# Appendix A: Project Proposal Form

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| Team letter: | Ganges | Name of person elected as team leader: | Ben Rowlinson |

## Responsibilities

*List the responsibilities of each team member.*

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| Lab pair no. | Name | Design responsibility |
|  | **Ben Rowlinson** | **Integration, Cargo Acquisition, Data-logging, Power Management, Team Leader** |
| **Lawrence Gray** | **Chassis design, Control Processing, Integration, Financing** |
|  | **Joseph Hindmarsh** | **Gyroscope/Accelerometer interface, Cargo Acquisition, Liaisons** |
| **Joel Trickey** | **Communications, Telemetry, Encryption, Secretary** |
|  | **Mohammed Ibrahim** | **Human Interface, Air-to-Ground Communications, Telemetry, Documentation** |
| **Jon Simmons** | **Engineering Consultant** |

## Overall Design Summary

*Give a summary of your design.* *Please make explicit exactly what you intend to build. Remember, a working design with more features would always obtain better marks. Be aware that you will be marked against what you declare in this document. YOU are setting the standard, YOU choose your goals and what you want to achieve.*

*Include a SPECIFICATION for the system you are designing.* Be ***specific***, it’s a ***specific***ation – e.g. the specification of the audio amplifier is: a gain of *x*, a bandwidth of *y*, capable of amplifying two independent audio channels, etc.

To fulfil the brief effectively the UAV must:

* Have a high maximum cargo weight to UAV weight ratio (cargo-UAV ratio)
* Produce a stable flight-path
* Have adequate battery life to transport the cargo then return to the base-station.
* Safely and quickly disarm the motors when commanded

We can afford a reasonable cargo-UAV ratio using 4 brushless DC motors. For stability, a microcontroller receiving feedback from a gyroscope-accelerometer module, forms a PID controller. This controller system devolves much of the responsibility for stability from the pilot. A second on-board microcontroller handles communications with the ground to relieve strain on the control system. Log data is written to an on-board SD card and transmitted back to ground. The pilot communicates with the UAV using X-Y joystick potentiometers and a microcontroller, which translate the pilot’s commands to the desired Throttle, Pitch, Roll, and Yaw values. Switches disarm the motors, enable changes to PID gains, or activate the servo-controlled cargo acquisition mechanism.

Specification

* x4 2204 2300kV brushless DC motor
* Arming system for the motors to ensure safety compliance
* 5030 ABS Propellers – 5 inches diameter, 3 inches up per rev
* Motor Speed controlled by 1-2ms PWM Electronic Speed Controllers (ESCs) – IMAX : 20A
* Powered by 3 Cell 11.1V 1550mAh LiPo Battery – IMAX : 45A (Continuously) 90A (Burst)
* 2-Way communication between Ground Control and the UAV – Commands Up and Telemetry Down
* On-board file logging to SD card – Same data as telemetry
* Gyroscope and Accelerometer (MPU6050) - with in-built Digital Motion Processing and an I2C interface
* Servo used for cargo acquisition – Controlled by PWM, located underneath the chassis, carrying cargo using a hook.
* Laser-cut acrylic chassis, assembled using acrylic glue
* I-style design for easier weight distribution and more carrying capacity
* Reprogram the PID controller on the fly by changing k values wirelessly for faster tuning
* Interfaced with the pilot using two X-Y joystick potentiometers, a bank of function switches, and a microcontroller
* RFM12B-S2 ISM band modules for both uplink and downlink - using an SPI interface
* Sharp GP2Y0A41SK0F IR sensor provides altitude sensing for telemetry and autonomous landing, with accuracy from 15cm to 120cm

## Module Design Proposals

*Please give details of each module of your overall design. In particular, give interfacing details between your module and other parts of the system. Complete one of these pages for each module of the design (continue on an additional sheet if necessary).*

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| Names of people involved: |  |
| Title of Module: |  |

## Cost Estimates

*Please give detailed calculations and estimates of the overall cost of your proposed design below. Take care to include person-hour estimates for your software, board production and debugging, as well as your components and consumables. You should also estimate the production cost of your final unit (you may assume a large quantity are to be produced), the market price and determine how many need to be sold to be profitable.*

*Costing:*

*Development:*

Unmanned Tech: £79.03

Other components:

Arduino Leonardo: £18.50

Micro Servo Motor: £7.70

Gyroscope: £1.50

Misc. components + boards: £8

Transceiver: £5.65

Atmel atMega644p chip x 2: £12.62

A2 acrylic sheet: £10.55

TOTAL: £143.55

*Production:*

Unmanned Tech: £79.03

Other components:

Arduino Leonardo: £12.49

Micro Servo Motor: £2

Gyroscope: £1.50

Misc. components + boards: £4

Transceiver: £5.09

Atmel atMega644p chip x 2: £8.04

A2 acrylic sheet: £8

2 hours of construction cost (£20 per hour): £40

TOTAL: £160.15

*Project hours per person:*

Over a span of 2 weeks of designing and testing an estimate of total 88 hours (based on current work time)

Total of 440 man hours: (guess split of those hours)

160 hours developing software

40 hours board production and building

240 hours total debugging

At £75 per man hour total cost of £33,000

CE mark: £2000

Manufacturing costs: £100,000

Total Development costs and manufacturing costs: £135,143.55

*Profit Margin:*

To make money if they are being sold at £300 (profit margin of 53% we need to make 965 units (assuming 100% yield) at 90% yield (worst case) we need 1073 units before breaking even

## Prototyping and Construction Method

*Briefly describe your proposed method(s) of prototyping and construction, including whether you will use any surface mount packages.*

Prototyping and Construction Method

- Briefly describe your proposed method(s) of prototyping and construction, including whether you will use any surface mount packages.

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To test the dimensions of the drone we are planning to construct a full-scale model of the chassis using cardboard and glue. We will be achieving this by cutting out cardboard as per our laser-cut design. This will allow us to ensure that the design has enough space for routing wires; identify areas where size can be reduced; and gain a basic knowledge of its structural integrity.

Initially, we will utilise the breadboards on the Il Mattos to allow quick and easy testing and prototyping of various systems. Such systems include the IR sensors interfacing with the microcontroller and the controller (joysticks, buttons etc.) with the Il Matto on the ground. Once the tests are successful we will permanently connect the modules, without breadboards.

To make the debug process easier and more efficient, various sub-systems will be tested in isolation (starting with the most critical parts: Motor Control, Gyroscope, Ground-to-Air communications) before being gradually integrated together.

Firstly, we will test communications between the Il Matto and the Arduino on the UAV as well as the PWM from the Arduino to the ESCs. After these functionalities have been fully verified, and any issues have been corrected, these systems can be combined. Similarly, the HID controller and the Il Matto on the ground will be prototyped, tested, then linked directly to the Il Matto on the drone. We can then introduce the wireless radio communications between ground and air. Finally, the less crucial components (SD card logging, cargo acquisition servo, computer interface) will be added into the system, provided critical tasks have been completed.

After prototyping has been completed, we will construct the chassis. This involves using the ECS Makerspace facilities to laser cut 5mm acrylic as per the outline we will have created and using acrylic glue (Dichloromethane) to hold the pieces together. Tabs in the design will allow perpendicular parts to be fitted together, and to be constructed initially without glue. As we are planning a two-tiered design, the top layer will not be constructed until the components on the bottom tier (Il Matto, Arduino) have been successfully fitted. The chassis' design will enable components to be easily accessible and make construction easier.

Sticky tape will be used to attach most of the various components to the chassis. An exception is the motors which will be attached using the provided screws, through holes in the motor pads of the chassis.

The ESCs will be mounted underneath the second tier, with power distribution achieved by soldering onto stripboard. The gyroscope will be placed in the centre of the drone and connected to the Arduino using flying leads. The pin header on the breakout board will be flipped through de-soldering and re-soldering on the other side.

The servo for cargo acquisition will be accommodated on the bottom side of the drone through a gap in the acrylic.

######HID CONTROLLER########

We will only be using pre-made surface mount packages with breakout boards, as this eases the prototyping process.

## Planned Project Activities

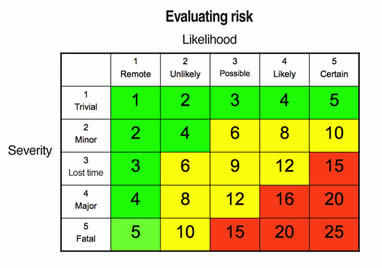
*Please list the activities that you intend taking place during your laboratory time, and indicate when they should occur, and who will do them. The ‘Initials’ column must specify only one person. If two people are working on the same subsystem or task, you should list this as two separate activities, and be clear about what each individual is contributing to it.*

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| Activity | Initials | Fri  am | Fri  pm | Mon  am | Mon  pm | Tue | Wed | Thu | Fri  am | Fri  pm | Mon  am | Mon  pm |
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## Risk Management

The D4 exercise is intensive, having demanding requirements yet running over a very short period of time. Successful project management requires management (i.e. planning) of risks. On the right hand side of this form, you should identify the predominant risks to your project, and the controls that you are going to put in place to minimise/mitigate them. Some things you may want to consider are illness of a team member(s), disruption to lab access, broken/faulty components, etc.

All members of your team should sign below to indicate that you have read the [Risk Assessment form](https://secure.ecs.soton.ac.uk/notes/elec2205/D4/2017/RiskAssessment.docx), taking particular note of items 20 and 21. If you can identify any additional risks to your health and safety that are specific to your design, then you should add corresponding entries to the [Risk Assessment form](https://secure.ecs.soton.ac.uk/notes/elec2205/D4/2017/RiskAssessment.docx) and attach a copy to this project proposal form. If they are satisfied with your additions, a member of academic staff will sign this form during your first laboratory session on 3rd March 2017. In any case, You should also be aware of the regulations that govern the flight of UAVs in the UK – you can see summaries of these [here](https://bmfa.org/DesktopModules/Bring2mind/DMX/Download.aspx?Command=Core_Download&EntryId=1541) and [here](http://www.modellbauuk.com/drones--fpv-racing-25-c.asp).



International Register of Certified Auditors (IRCA), “A History of Risk”, <http://www.irca.org/Global/Images/technical/inform/issue%2024/24-SAsbury-Figure1.jpg>

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| **Hazard** | **Severity** | **Likelihood** | **Risk** | **Control** | **Controlled Severity** | **Controlled Likelihood** | **Controlled Risk** |
| Components are damaged/broken through misuse | 3 | 4 | 12 | Comply with ESD handling guidelines. Confirm correct wiring with datasheet before applying power. Turn off power before rewiring. Order a spare of key components, if budget permits. | 2 | 2 | 4 |
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| **Team member** | **I have read the** [**Risk Assessment form**](https://secure.ecs.soton.ac.uk/notes/elec2205/D4/2017/RiskAssessment.docx) **and I agree to the described operating procedure** |
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