorrectly defines the throttle setting, the aircraft flying into the ground. It might be useful to consider which angle of crash might be the most severe.

Q. What is the performance of the propeller/motor?

A. Approximate performance figures for this propeller/motor combination are given in the table below.

Electrical Power (W)	Thrust (g)
119	475
319	960

Q. What torque will the motor impart?

A. This depends on the thrust required and therefore the weight of the aircraft. Thrust and torque can be related using the standard propeller efficiency equations for the literature and an assumption of the efficiency of the motor and propeller. A safety factor should be used to ensure that the assumed torque is not too low.

Q. How efficient is the motor?

A. This has not been tested but an assumed efficiency of 60% is reasonable.

Q. What size/model is the propeller?

A. The propeller is a Gemfan 6030 and has a diameter of 6”.

Q. Does the mass constraint include the mass of the camera

A. No.

Q. Does the mass constraint include the mass of the battery?

A. Yes.

Q. Does the mass constraint include the mass of the li-po battery bag?

A. Yes.

Q. Can the structure of the aircraft exceed the 235mm square specified for the motor centres?

A. Yes it can up to the 275mm square footprint outlined in the list of constraints.

Q. Are we expected to return the provided components?

A. **Yes! Yes! Yes!** All of the provided components, including sensors, receivers etc. should be returned at the end of the project or after any aircraft has been presented in the design show. These components should be returned in an “as new” condition. Please seek advice before soldering any components if unsure about this. Ideally, you should not solder to sensors but instead use cables with appropriate connectors. This also helps if a component fails and you need to replace it quickly!

Q. Are we permitted to modify the wires on the motors or speed controllers?

A. No. The lengths of all of these wires should not be adjusted and left as provided.

Q. Is the mass of the camera included in the mass constraint?

A. No. The mass of the camera does not need to be considered.

Q. Will we be given a camera?

A. No you do not need a camera to complete the project. The assessment is based on the movement of the gimbal which does not require a camera to be present. The dimensions of the mount for the camera, however, will be assessed.

Manufacturing Questions

Q. What materials are available for manufacture?

A. Plywood, balsa wood, mylar, Styrofoam, electrical wire, 3 pin connectors, solder, tape, wood glue, epoxy to name a few.

Q. What materials are definitely not available?

A. Carbon fibre tubing or sheets, glass fibre. Of course this does not stop you from purchasing specialised materials yourself, easycomposites.co.uk, for example, is a great source of composite materials which are reasonably priced a 1m, 10mm diameter tube, for example, will cost under £10. Additional fasteners may also need to be purchased depending on your design.

Q. Are there any rules around using carbon fibre?

A. Carbon fibre can only be cut in a limited number of locations in the university due to the carcinogenic qualities of the dust it produces. Before purchasing please discuss these limitations with your supervisor.

Q. Will we have to spend lots of money on components?

A. You can spend as little or as much as your team wishes on non-stock items. There are a number of websites which offer relatively cheap R/C model components like servo extension cables and you're free to use these. If you are buying components you may wish to share delivery costs with other groups or split packs of components with other groups. Teams in the past have even made a small profit selling leftover components to other teams. It is possible to design and build your aircraft without buying anything in, with a little foresight the provided materials can be manufactured into most components.

Q. Can we use the 3D printers to create components?

A. Yes. The university has a 3D print hub which you can exploit for this. Remember though that 3D printed components tend to be quite heavy if naively designed and this should be taken into account when designing the aircraft.

Q. Will the studio and workshop be open over the Easter vacation?

A. Both the design studio and workshops should be open but this will depend on staff availability. Please listen out for announcements regarding this closer to the time.

Q. I don't feel confident with a soldering iron will training be provided?

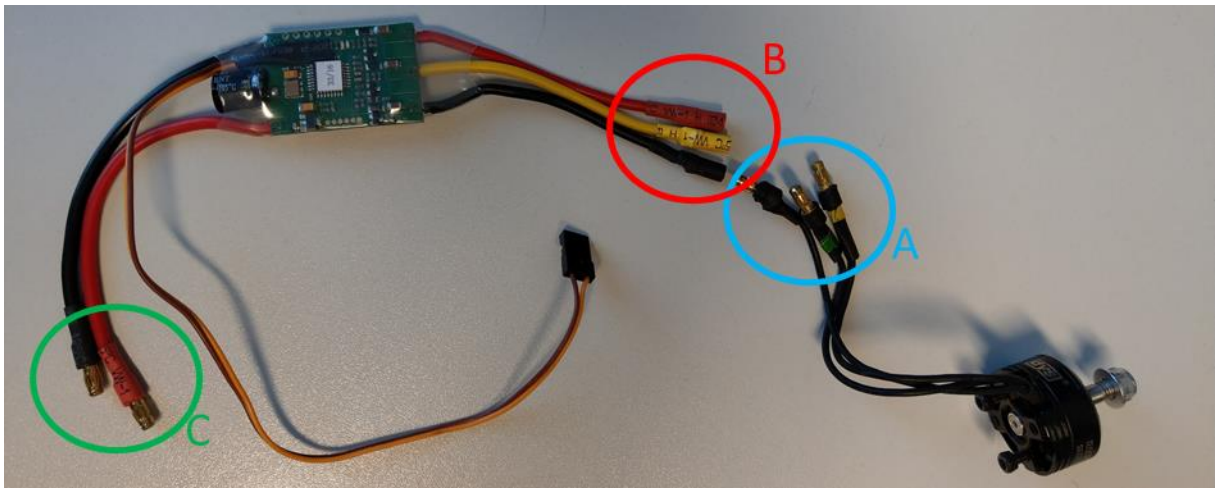
A. You should have had some formal training with a soldering iron but please ask the technicians, supervisor or PGRAs for advice.

Q. How do I get items manufactured from foam?

A. Please speak to your supervisor about foam parts and your requirements. If the components can be manufactured in foam a separate foam cutting guide is available.

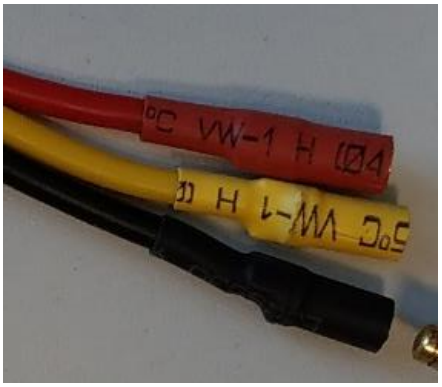
Q. How should the bullet connectors be soldered to the motors and ESCs?

A. The motors should have male bullet connectors soldered to them (circle A in the image below). The corresponding three leads on the ESC should have female connectors soldered (circle B). The two leads from the ESC should have male connectors (circle C). The power distribution board should therefore have female bullets attached.



Bullet connector layout for ESC and motor

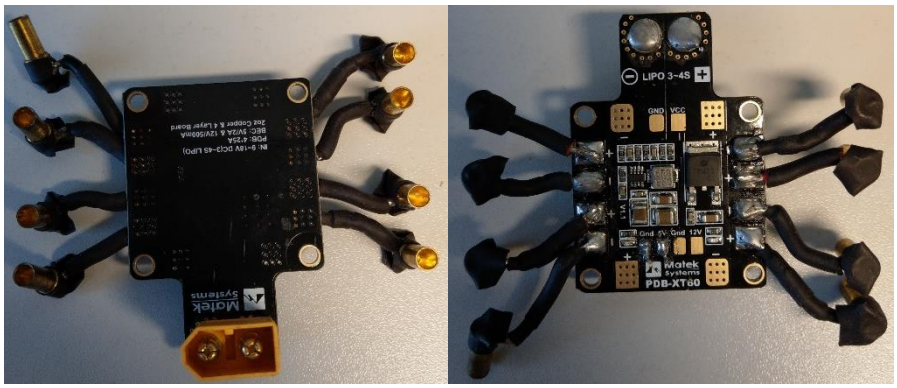
Male bullet connector



Female bullet connector

Q. How should the bullet connectors be attached to the power distribution board?

A. Do not solder the bullet connectors directly to the board. It is quite difficult to achieve a good bond and the bullet is prone to breaking off. Instead solder the bullet connector to a short length of wire and solder the other end of the wire to the board, as per the images below.



Example of bullet connectors soldered to a power distribution board

Q. Do we have access to bullet connectors?

A. Yes these should be available from the workshop.

Design Simulation Questions

Q. What information is available on the blue foam available for construction?

A. Roofmate Styrofoam is provided for wing construction. The foam is purchased from Sheffield insulation and information on the foam's properties can be found on the DOW chemical website.

Tensile strength ≈ 0.485MPa
Compressive strength ≈ 0.24MPa
Young's modulus ≈ 10.4MPa
Poisson's ratio ≈ 0.34
Density ≈ 36kg/m^3 or 0.036g/cm^3

Q. How do I find the mass of the provided components?

A. The approximate masses for the majority of the provided components are noted in the table below. The mass of new foam-based components can be calculated using Solidworks and the above density. If in doubt weigh the component.

Component	Mass (kg)
Battery	0.168
Arduino Uno	0.025
GPS shield	0.025
Gyroscope	0.001
Receiver	0.005
Naze32 flight controller	0.018
Afro 30 amp speed controller[1]	0.027
Turnigy MultiStar 30A speed controller	0.015
DYS SE2205-2300KV motor	0.030
Gemfan 6030 propeller	0.012
Matek power distribution board	0.011
Infrared 10-150cm analogue distance sensor	0.001
Beanbag	0.075
Li-po bag	0.040
Ultrasonic range finder	0.015

[1] Replaced in 2017/18 but may be used as a backup. If so the mass constraint will be adjusted.

Arduino Questions

Q. Arduino does not appear to be installed on the design studio desktop PC.

A. You should be able to manually install Arduino using the “additional software” icon on the desktop.

Q. How should components be attached to the aircraft?

A. It is recommended that all components such as the battery, receiver and Arduino be attached securely to the aircraft but in such a way that they can be easily removed or replaced. The battery in particular may need to be replaced a number of times during flight testing.

Q. Can we use a different Arduino system?

A. No, only the provided Arduino UNO or equivalent may be used for this project. There is nothing to prevent you using additional breakout boards, sensors or multiple UNOs though. However, remember that you should be able to justify your design choices, including the electronic systems architecture within your final report.

Q. Can we use an alternative computing system?

A. No the use of a Raspberry Pi etc. will not be permitted.

Q. How can we trace the error in my code?

A. Debugging code is an important skill to learn. Use frequent print statements to write to the serial monitor before or after functions. This will give an indication as to how far your code will run before encountering an error. Similarly add print statements to write out sensor data if you’re not sure if something is behaving correctly. All debug statements can then be commented out or deleted in your final code.

Q. Only part of my debug statement appears to be written to the serial monitor what’s causing this?

A. The serial monitor does not print out as soon as the function is called. In some cases it might be part way through the write when an error further in the code causes a crash. Try using the flush() (LINK) statement after the code to write the line to the serial monitor. This will clear the write buffer before moving on to the next operation.

Q. I can’t seem to write to the SD card

A. There are a number of things which may be causing this:

1. Check the length of the SD card file name. It may seem obvious but if you’ve changed the name and forgot to change the size of the character array containing that name you won’t be able to create the file.
2. There are alternative ways of implementing an SD write. Some templates open the SD card at the start of the script and close it at the end. In a similar manner to the serial monitor the write buffer is only flushed once you close the file. Writing out a lot of data can therefore lead to memory issues and debugging the write process may also continually produce an empty file. An alternative is to open the file once in the preamble, keep it open and periodically flush

(LINK) the write buffer within your script. This will stop the buffer using too much memory and aid with debugging.

Q. What does "standard 3 pin connectors should be used when connecting all electronics" mean?

A. In semester one as part of your Arduino system you were provided with a servo. This servo has a 3 pin connector attached to the end of the lead. All of the provided servo systems use this type of connector and the receiver also accepts this connector. To improve the speed of assembly these connectors should be used wherever possible. Servo wires etc. should not be soldered directly to the Arduino board. Instead a 3 pin connector should be attached to the end of the servo wires and a female connector attached to the Arduino board.

Q. I can't seem to get all of my sensors working what am I doing wrong?

A. This is part of the design challenge. The Uno board you've been provided may not have enough memory to be able to run all of the sensors you wish. The down selection of an appropriate sensor set is therefore an important task which needs to be carried out early in the project.

Q. I'm struggling with implementing a GPS and a sensor what can I do?

A. Firstly, read the above question. The GPS is particularly memory heavy one solution to this is to use the TinyGPS libraries rather than the standard ones. However, no comparison has been done between the accuracies of the two libraries.

Q. Do I need to use a separate 9V battery to power the Arduino?

A. No, the provided power distribution board has a dedicated 5v or 12v power supply which can be used to power the Arduino from. Remember not to solder these directly together in case either components fails and needs to be replaced. Use either a set of pin connectors or your own shield. While the power distribution board is regulated please use the regulated voltage input on the Ardunio board to further protect against power spikes. Always check that he Arduino board can handle the voltage input you intend to use.

Q. How do I interface the Arduino board with a signal from the receiver?

A. The third pin on the receiver is for a signal e.g. to a servo. This signal is in the form of a pulse, the length of which is used to determine what the component should do. A pulse of 1800µs might, for example, indicate the servos should be at 180˚ and a pulse of 1200µs might indicate an angle of 90˚. To interface with the receiver this pin should be connected to an input pin on your Arduino board and the pulsein() function (LINK) can be used to return the length of pulse. Interrupts can also be used to improve performance if implementing a switch.

Q. I have the receiver pin connected to the Arduino board but when I print out the pulse to the serial monitor it seems to change randomly. What's causing this?

A. Typically this occurs because the Arduino board and the receiver are not connected to the same ground.

Q. What are the range of pulse settings?

A. Typically 1100 to 1800 but you should check using Cleanflight or your Arduino board.

Q. What do "AUX1" and "gear" do on the receiver?

A. These switches should be used to switch from manual to autopilot mode and arm/disarm the aircraft (see the flight controller guide).

Q. The Arduino gyro doesn't seem to work when I run the test script bundled with the gyro's library.

A. By default the test library does not use the I2C interface. To enable this uncomment line 22 from the code, the test script should now run correctly.

Q. I'm getting an error stating that the "method is not recognised", what does this mean?

A. Generally this means that the initialisation of a class has failed because it doesn't recognise the name of it. Either the .h file for this class has not been included at the start of your script or the class/function has been called incorrectly. The easiest way to check this is by looking at how a class is called in an example script. Open an example script and double check that the include statement is correct and the functions have the correct name.

Q. What should we consider when using infrared distance sensors?

A. The accuracy of these distance sensors is quite important to the successful operation of your aircraft. Some effort should therefore be spent calibrating these sensors and the readings from them to ensure that the accurately reflect the true distance. Some important performance factors to be aware of include:

- The sensor will perform differently depending on the reflectivity of the surface
- The sensor will perform differently depending on the ambient lighting
- The sensor may give an intermittent null voltage reading in some cases which can lead to a considerable under/overestimation of the distance resulting in wild manoeuvres to compensate. This should be considered when using the readings
- Depending on the ambient light, surface reflectivity and supplied voltage the voltage returned by the sensor may be noisy. A filtering algorithm should therefore be employed
- Multiple sensors can be used to compensate for each other for a single distance measure

Q Can I use a different distance sensor?

A. You have been provided with an ultrasonic distance sensor. You can, however, use another sensor if you wish but you will have to buy this yourself. Infrared sensors can be used but laser range finders tend to be rather expensive.

Q. Which sensors should we use?

A. It is up to you to decide which sensor(s) should be used and in which combination.

Q. Can I solder things to the flight controller and power distribution board?

A. Yes and no. You are free to solder headers and sockets but not wires. This improves the modularity of the system in case of a component failure and simplifies the process for returning the components at the end of the semester.

Arduino Tips

1. If you have multiple sensors attached to your board calling more than one sensor with the same event can cause issues. Try to use separate events for different sensors.
2. Save incremental versions of your code. This is extremely useful when things start to go wrong as it's very easy to open up a version of the code that worked and track down the changes you've made to find the error. There is software for doing this automatically but's not really necessary that you use it, just adding a suffix "_1" or "_b" to the file name is sufficient.
3. If you wish to manage your code professionally you are free to use a SVN or Git repository.

NAZE32 Tips

Q. **Why won't my flight controller disarm?**

A. There are a number of reasons for this:

- Check that the "stick low" threshold is appropriately defined in the receiver tab in Cleanflight. If this is not low enough the flight controller will not recognise the inputs from the receiver.
- On the "configuration" tab in clean flight ensure that the minimum throttle and minimum command values are appropriate. The flight controller will lock out the system if it is turned on and it thinks there is a throttle input.
- On the receiver tab check that the PWM values for roll, pitch, yaw and throttle change as the sticks on the transmitter are moved. If any of these four signals is missing the flight controller will lock and cannot be disarmed.
- On the "modes" tab check that the arm mode has been correctly set up and the PWM value will change when the switch is flicked on the transmitter.
- Ensure that the transmitter arm switch is in the disarmed position when powering up the flight computer. If it is in the armed position the controller will lock out the pilot and refuse to disarm until it is powered down and the flight controller switch set correctly.

Q. My aircraft appears to have little/no yaw control and spin around when powered up.

A. Check the firmware version. Version 2.1.0 has a yaw control issue, switch to 2.0.0 or 2.2.0.

Conceptual Report Questions

Q. Does the guideline report length include appendices and bibliography?

A. No the guideline length does not include appendices, bibliography, tables of contents & figures as well as title or cover pages.

Q. Should the conceptual design techniques taught in semester 1 be used?

A. Yes.

Q. What is meant by customer requirements capturing?

A. You have been provided with a general design spec, part of the assessment is for you to define an appropriate set of customer requirements based on what the aircraft should do. With these defined then you are able to apply the trade-off techniques taught during semester 1.

Q. Does 5 pages mean 5 sides?

A. Yes the final report should be 5 sides of paper not 10.

Flight Testing Questions

Q. Who will fly the aircraft?

A. Students are not permitted to fly their own aircraft. All flights will be carried out by the supervisor or another suitable member of staff.

Q. How will flight performance be assessed?

A. Performance of your aircraft will be assessed in a variety of different ways. Please see the design brief and the flight testing document for further details.

Q. Will there be opportunities to test fly the aircraft before the final tests?

A. Yes. There will be a number of opportunities throughout the year to test fly your aircraft. If you wish to fly your aircraft please contact your academic supervisor.

General Report & Presentation Tips

1. Try to use software for your presentations which does not require an internet connection and keep a backup on a USB stick i.e. PowerPoint. Believe it or not there are rooms in the University without an internet connection. In the past we've experience particular difficulty with Prezi which delays the group presentations considerably.
2. Tables and graphs with lots of information and a small font are very difficult to read on a screen. Tell the audience the pertinent information during a presentation.