The University Of Sheffield.

Aerospace Engineering.

AER301/6001

Aerospace Group Design Handbook

2019-2020
Autumn Semester

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Disclaimer
Please note that this handbook is subject to change and therefore it is recommended to check periodically that you are using the most current version on Blackboard. Students will receive an email notification if changes are made to the handbook.

1. Introduction

As part of your Aerospace degree it is important that you develop your technical knowledge and understanding, technical and personal skills and an appreciation of the wider context of your studies. Both the group design and final year projects are important in building on your taught modules and developing a greater level of independence in your learning and work.

The aim of the group design project is to give you the opportunity to apply and further develop your knowledge and skills to solve a challenging engineering problem. A key part of this is working in a team and therefore developing your team working skills. The module leader will provide overall guidance on the project. However, as MEng students you are expected to demonstrate a high level of initiative and independence and skills in creative and critical thinking, analyses, reflection, effective project management and communication.

The project is very different from many of your taught modules where the lecturer takes the lead in your learning. **In the project you are expected, as a group, to take the lead and the module leader is expected to provide overall guidance, support and help.** You are also likely to work in technical areas and use skills that you have limited knowledge or have not covered in vast detail previously. Again, this is part of the project and is a key part of where you can demonstrate your initiative in developing such technical knowledge and skills as appropriate.

This handbook provides a summary of the project including the aims, timetable and assessment, description of the deliverables and guidance on report writing and presentations. Copies of the actual assessment forms that will be used are also provided. You should read through this handbook and refer to it during your project.

This module is a prerequisite for AER302/6002 which is where you will take your design and manufacture and test it.

If you have any queries with respect to the project, discuss these with us.

AER301/6001 (Autumn Semester):	Dr. Charles Lord c.lord@sheffield.ac.uk Mappin Building, RD07
AER302/6002 (Spring Semester):	Dr. Simon Hayes s.a.hayes@sheffield.ac.uk The Diamond

2. Project Aims and Design Constraints

The aim of this project is to develop an unmanned aerial vehicle (UAV). The UAV should support aerial photography/video and can travel to geographical coordinates via global positioning system (GPS). The definition of a UAV has no official consensus but is, as the name states, an aircraft that is controlled via radio control. UAVs fit into various classifications and in the UK, for this project, you will be designing, manufacturing and testing a Small Unmanned Surveillance Aircraft (SUSA) as defined by the Civil Aviation Authority (CAA).

Specific requirements and constraints for the UAV that must be met are:

- No rotating wing (e.g. quadcopters) or pressurised designs (e.g. helium filled) will be allowed. Other than the limits of the design, there is no further restriction on the type of UAV (fixed wing, et cetera). You should consider the design, manufacturing, schedule and budget required during your selection process.
- The UAV must meet all appropriate legislation for operation in the UK. As the experts, it is your responsibility to find out what the legal rules are and ensure the design meets these. Some of these requirements are, but not limited to:
    - https://publicapps.caa.co.uk/docs/33/InformationNotice%202014190.pdf
    - http://www.quadcopters.co.uk/caa-pfaw-guide-30-w.asp
    - https://www.caa.co.uk/Consumers/Model-aircraft-and-drones/Flying-drones/
    - https://www.youtube.com/watch?v=A6uU1LTdI8M
    - https://www.caa.co.uk/unmannedaircraft/
- The UAV could be operated in a non-ideal environment subject to low levels of wind and rain. The UAV must therefore be robust enough to be tolerable to such operating conditions and to potential crashes.
- The UAV should be capable of being operated by someone with minimal training so it must be as stable and easy to fly as possible. The UAV does not need to be fully autonomous but the higher the degree of autonomy the better.
- The UAV should be easy to maintain and modular so that components can be replaced easily if broken or as upgrades become available.
- The UAV must be capable of being fully set up in less than 10 minutes in remote locations where minimal tools will be available (simple hand tools that must be carried by the users).
- No single assembled dimension (length or width) shall exceed 1.0 metre. The complete UAV system must be portable in the hold of a coach-type bus.
- The total weight of the UAV should be no greater than </=1.5kg.
- The UAV must use only electric propulsion and be capable of a minimum endurance of 10 minutes without recharging batteries which will consist of takeoff, steady flight and landing.
- The UAV must have an emergency stop that is operational from the controller. This will need to be demonstrated before flying.
- The UAV must take photographs of the ground. The photos need to either be stored on the UAV or downloaded directly to the ground station.
- The UAV must, as a minimum, report continually to a ground base station its current location (superimposed on a map), estimated battery level and live video feed. The ground base station

must be designed to work on a standard laptop or tablet. You are required to check that hardware and software are available and installed on the flight day.

- The UAV must be equipped with an undercarriage (either fixed or removable) and must be able to takeoff and land from a close cut grass runway (model aircraft grade). It is recommended to use at least 75mm diameter tyres on the undercarriage.
- Each UAV must have both a manual shutdown that can be operated by the controller and also an automatic shutdown if signal is lost between the controller and the receiver. You will need to demonstrate these on the day; without them your UAV will not be allowed to fly.
- Autopilot must be used to autonomously identify 4 different GPS coordinate points (pt).
    - Takeoff (manual control) where determined by the pilot
    - Coordinate pt1: TBD
    - Coordinate pt2: TBD
    - Coordinate pt3: TBD
    - Coordinate pt4: TBD
    - Landing (manual control) where determined by the pilot

  ***It is important that you input these coordinates into the autopilot system correctly to the precision stated (or if using degrees, minutes and seconds, up to 0.001 seconds (0.001")) to be within the CAA requirements. The above coordinates can easily be converted into degrees, minutes and seconds using:**

  https://www.rapidtables.com/convert/number/degrees-to-degrees-minutes-seconds.html
- Each group will use a provided experienced model aircraft operator to pilot the UAV. This provides the highest chance of success and consistency.
- Each group will be provided with either a Futaba 7C or 6K radio controller and the appropriate receiver. These will be distributed in Week 4 of Semester 1. If these are required prior to this date, let me know. A randomised distribution of controllers will be provided on Blackboard in Week 4. Owner's manuals for both controllers are provided on Blackboard.
- Each group will have a maximum budget of £850 to spend. Throughout the project each group is required to keep a budgetary record. Groups are NOT allowed to add to the budget by seeking outside sponsorship. No further money will be provided by the university.
- Each group must provide a risk assessment **before** performing any testing at either the component level or of the entire UAV configuration.

2.1. Technical Areas

When researching and designing your UAV, you will need to consider a number of technical areas. Each of these must be researched, alternative options considered and discussed and conclusions drawn. **It is important that you conduct the necessary calculations, simulations and/or experimental work to justify the conclusions and to demonstrate your knowledge in each of these areas. You need to prove your design through engineering (not guessing)!** Your ability to critically evaluate different solutions is a key skill that you will need to demonstrate. You need to consider the various aspects of the design. These include, but are not limited to:

a. Aerodynamics

   you should consider computational fluid dynamics, wind tunnel testing, what designs are aerodynamically most efficient, consider lift-to-drag ratios, wing planforms, et cetera.

b. Propulsion and electrical power

you should consider different types of electric motors, power-to-weight ratios, what propeller is optimal, endurance, what type of batteries are best, battery discharge testing, other power sources (e.g. solar power, fuel cells).

c. Materials and structure

you should consider what materials will be used for the UAV. Consider weight, stiffness, strength, toughness, machinability, availability, cost, et cetera. You should perform analytical and/or numerical analysis to prove your design. Why have you chosen a particular option, prove why mathematically. You should perform material and/or testing. You will need to identify using CAD what will the UAV look like, what structure will it be built from, is it a module design (can you exchange certain parts easily), how will it be manufactured, need CAD drawings for manufactured parts, how will the parts be manufactured.

d. Electronics, control and communication

- *Ground station and communication*
  you should consider how you will interact with the UAV, what information needs to be displayed to the operator (map, location, direction, et cetera), how will information be displayed to operator, what will the graphical display look like, how user friendly is it, how will the UAV be controlled by the operator, what interface will be used (radio control is most obvious but many other possibilities).

- *Control - autopilot/autostabilisation*
  you should consider what level of autonomy is realistic and desired, full autonomy or just stability enhancement to make it easy to fly, what autopilot to use; there are a number of open source and cheap versions available, software. Choices are the Ardupilot, Arduino, or Raspberry Pi. Note that the Pixhawk cannot be used. Options are

- *Sensors, actuators and communications*
  you should consider what actuators are needed to control the UAV, are there novel actuators or ways of controlling the aircraft (standard way is control surfaces with servos but other methods exist (e.g. morphing structures and components)), what sensors are needed for autonomy and stability augmentation, sensors for UAV location, transmission and reception of commands and data (links to ground station), what wireless method to use, frequency of transmission, need to avoid frequency interference, test interference and range of wireless devices.

Each of these Technical Areas are required sections in Assignments 1 and 2.

3. Groups

Groups are comprised of 5 to 6 people and include a range of the diverse aerospace engineering streams. This project is multifaceted and will require knowledge and support from each group member. It is the group's responsibility to allocate the various group members to specific roles. Where there is a dispute, the group members will need to come to an amicable decision and agreement. Remember when you go to industry you will not always get the role in a project that you most want.

3.1. Purchasing

The budget that you will be given can be spent as deemed necessary for a successful UAV (unfortunately, no pub visits). Purchases should be considered from the University approved suppliers list. Suppliers are:

- General electronic components
  - Onecall (Farnell Ltd) (https://uk.farnell.com/)

- RS Components (www.uk.rs-online.com/web)
- Active Robots (https://www.active-robots.com)
- Proto-Pic (www.proto-pic.co.uk)

- Materials: carbon fibre, balsa wood, foam
  - Easy Composites (https://www.easycomposites.co.uk)
  - The Balsa Cabin (https://www.balsacabin.co.uk)

- Autopilot, stabilization, and general radio control
  - Build Your Own Drone (www.buildyourowndrone.co.uk)
  - Cool Components (www.coolcomponents.co.uk)
  - Unmanned Tech (www.unmannedtechshop.co.uk)
  - Wireless Madness (www.wirelessmadness.com)
  - Steve Webb Models (www.stevewebb.co.uk)

Please note that often you will find products at a lesser price elsewhere. These cannot however be purchased as they will not be on the approved vendor list.

Students **will not be allowed** to make purchases using their own funds.

Before any purchases are completed, the group should be made aware and agree on the purchases. It is recommended that when groups meet, they discuss the budget and the purchases required for the project.

Each group will be required to nominate a member as the purchaser. The ordering process is:

Step 1: Each group is required to place their order(s) through the Google order form: https://goo.gl/forms/uPaWHflMcSyDvJZ62

Step 2: The form is then sent to the Module Leader for approval.

Step 3: Any issues with this then the Module Leader will contact the group to discuss.

Step 4: Once approved the order is raised by the Finance Team.

Step 5: Orders are raised once per day. It is checked again to make sure your group is within budget, if not your order will not be approved.

Step 6: The order is then sent to the Supplier.

Step 7: Any problems with the order, the Finance Team will inform the person who completed the form via email.

Step 8: If there are no problems with the order, the Diamond Stores team will contact the person completing the form, once the order has arrived, for pick up.

Step 9: If the contact is not the person collecting the order, you must inform the Diamond Stores.

For any issues related to purchasing, you should email: **aero-group-design-project@sheffield.ac.uk**

It is up to each group to keep detailed records of your purchases and remaining budget in case of any disagreement in balances. This will be part of the overall module grade.

3.2. Storage

Each group will be given a dedicated storage space for their UAV in a provided storage container that will reside in the Diamond. This space is limited and is restricted to only AER301/6001 UAVs. If additional storage is required, it is the groups responsibility to identify this location. It is each group's responsibility and risk for storing things here.

Anyone found tampering with another groups UAV will be penalised as outlined in the University regulations.

4. Module Overview

4.1. Project Syllabus

The project syllabus includes all activities, required lectures and meeting times allocated AER301/6001. It is expected, and pertinent, that groups will meet outside of these times to complete their project and assignments.

Week	Due Date	Topic		Time	Location
1	4-Oct	Lecture	Introduction to Module	9:00A.M.	38 Mappin, Workroom 2
2	11-Oct	Lecture	Introduction to Finite Element Modelling	9:00A.M.	38 Mappin, Workroom 2
		Group Meeting	Discuss initial design concepts		
		Computer Lab	ANSYS tutorial & exercise		North Campus PC room
3	18-Oct	Lecture	Introduction to Systems Engineering	9:00A.M.	38 Mappin, Workroom 2
		Group Meeting	Discuss final design concept to proceed		
			Milestone 1 Due		
		Computer Lab	ANSYS Q&A	1:00P.M.	North Campus PC room
4	25-Oct	Lecture	Introduction to Flight Control	9:00A.M.	38 Mappin, Workroom 2
		Group Meeting	Allocate work, produce schedule and budget		
		Computer Lab	ANSYS Q&A	1:00P.M.	North Campus PC room
5	1-Nov	-	Peer Assessment 1, due by 4:00P.M. via Blackboard upload	-	-
		Group Meeting	Discuss progress toward project and milestones	10:00A.M.	38 Mappin, Workroom 2
			Milestone 2 Due		
		Computer Lab	ANSYS Q&A	1:00P.M.	North Campus PC room
6	8-Nov	Group Meeting	Discsuss progress toward project and milestones	10:00A.M.	38 Mappin, Workroom 2
			Milestone 3 (TBC)		
		Computer Lab	ANSYS Q&A	1:00P.M.	North Campus PC room
7	15-Nov	Group Meeting	Discuss progress toward project and milestones	10:00A.M.	38 Mappin, Workroom 2
			Milestone 4 Due		
8	22-Nov	Group Meeting	Discsuss progress toward project and milestones	10:00A.M.	38 Mappin, Workroom 2
9	29-Nov	Group Meeting	Discuss progress toward project and milestones	10:00A.M.	38 Mappin, Workroom 2
10	6-Dec	Group Meeting	Discsuss progress toward project and upcoming assignments	10:00A.M.	38 Mappin, Workroom 2
			Milestone 5 Due		
		-	Submit Assignment 2: Design Presentation, due by 12:00P.M. (noon). **Upload on Blackboard and also email to aerosupport@sheffield.ac.uk**	-	-
11	12-Dec	-	Submit Assignment 1: Design Report, due by 4:00P.M.	-	-
	13-Dec	Group Presentation	Assignment 2: Design Poster Presentations (from 9:00A.M. until 1:30P.M.	9:00A.M.	38 Mappin, Workroom 2
12	20-Dec	-	Peer Assessment 2, due by 4:00P.M.	-	-
		Group Meeting	Discuss proposed changes from Assignment 2 IAB feedback	10:00A.M.	38 Mappin, Workroom 2

4.2. Project Deliverables

4.2.1. Milestones

Throughout the semester, there are a number of milestones that each group is required to complete by the deadlines given in the syllabus. These milestones will be presented during the timetabled "Group Meeting" times listed in syllabus. Each group will need to provide evidence of the milestone when requested. The milestones are:

- Milestone 1: Concept configuration

  The concept configuration should demonstrate a direction of the format for the UAV that your group will proceed to design.

- Milestone 2: CAD model

  You will need to produce a 3-D CAD model of your conceptual configuration. The closer you can get this to the final design, the better. You should use the CAD model iteratively to use in the CFD and FEA analyses and then update to meet your requirements. The CAD model can also be helpful to demonstrate the rotation required for servos that drive the control surfaces, to identify the centre of gravity, to check for interference of components and how well they fit.

- Milestone 3: Flight simulators

  Each group will have the opportunity to incorporate their concept configuration into the flight simulators. The flight simulators will help you gain important information on how your UAV might perform and will also help direct you with the sizing of your control surfaces and the location for the centre of gravity.

- Milestone 4: Initial analysis

  Each group will need to provide an initial set of analyses your UAV. You will be required to have performed FEA for the wing and fuselage and CFD for the wing and fuselage, provide control surfaces configuration layout, telemetry configuration and layout for the avionics. This is not expected to be the final set of analyses. It is expected that your report will contain a much larger amount of analyses and detail.

- Milestone 5: Bill of materials

  Each group is required to provide a detailed bill of materials (BOM) for their UAV. This should include the materials required to manufacture your UAV and all of the components and electronics. You should have a detailed cost breakdown, unit pricing, total price, supplier, estimated delivery time. This is important to keep track of and determine if something is late or lost. This should help determine your schedule for AER302/6002.

The marking of these will count toward your professionalism. You should have these ready for the due date and not be working on it during the session. These will also help to provide feedback to your group.

4.2.2. Assignments

All assignments are to be submitted from one nominated trustworthy person within the group using TurnItIn. When submitting to TurnItIn, the person submitting the assignment should choose their name as the submission author. This will then be linked to your group. In the 'Submission title', use the format "Assignment X". **All assignments are to be submitted in .pdf format**.

It is imperative that all group members' names and registration numbers appear on the title page for each assignment. All due dates and times for submitted assignments and peer assessments are of

the week listed by 4:00P.M. All assignments due times are UK time based on Blackboard time. Allow yourself enough time for network or uploading issues. Save a receipt of your upload time for your records.

A summary of the due dates and times along with the total mark breakdown is provided in the following table.

Due Date	Assignment	Task	Marking	
			Individual	Group
refer to project semester syllabus	-	Peer Assessment 1	-	-
	1	Design Report	70.0%	10.0%
	2	Design Presentation	-	15.0%
	-	Peer Assessment 2	-	-
	-	Milestones and Professionalism	-	5%

4.2.2.1. Assignment 1

Description: Assignment 1 is the Design Report in which all members are to contribute. The design report should contain, as a minimum, information outlining the selection process of your UAV design, a budgetary outline including any expenditures and planned expenditures, a schedule for the semester, and the supporting analyses for your design for each of the Technical Areas (as outlined in Section 2.1). Each Technical Area will need to be a separate section in the report.

Requirements: The report should be no longer than 80 pages (excluding the title and declaration pages, table of contents and references). **No appendices are allowed**. Text font is to be 12 point Times New Roman. Margins should be no less than 20mm. All sections should be left and right justified. Figures should be numbered as "Figure 1", "Figure 2", et cetera. Tables should be numbered "Table 1", "Table 2", et cetera. Each figure and table should have an appropriate and descriptive caption. Equations should be provided inline with the text, they should be numbered with right justification for the equation number and the equation centred. Equations should be written using the Microsoft Equation (Insert → Object → Microsoft Equation), MathType or Latex. All variables within an equation and any reference to the variables need to be italicised. All citations need to be made within the text with "[X]" and referencing should be in Harvard style in a 'References' section immediately following the 'Conclusions'. Immediately after the title page of the report a completed copy of the Declaration Page (on Blackboard) will need to be included.

Marking/ Assessment Criteria: The total mark for this assignment comprises both of individual and group work. Marking will be from the summation of the products of the contribution of a group member for each of the Technical Area(s) and the total mark for those area(s) for the individual mark. There will be no penalty for a member with a zero contribution to a Technical Area but there will be no benefit either. Each Technical Area will be marked in four categories:

- Demonstration of understanding of underlying science and engineering (use of analyses)
- Presence of necessary/required information and rigor
- Appropriateness, informativeness and reasoning of decisions
- Accuracy of analyses and approach

The group mark will be derived from how well the overall report links together between the Technical Areas, including the introduction and conclusions, the selection process rationale, the budget outline and schedule.

Feedback: Each group will be given feedback for each of the Technical Areas sections and for the report as a whole. This will be in the form of written feedback as a score which can then be compared to the Assignment 1 rubric located in Blackboard. Further feedback will be given to each member of each group on in a one-to-one discussion. Feedback will be given by Friday of Exam Week 2.

The feedback should be used to tell you how you did in within each Technical Area and give you an idea whether it needs to be improved or not. For example, if you received a low score for "Presence of necessary/required information" for a Technical Area, then that area needs to have more detail to show that it is convincing for the UAV design (justification and rationale).

4.2.2.2. Assignment 2

Description: Assignment 2 is a poster presentation which will be presented to a mixture of other groups, academic staff, and aerospace industrial members from the Aerospace Industrial Advisory Board. The poster size will be A0. Each group will need to provide your completed poster to the electronically to aerosupport@sheffield.ac.uk with the subject as “Group X Poster Presentation”. This also needs to be uploaded onto Blackboard. Only one person from each group needs to send this. All printing will be handled by the Interdisciplinary Programmes Engineering office as long as the poster has been submitted on time per the Project Syllabus. Any group submitting late, may be required to print their own poster. Your poster presentations will be available for collection in 38 Mappin, Workroom 2 on the Group Presentation day (December 13) at 8:30A.M.

The presentation should encompass information from your Assignment 1. The poster should explain your design. Remember, your decisions should be backed with reasoning and engineering. During the presentation, it is expected that everyone will be dressed appropriately (at a minimum business casual). On the presentation day, you should have your presentation and group ready for a start time of 9:00A.M. Late arrivals will not be tolerated and you could receive a reduced or zero mark unless arrangements have been discussed and agreed previously well in advance. All groups must be present from 9:00A.M. until the end of the session. Any group that arrives late or leaves early will lose marks for professionalism. Following the presentations, all groups are invited to a luncheon with academic and industrial visitors. This is a good opportunity to network and mingle.

Marking/ Assessment Criteria: The total mark for this assignment is from group work. The presentations will be marked by the academic staff and industrial visitors for the quality, professionalism, conveyance of design and technical approach. The marking will be allocated into two separate groups: for the ‘presentation’ and for the ‘questioning’. Within the ‘presentation’ grouping, several aspects will be considered

- Visual Aids and Presentation Style (20% of mark)
- Demonstration of Knowledge (30% of mark)
- Design Approach (30% of mark)
- Professionalism (20% of mark)

Within the ‘questioning’ grouping, the aspect that is consider is only the questioning and how well each group responds demonstrating consideration of the topic, accuracy of response and the rationale.

Feedback: Each group will be given verbal and written feedback for the presentation as a whole. The verbal feedback will come from the audience questioning after the presentation. The written feedback will be in the form of a score which can then be compared to the Assignment 2 rubric located in Blackboard along with written comments. Feedback will be given by Friday of Exam Week 3.

Both the verbal and written feedback should be used to not only to tell you what areas could be improved, but how they could be presented better to the audience and what level of detail and rigour is required. Use this for AER302/6002.

4.2.3. Peer Assessments

Description: There are a total of 2 Peer Assessments throughout this module. The purpose of the peer assessments is to provide constructive feedback to your peers as to how you rank their performance and to receive the same from them. Four key areas will be marked:

- Attendance - overall contribution to meetings
- Contribution - overall contribution to the research and design of the UAV and overall project management/business aspects of the project
- Professionalism - overall professionalism (e.g. time keeping, meeting deadlines) and group working skills
- Rigour – overall how detailed rigourous the group member is

Marking will be out of 10 (10 being outstanding). The peer assessments will be available through Blackboard at least one week before they are due. All responses will be anonymous to the person that is receiving the feedback so be honest and concise but diplomatic and constructive. **Anyone leaving unprofessional responses will receive a reduced mark for professionalism. A response to each question is required and must have a minimum of 2 sentences; don't rant though and be to the point**

Marking: These marks are included in the professionalism marking.

Feedback: Each person will receive anonymous feedback as to how the other group members ranked them in the four areas listed above. This feedback will be in the form of written feedback approximately 2 weeks after the peer assessment due date.

5. Safety

Safety is a priority when working around equipment and your UAV. It is imperative that the use of safety glasses and proper equipment and the consideration for all bystanders is fully considered while working on your UAV. Anyone not adhering to safe use of the lab and/or equipment will be asked to leave. This will be at the discretion of the Diamond staff.

5.1. Risk Assessments

5.1.1. Lab

Before carrying out any experiments in the labs, a Risk Assessment needs to be completed detailing what you are doing, the risks of the experiment, the severity of the risks and the likelihood of the risks. The purpose of the Risk Assessment is to evaluate the potential dangers with the experiment for yourself and others in the lab. Before an experiment can begin, the technician responsible for the lab will need to approve each Risk Assessment. You will need to have a copy of the completed Risk Assessment next to the experiment at all times so others can view it. If you are found doing experiments without a Risk Assessment, you will be told to stop immediately and your access to the lab may be removed.

5.1.2. Control of Substances Hazardous to Health (COSHH) form

Before using any chemicals, adhesives or epoxies you will need to complete a COSHH form. The purpose of the form is to identify any hazards and how to limit the exposure of the substance with others. These will be required to be approved and signed by the appropriate lab technician.

5.1.3. Batteries

Batteries and generally very safe but do require proper handling, operation and storage to avoid potential dangers. Although this applies to all battery chemistries, this is particularly true for lithium ion and lithium polymer batteries. These types of batteries are used in many electronic devices (e.g. mobile phones, laptops). It is important that all batteries are used and operated within the manufacturer's specifications only. Over charging and over discharging lithium ion and lithium polymer batteries is dangerous. When charging your batteries, the operator **must be present the entire time**. Do not leave these to charge unattended. As a safety precaution, each group **must use a fireproof bag when charging and storing** their batteries. Each group will receive one fireproof bag (at their request) but others can be made available if required. It is your responsibility to properly handle your batteries.

5.2. Group Working, Overall Project Supervision and Communication

This is a group project and it is very important to ensure that you work as a group and that every member of the group engages fully and contributes equally to the group. Common problems within groups include:

- Group members taking too much control and dominating the group. This is poor team working, can lead to resentment, may result in the wrong work being done (as the dominant person is incorrect) and ultimately can lead to a breakdown in the group.
- Group members not contributing sufficiently and in a timely fashion to group activities and deliverables. This leads to other group members having to work extra to cover weaker group members and can disrupt their own carefully planned work schedule.
- Group members not being sensitive to cultural and personal differences. It is the responsibility of all group members to contribute and to encourage others to contribute.

It is very important for you all to work effectively within your groups. This includes attending ALL group meetings promptly (and providing sufficient notice of unavoidable absences), planning your work realistically and effectively (including taking account of other coursework deadlines), communicating effectively, discussing issues as they arise, being honest and ensuring you put in your fair share of work. Group work can be difficult but it is a very important skill you need to develop and is a key part of being a professional engineer. It is also important to deal with issues in a timely and professional manner. It is better to resolve group issues earlier rather than later.

It is expected that you should be meeting as a group at least once every week to discuss progress and the overall direction of the project against the plans. In addition, you may meet in smaller subgroups about specific aspects of the project. You should conduct the meetings professionally and it is recommended that you appoint a chair for each meeting (which can vary throughout the project) and someone to take minutes (in particular of agreed actions and timescales).

In addition, you will meet with the module leader for surgery sessions throughout the project. These will provide an opportunity for you to seek clarification on the project aims and objectives, advice on the direction you are taking and to discuss ideas for work to be undertaken. These meetings are not intended for the module leader to tell you what to do but to provide feedback and ideas. You are expected to show initiative and independence in your work during this project. Attendance at these meetings will be monitored and it is expected that you act professionally and attend promptly.

If you need to contact the module leader outside of these meetings (e.g. to discuss particular problems with the group) then please email the module leader to arrange a suitable time. You should expect to receive a reply within a few days but be reasonable with your expectations.

6. General Advice

This project is worth 10 credits toward the Aerospace MEng and MSc degrees, therefore you are expected to spend approximately 100 hours each in total working on the project during the academic year. As a guide, you should be spending, on average, at least 8 hours working on the project per week. You should not underestimate the amount of time you need to spend on the project and you must ensure you manage your time effectively and efficiently, both individually and as a group. The amount of time you spend on the project each week will vary. It is very easy to work ineffectively, particularly when in a group, so ensure you plan and use your time well. Experience clearly demonstrates that 100 hours is more than sufficient to produce a high quality UAV and deliverables for this project.

It is very important that you manage tasks across group members effectively. Each member of the group must do their fair share of the workload. You will have other assignments and coursework during the year and therefore you need to ensure you manage deadlines effectively. Note that these hours are a guide and in practice you may spend more time on the project at particular times during the project, in particular towards the end of the project you are likely to spend considerably more hours working on the project.

A key element of the group design project is that you learn about how to work (in addition to actually doing the work). There are many examples in industry of projects that fail due to poor planning and project management. You are therefore expected to use appropriate tools and methods to plan and manage the project. You should not write up the theory of project management in any of the reports but show evidence of having used appropriate tools and methodology.

You should apply a Systems Engineering approach to project management. There are many definitions of precisely what is meant by systems engineering but in essence it is about the project life cycle and how complex engineering projects are undertaken. There are many variations on how projects should be undertaken but the systems engineering process described at:

http://en.wikipedia.org/wiki/Systems_engineering_process

and the V model described at:

http://en.wikipedia.org/wiki/V-Model

are good examples. They both highlight the importance of requirements capture and analysis; detailed (conceptual) design; design, testing and verification of subsystems; integration of subsystems, testing, verification and validation of the complete system. It is expected that you utilize these ideas in running this project and provide evidence of a systematic approach through your reports. A further aspect of systems engineering is the need to bring together many different engineering disciplines into the successful design of a single complex engineering product. It is therefore very important that, whilst working on individual subsystems, you should be thinking about the interrelationship with other aspects of the design and how they will interact.