Supported by

BAE SYSTEMS

The British Model Flying Association invite your university or school to enter a team or teams in the,

# Heavy Lift Challenge 2012.

The information contained in this brochure provides a detailed overview of the 2012 Heavy Lift Challenge as well as all information and forms for prospective entrants. We look forward to meeting your staff and students in 2012.

Should you require any assistance please contact
the BMFA Challenge Co-ordinator.
Manny Williamson
(Address as on the entry form, final page)

## NOTE

These competitions are supported by cash prizes, both for the university department and the individual members of the winning teams.

## FOREWORD

My career in aviation spans some 49 years, beginning with a 5 year apprenticeship at the Royal Aircraft Establishment, Farnborough and leading on to 38 years in the Royal Air Force until the present. In all that time I have found numerous instances amongst my contemporaries that lead me to conclude that a good grounding in aviation begins with a sound understanding of the principles of flight. And the best way to achieve that understanding is through the fascination of designing, building and flying model aircraft.

I can think of many famous names amongst the pioneers of aviation who began with a love of model aircraft but none more so than the man who was arguably the greatest innovator of modern aviation, Frank Whittle. It was Frank Whittle who invented the turbo jet engine without which aviation and air travel today would be a very different business. As a young man Whittle was forever experimenting with models, an interest that surely had something to do with his own quest to find ways of fundamentally overcoming the limitations of propeller driven power plants. His life and work as an aeronautical engineer of great distinction is reason enough to inspire anyone to at least take a leaf out of his book and learn from model aviation.

Everyone needs a challenge. The Heavy Lift Challenges pose both intellectual and practical challenges. By any stretch of the imagination, designing a unique aircraft to meet the stringent specifications is a challenge to the intellect, to understand the aerodynamic principles, and to optimise the various performance characteristics to give the best result. And it is certainly a practical challenge to construct the aircraft with sufficient strength and reliability to perform the contest flights in any weather.

As a life long aeromodeller I can think of no better practical challenge than the two BMFA Heavy Lift Challenges to inspire understanding and innovation in the science of aeronautics.

Air Chief Marshal Sir Michael Alcock, GCB, KBE, DSc, FREng, FiMechE, FRAeS
President, British Model Flying Association

# INTRODUCTION

University degree courses in engineering subjects provide an excellent technical and theoretical basis for students wishing to embark upon a career in the engineering industry. However, it is often the case, that universities lack the facilities to allow students to gain practical experience working on meaningful design, manufacturing and operational projects. This is particularly so in aviation where full size aircraft projects demand large and expensive facilities if the projects are to be realistic. Although it is perfectly feasible for students to undertake aircraft design projects, these will inevitably feel incomplete unless they result in a real flying machine. The University Challenge Competitions are intended to fill this gap, whilst at the same time providing the framework for a compulsive, enjoyable and competitive experience.

Although the competitions centre on the design, manufacture and demonstration of model aircraft, the aim is to relate this, as far as possible, to the activities and processes that would be used in a full size machine. To this end the competing aircraft have to perform a genuine operational task in terms of payload, power plant type, etc. Furthermore the aerodynamic and structural design of the aircraft must be properly assessed in order to predict operational performance, and this assessment has to be presented in the form of a design report and design drawings.

Apart from the technical aspects, the project is intended to be carried out by A STUDENT OR GROUP OF STUDENTS, and this gives them valuable experience operating as a team in much the same way as they will ultimately have to do in their industrial careers. Furthermore they are given the opportunity to demonstrate their presentation skills when they give a short talk about their machine. The importance of the presentation should not be overlooked, as valuable points can be gained. In past years we have noted that teams often miss this opportunity to gain valuable points.

It is not intended that teams entering the competition are necessarily studying aeronautics and indeed many of the past winners have come from universities that do not have an aeronautical engineering faculty. Many students are undecided on their ultimate career direction when they embark upon a university course and it is the experience gained at university that will often point them in a particular direction. The competitions provide such experience in aviation technology and this may provoke an interest in aviation that might otherwise not arise.

The following sections of this brochure set out the rules and describe the characteristics and operational task of the competing aircraft. The brochure concludes with a set of notes, which are intended to help students in designing their machine, writing their design report and producing their design drawings.

Please note, it is very strongly recommended that the help of an experienced aero modeller is enlisted from the very start. Local contacts are available from the BMFA office.

# LIST OF CONTENTS

## 1. OBJECTIVES

Contestants are to design and build a radio controlled, payload carrying aircraft using the specified 0.40 cu. in. glow ignition engine. They should design their aircraft to maximise the value of the ratio "payload/aircraft empty mass". The aircraft empty mass is defined as the mass without payload, payload box and without fuel. In addition to this the airframe must make provision for the attachment of a forward facing optical sensor (half a tennis ball) to comply with the specification set out within the rules.

Teams are required to produce a technical report describing their aircraft's design and construction together with design drawings. They then have to give a verbal presentation on their aircraft and finally take part in a flight competition aimed at verifying their performance predictions.

The flight competition will be judged on the basis of the achieved value of the "payload/empty aircraft mass" ratio.

The winners are the team who are judged to have scored the highest aggregate score for all aspects of the competition. Although normal course tuition and guidance is expected, the reports, drawings and the building of the aircraft are to be treated as though they are examination submissions and are to be the sole work of the students.

## 2. CONTEST ELIGIBILITY

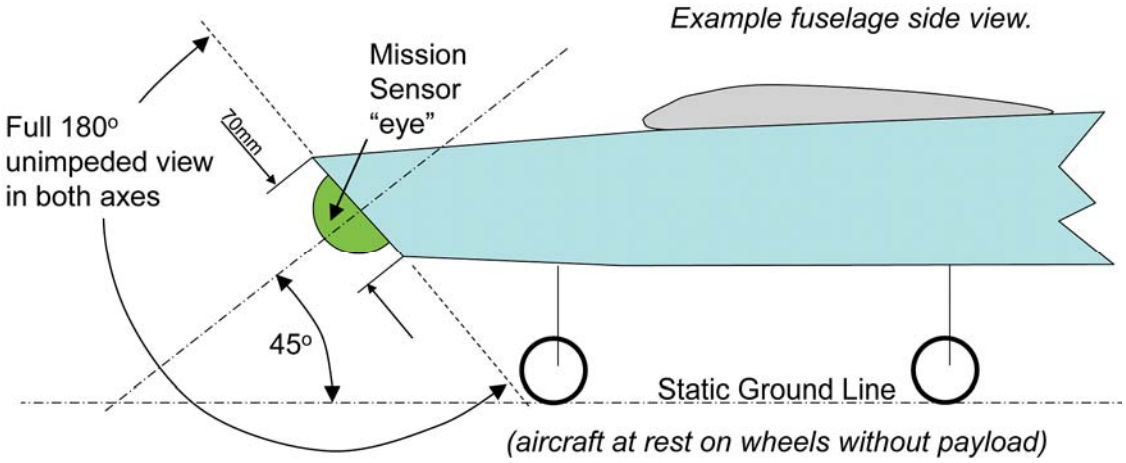
The contest is open to all Further Education, University and 6th Form College students. The pilot of the aircraft need not be a member of the group which has entered the competition as designers and builders, but must be a member of the BMFA and hold at least a 'B' Fixed Wing Power Achievement Scheme Certificate. The maximum number in a team will be five students plus a manager and a pilot. For the flying part of the contest a pilot can be supplied by the contest organisation.

## 3. AIRCRAFT CONFIGURATION & MISSION SENSOR PROVISION

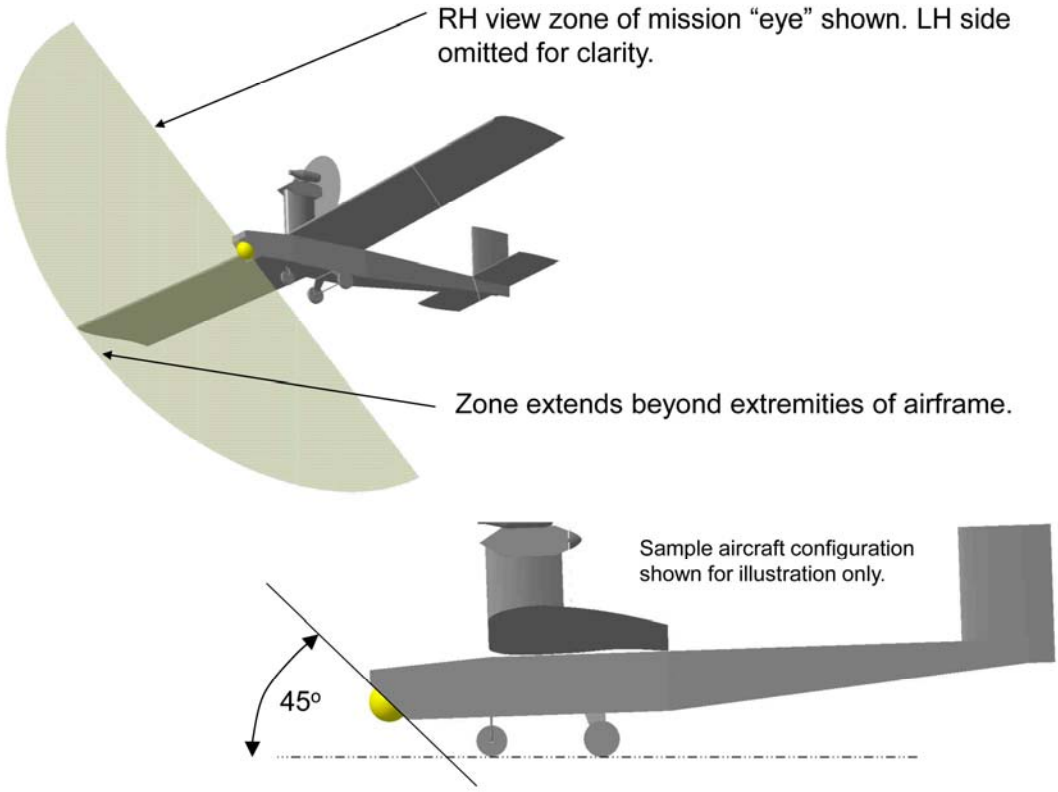
3.1 Only fixed wing designs will be allowed to enter the competition. The maximum wingspan of the aircraft is to be **2000mm**. Rotary lifting surfaces are not permitted.

3.2 A hemispherical "eye" (half a tennis ball measuring between 63.5mm and 66.7mm diameter) is to be located at the nose of the aircraft, securely bonded to the fuselage. The face to which the "eye" is attached will be angled at 45degrees down from the static ground line and zero degrees sideways relative to the aircraft centre line (acceptable tolerance for both angular measurements will be plus/minus 3 degrees. This planar face will have a minimum dimension of 70mm diameter to permit the full diameter of the hemisphere to be attached. The view from the centre point of the

hemisphere must not be obscured by any element of the airframe, engine or propeller, moving or fixed.




Note that a "taildragger" configuration (ie: 2 main wheels and tailwheel) will still require this angle as shown below.




3.3 A standard specified 0.40 cu.in. glow engine (6.55 cc), fitted with a specified silencer, is to be used. No extra tuning is allowed. No external modification to the engine is allowed unless agreed with the Challenge Co-ordinator and included on the plans submitted for assessment. Gearing is permitted.

3.4 A propeller spinner or rounded safety nut must be used on forward facing motors, metal propellers and variable pitch propellers are not permitted.

3.5 A cargo bay must be included in the aircraft. This cargo bay must be fully enclosed in flight and readily accessible on the ground to install an official competition cargo box. A competing team is responsible for constructing their own cargo box and supplying adequate weights for the flight contest. The internal dimensions of the cargo box must not be less than 80mm x 80mm x 200mm. Entries with cargo boxes that have any dimensions under the above stated sizes will incur a penalty. For every 2mm less than the dimensions stated above, 5 penalty points will be accrued. The cargo box can be made from any metal sheet. Lead, steel shot or plate is to be used for the payload. The cargo box cannot be an integral part of the aircraft's structure. It must be removable to allow its dimensions and mass to be checked. Securing the cargo box to the aircraft should not intentionally add structural stability to the design.

3.6 The load in the cargo box must be centrally loaded. The remaining space in the cargo box must be packed with filler to keep the contents in place, but no lateral or longitudinal positioning of the load will be allowed.

3.7 The payload for the competition will be the total mass of the cargo box and its contents. Immediately after flying the payload box must be presented at the weighing/scoring station with the appropriate flight card.

3.8 BE ADVISED: Payload will be rounded down to the nearest 100 grams. Consider the mass of your cargo box and provide appropriate lead/steel payload.

3.9 The recorded payload that is given by the organisers' scales will constitute the value that is used in scoring calculations for the competition.

3.10 In order to facilitate the calculation of the "payload/aircraft empty mass" ratio, the empty mass of each competing aircraft will be measured before the flying competition on the afternoon of the presentations. The measured empty mass will be rounded up to the nearest 10 grams. The aircraft empty mass is defined as the mass without payload, payload box and without fuel. If during the flying competition it is necessary to make repairs to the aircraft, such repairs must not reduce the empty mass.

3.11 Fuel tank must be accessible to determine contents during inspection. Fuel may be pressurised by stock fitting on the silencer only (no pumps allowed). Fuel tanks will be filled before each flight. The fuel, which will be supplied and used in the competition, will be a 5% Nitromethane mix.

## 4. RADIO RESTRICTIONS

4.1 Radio control will be used to fly and manoeuvre the aircraft. No gyroscopic or electronic stability aid of any kind is permitted. All radio equipment will be scrutinised by the organisers and must be deemed fit for the intended application. Contestants must satisfy themselves that servos and linkages will be capable of handling the anticipated air loads. All on-board radio equipment must be protected from the weather since the flight competition may take place in adverse weather conditions.

4.2 A seven hundred and fifty (750) mAh battery pack is the minimum required size for the competition. Batteries may be charged or changed at any time on the ground.

4.3 Computer transmitters are permitted, however any extra functions, mixing or advanced programming must be explained and demonstrated during the presentation to the judges.

4.4 Equipment on the 2.4GHz band will be the only permitted frequency.

## 5. COMPETITION PROCEDURES

There will be two elements to the competitions in which all participants are required to compete. The first, the design competition, will enable the contestants to present their designs and demonstrate their calculations in predicting the maximum payload that their aircraft will lift. Valuable points can be gained here! The second, the flight competition, will determine which aircraft can achieve the highest value for the "payload/empty aircraft mass" ratio.

Please note; each team must display a sign with team name of at least A3 size in the pit area.

## 6. DESIGN COMPETITION

*Consider that you are compiling a technical document in support of a competitive tender. Compliance with the following directions will add credibility to your design proposal. Your team will earn more points if the data contained in the drawings corresponds to the values used and derived in your report.*

## 6.1 DRAWINGS:

Each team must submit detailed drawings for the aircraft which is to be flown. The drawings must contain fully dimensioned front, side, and top views and wing section details. These must all be drawn to scale and with the scale shown. The plan view must contain a

listing of all the relevant aerodynamic surface areas. Drawing minimum size is A3 and a maximum size is AO, all sheets to be the same size. Materials and sizes are to be indicated. Detail drawings, which are deemed necessary to explain structure of the aircraft and the range of movement of the aerodynamic control surfaces, are also to be included. Each drawing sheet will include the name of the team in the Title box. For the 2012 competition teams are to submit the drawing set by email in PDF format. The judges will evaluate the drawings based on a professional standard format. Areas of evaluation will include.

Detail
Completeness
Explanation of structures
Readability
Graphical standards

A maximum of ten sheets of drawings is permitted. The drawings will be worth 50 points. *For more guidance on drawing content, see Appendix A, Para. i.*

## 6.2 REPORT:

Each team must submit a report which details the design philosophy, structural and aerodynamic design. The report should also include performance calculations and must quote a prediction of the maximum payload to be carried in the Flight Competition. Any original or innovative ideas should be described, together with the use of unique or advanced structural techniques and materials. The report is worth 50 points and should comprise no more than 25 double-spaced, typewritten pages of A4 paper, including any appendices and diagrams. Minimum type size to be 12 point. Where an institution enters more than one team, the designs, reports and drawings are to be produced by each team independently. Each page of the report will include the name of the team in the footer or header. If a report exceeds 25 pages only the first 25 pages will be marked. As per the drawings, the report may be submitted in PDF format.
*For more guidance on report content, see Appendix A, Para.ii*

Copies of all drawings and reports are to be sent to the chief judge at least 30 days prior to the start of the flight competition.

Late submissions will be penalised and competitors are advised that, in these circumstances, the judges' comments may be less carefully considered. The organisers are not responsible for lost/misdirected drawings/reports.

Although normal course tuition and guidance is expected, the reports, drawings and the building of the aircraft are to be treated as though they are examination submissions and are to be the sole work of the students.

## 6.3 PRESENTATION:

Prior to the first competition flight, each team will present their aircraft design before a panel of professional engineers. Order of presentation will be decided by drawing lots. Each team will be allocated seven minutes in which to describe their design. OTHER THAN THE PROJECT REPORT AND THE AIRCRAFT (INCLUDING TRANSMITTER IF APPROPRIATE), NO VISUAL AIDS WILL BE AVAILABLE OR PERMITTED. THE AIRCRAFT MUST BE AVAILABLE FOR THE PRESENTATION.

Two points will be deducted for each ten-second-time period or part thereof over the seven minutes allowed for the presentation. The presentation is worth 30 points. Judging criteria for the presentation will include:

- Balance and continuity
- Articulation
- Technical highlights

## 6.4 SCRUTINEERING:

Subsequent to each team's presentation, aircraft details will be recorded, this will include a physical check of the overall wingspan, critical dimensions and features and also measurement of the ballast box. (See Build Penalties below) A safety and airworthiness inspection will also be conducted at this time to enable teams to address any item requiring attention before flight.

Build Penalties

5 points deducted where the "optical sensor" hemisphere is omitted.
5 points deducted where optical sensor mounting face is out of alignment by more than 3 degrees. (see angle $45^{o}$ at paragraph 3.2)
5 points deducted where any element of the aircraft intrudes into the $180^{o}$ hemisphere described at paragraph 3.2.
5 points deducted for each 2mm decrement in each of the dimensions of the payload box as described in para 3.5.

Failsafe

Correct Failsafe operation must be demonstrated at this time (note: Failsafe = a system whereby the throttle moves to the closed position if the receiver experiences any external interference or loss of signal) .

The ability to "cut" the engine from the transmitter must also be demonstrated.

## 7. FLIGHT COMPETITION

7.1 First Round: Each aircraft is required to complete a flight (*Take off, circuit and landing in accordance with competition parameters as per 7.11 below*) without any payload or payload box. Successful completion of this qualification round is essential before a payload scoring round can be flown.

7.2 Second Round: Each aircraft is required to complete a flight carrying a maximum payload of 2kg. The payload can exceed 2kg, but only 2kg will score. Points awarded as per Appendix E.

7.3 Third Round: Each aircraft is required to complete a flight carrying a maximum payload of 4kg. The payload can exceed 4kg, but only 4kg will score. Points awarded as per Appendix E.

7.4 A team which has successfully completed the qualification flight at the second attempt (ie; during the Second Round) may attempt the full 4kg lift in the Third round.

7.5 The organisers' scoring computer will not be available to the teams. "Payload/aircraft empty mass" ratios will not be published until the end of the competition but teams will be advised of the points scored on a regular basis.

7.6 Payload is measured in 100-gram increments. Contest directors will verify the payload once a successful flight has been made. The team captain or his appointee will be present at the official weighing of the cargo box. The payload recorded will be:

(mass of lead/steel plus mass of cargo box) rounded down to the nearest 100 grams

7.7 During each round of the flight competition, the team will have a defined period on entering the Start-up Box in which to complete their flight. A score will only be recorded if the aircraft completes its required flight pattern and lands within the designated touch down area within the allotted period.

7.8 Completion of a flight will be recorded as the time at which the main wheels touch down for the last time prior to landing roll. It will be judged by the Contest Director or his appointee. A team may make any number of take-off attempts within the defined period which is allotted to them, but it is the final attempt which is the one that scores. i.e. a second attempt invalidates any score from a previous attempt in that round of the competition. An attempt is deemed to have begun when the aircraft begins its take-off roll.

7.9 At the end of the defined period the team will leave the Start-up Box and may not return until their next flying slot.

7.10 The aim is for each team to fly three ten minute slots, however, a final decision will be announced at the morning briefing to reflect the time available, the number of teams competing and the expected weather conditions.

7.11 The aircraft must take off from a stationary start within the designated 61metre runway, fly a circuit (either left-hand or right-hand, according to the prevailing conditions), and then touch down within the designated landing area. During its circuit, the aircraft will be required to perform an additional 360-degree turn in the opposite direction to demonstrate its manoeuvrability. The designated touch down area will be 122 metres in length, but may not be orientated into-wind. Every attempt will be made to provide a smooth runway, but the quality of the surface cannot be guaranteed. Although every effort will be made to ensure that take off is predominantly into wind, crosswinds may be encountered.

7.12 Lift-off beyond the 61metre mark (indicated by a red flag) will be penalised by a 10 point deduction from the overall score.

7.13 Once in flight and clear of the runway, touching down outside of the 122metre area, or crashing, invalidates that attempt. However, further attempts to fly can be made subject to the flights being made within the allotted defined period (subject to airworthiness and safety considerations). A good landing is defined as a controlled touchdown in the designated 122metre landing area and rolling to a stop. The rollout must commence within the 122metre landing area, but may carry the aircraft beyond it, the airframe must also be deemed fit to fly again.

7.14 The aircraft must take off and land with all of the same parts to receive any flight score. No jettisoning; deliberate or otherwise, is permitted. (Damage to propeller and/or wheels is permitted)

7.15 The original design of the aircraft as presented in the Design Competition may not be altered during the course of the competition, but it may be repaired. The aircraft must finish with its original parts, with the exception of its propeller, glow plug and landing gear components, which may be substituted or changed at any time on the ground. No spare parts, with the above exceptions, will be permitted. Any other alteration from the original design will result in a score of zero points for the Flight Competition. All repairs to be checked by the Contest Director before flight.

7.16 The organisers will supply fuel for the competition and this will be the only fuel used for the contest. This fuel will be a commercial product containing 20% Castor oil and 5% Nitromethane in a Methanol base.

7.17 Any protest must be filed in writing to the Contest Director by the faculty advisor or team captain. Any protest must be filed no more than 10 minutes after the Flight Competition is announced as being completed. In order to have a protest considered a team must be willing to put up 25 points, which may be forfeit, if their protest is rejected or not upheld. The Contest Director may call upon a jury of interested parties to help with his decision. This decision is final.

# 8. SCORING

Overall score =

Drawings score (max. 50)
+ Report score (max. 50)
+ Presentation score (max. 30)
– (Late Penalties + overrun penalties + Build Penalties)
+ Total Flight Score

Penalty points are assessed as follows:

- 2 points deducted for each day or part day late in delivery of plans or reports
- 2 points deducted for each ten second time period or part thereof by which the presentation overruns its allotted 7 minutes
- Build Penalties as detailed in Para. 6.4.
- 10 points deducted for overrun of the 61m take off distance

The Flight scores are calculated from the appended graph at Appendix E.

Subject to conditions for the event, 3 rounds will be flown by each team:

First round will be with NO PAYLOAD CARRIED. Successful completion of this round is worth 30 points. Teams who record a "No Fly" can make a second and third attempt at qualification during the subsequent rounds.

Second round will be with a maximum payload of 2.0kg. (Note that the actual payload carried should marginally exceed this value to avoid rounding down at the weigh-in, see para 3.8 above)

Third and final round will be flown with a maximum payload of 4.0kg.

The payload round scores are calculated from the appended graph, these are added together with the qualification score to give the Total Flight Score for the flying competition.

# 9. GENERAL CONDUCT AND SAFETY

9.1 NOTE: THE WORD OF THE CONTEST DIRECTOR IS FINAL IN ALL MATTERS.

9.2 It is important that all team members including the pilot attend the morning briefing; this will consist of safety information as well as other information pertinent to the day's activities. The time for this briefing will be announced on the Saturday after presentations to the judges have taken place.

9.3 In the event of unsportsmanlike conduct, the team will receive a warning from the Contest Director. A second violation will result in expulsion of the team from the competition.

9.4 Safety rules, as defined in the BMFA Handbook will be used during the flight competition. They will be explained to all team members prior to the flight competition.

9.5 Deliberate violation of safety rules will result in the team's expulsion from the competition.

9.6 All competing aircraft must be fitted with a serviceable failsafe that as a minimum returns the throttle to idle or stop on loss or corruption of the radio signal. 2.4GHz radio normally has a failsafe facility built in.

9.7 The Competition Director reserves the right to ground any aircraft if in his opinion, or that of his appointee; the aircraft does not meet a safe standard of construction or radio installation.

9.8 The extent of the flying area will be announced during the morning briefing, any pilot flying within the briefed "no fly" areas will be asked to land immediately.
Safety is of paramount importance and pilots must be prepared to "ditch" their aircraft on the order of the flight-line director, should he deem it necessary.

## 10. PRIZE AND AWARD DETAILS

The 2012 Heavy Lift Challenge will reward the winning teams with the following.

The Perkins Slade Trophy (an impressive piece of silverware, presented annually) *

£250.00 Cash prize, paid to university department or school.

£50.00 Cash prize, paid individually to each team member (up to a limit of seven persons)

* Note: the Perkins Slade Trophy is presented to the winning team on an annual basis and remains the property of the British Model Flying Association. The trophy must be returned 28 days prior to the competition of the following year in order that it is available to present at the event.

## 11. PARTICIPATION

PLEASE SEND ALL YOUR COMPLETED ENTRY FORMS TO THE CHALLENGE CO-ORDINATOR AT:

The British Model Flying Association
The Development Officer
Chacksfield House
31 St Andrews Road
Leicester
LE2 8RE Tel: 0116 2440028

Or by E mail marked for the attention of the Development Officer (Manny Williamson) at admin@bmfa.org

To facilitate planning, we must receive, by January 30th 2012, a formal notification of your intent to enter the 2012 competition.

## 12. REPORTS AND DRAWINGS

All reports and drawings must be submitted at least 30 days prior to the day of the flying competition, late submission will be penalised as described previously.

Material should be e-mailed to both judges:

andrew.white@baesystems.com and nigel.revill@baesystems.com

# APPENDIX A:

# GUIDANCE NOTES FOR COMPETITORS

## i. DRAWINGS

The drawings should be of good quality and sufficient detail to enable a third party to construct a duplicate of the machine. The drawings should include a three-view General Arrangement with all of the main dimensions shown. These include, but are not confined to;

Wing span, chord, area and section
Tail plane span, chord, area and section
Fin dimensions and area
Tail plane and fin moment arms
Propeller diameter and pitch
C.G location
Control surface dimensions and deflections
Lateral and longitudinal dihedral

Sufficient information should be provided to allow an assessment to be made of the structure‘s strength in respect of:-

Wing bending
Wing attachment
Fuselage bending
Tail unit attachment
Landing loads

This means that all materials and their sizes should be specified, together with the required adhesives and fasteners. These specifications should include, for example, covering materials, paints and dopes. Where reinforced plastics are used, the number of laminations, lay-up orientation, resin types, etc, should be shown.

## ii REPORT

The report should give the names of the team members and include a list of its contents. The technical responsibilities of the individual team members should be defined.

The topics to be addressed and the maximum points that can be scored are as follows:

| | |
|---|---|
| Overall design philosophy | 8 points |
| Aerodynamic design, stability and control | 10 points |
| Performance | 8 points |
| Structural integrity | 16 points |

A further 8 points can be scored for the overall layout of the report, its readability, etc.

Overall design philosophy should be a description of the logic used to derive the chosen configuration.

Aerodynamic design should be addressed under three-sub headings:-

| | |
|---|---|
| Wing | section, planform etc. |
| Propeller | diameter, pitch, rotational speed |
| Controls | areas, moment arms, etc. |

Stability and control should address longitudinal and lateral stability including the assessment of the neutral point, C.G and static margin.

Performance assessment should address thrust and drag, take-off, climb, level flight and landing, leading to a prediction of take off distance at maximum payload.

## iii STRUCTURAL INTEGRITY AND SAFETY

In order to assess Structural Integrity, it will be necessary to estimate the empty weight. This will then be added to the maximum payload of 4kg to give a value for Maximum Takeoff Weight. (Commonly known as MToW). The value for MToW should then be used in any analysis or testing to demonstrate the strength and stiffness against positive and negative manoeuvres, gusts and landing loads.

Particular attention must be given to wing spanwise bending. Appropriate assumptions should be made for spanwise lift distribution, normal acceleration and ultimate safety factor for all conditions of flight including manoeuvres. *In the absence of a rigorous theoretical analysis, evidence should be given that an adequate practical test has been undertaken to prove the spanwise bend strength and stiffness. The importance of this is reflected in the points available as shown above.*

Due to the relaxation of the plan form area rule in the 2001 Heavy Lift competition we saw several large wingspan entries with inadequate wing stiffness. The situation was made worse because several machines had transport joints along the semi span. This resulted in instances of wing aero-elastic divergence and suspected aileron reversal. This can be a significant safety hazard and therefore it is important that competitors are fully aware of this problem and ensure that their designs are adequately stiff. It is not practical for the organisers to monitor the designs in this regard prior to the flying competition but it is strongly recommended that teams perform their own stiffness test on their machines. A suitable test

would consist of holding the wing root rigidly, then applying a measured pitching torque to the wing tip whilst measuring the angular deflection of the tip relative to the root. The torque, in Newton metres, required to twist the tip by one degree should exceed M.c./2

Where M = Aircraft gross mass in Kg c = Tip chord in metres.

As a further precaution we are limiting the max payload to be carried.

The report should describe any features, which are included to improve the "damage tolerance" of the airframe, e.g. duplicated load paths.

## iv FLYING COMPETITION

Care should be taken in the preparation of your weights. If you fly with 3.99 kg, you will only score a flight load of 3.9 kg, since all loads are rounded down to the nearest 100 gm. Better to fly with 4.01 kg. Our measuring equipment is very accurate.

The figure below shows a sample set of flight scores.

| | | Round 1 (Qualifying) No Payload Needed | | Round 2 (max 2kg) | | | Round 3 (Max 4kg) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Example Heavylift Entries | Empty Aircraft Mass | Outcome | Score | Payload Attempted | Outcome | Score | Payload Attempted | Outcome | Score | Total Score |
| Walford | 5000 | 👍 | 30 | 2000 | 👍 | 32.00 | 3000 | 👍 | 48.00 | **110.00** |
| Ambridge | 3860 | 👎 | 0 | 0 Qualification | 👍 | 30.00 | 4000 | 👍 | 82.90 | **112.90** |
| Emmerdale | 2665 | 👍 | 30 | 2000 | 👎 | 0.00 | 3500 | 👍 | 105.07 | **135.07** |

This shows that failure to qualify in the first round or to successfully complete a round can be offset by later success, even when carrying less than the maximum payload permitted. The points margin is sufficiently narrow that a good report and drawing can still give a team the edge!

You have only a limited amount of time in each round in which to complete your flight.
This means that in the Heavy Lift Challenge you need to be slick with your start-up procedures. Your engines should need little adjustment on the day and should start readily. If you aren't familiar with glow engines, take advantage of local aeromodellers. We can put you in touch with local, experienced aeromodellers who can provide invaluable assistance to your team. The competition rules preclude their helping with the design aspects of the project, but they can still provide lots of useful pointers to your team.

We can provide experienced pilots for your team, should you need them. Most teams do need pilots and we have accumulated a few "old hands" over the years who will be able to fly your aircraft competitively. Nonetheless, it is best if the pilots can test the aircraft prior to the competition date and assess their handling, etc. Please don't be afraid to ask for assistance with your projects: the BMFA has a large membership of experienced aeromodellers, contact the Competition Director should your team require assistance.

This competition is as much a test of your organisational skills as of your engineering flair. You may well have a world-beating design....on paper. Each year several teams fail to complete their projects by the date of the Flight Competition.

## v RADIO CONTROL SYSTEMS AND ENGINE SAFETY

It is most important, for safety reasons, that your engine and radio are installed correctly and the competition director reserves the right to ground any model if it is considered that the installation does not meet a satisfactory standard. It is strongly advised that a modeller with experience in radio control model flying should make periodic checks on models during construction and advise on airworthiness matters.

## vi OPERATIONAL SAFETY MATTERS

The equipment used in this competition is potentially dangerous. Great care should be taken when starting and operating internal combustion engines, starting and adjusting should be carried out by a team member with suitable experience. The aircraft should be restrained for starting and all persons should be behind the line of rotating propellers. The pilot of the aircraft should satisfy himself before flight that all systems are functioning correctly and that all controls have full and free movement as well as operating in the correct sense.

# APPENDIX B

## USEFUL BIBLIOGRAPHY

Aerodynamics and Performance

- Theory of Wing Sections — I.G.Abbott and A.E. Doenhoff
- Airplane Aerodynamics — D.O.Domasch, S.S.Sherby and T.F.Connolly
- Aerodynamics for Engineering Students — E.L.Houghton and N.E.Carruthers

The above references are recommended for general purposes.

Up-to-date information on aerofoils, which are particularly suited to this competition, is available from the research work of Selig, Wortmann, Hollinger and Eppler. See the online database:

http://www.ae.uiuc.edu/m-selig/ads.html

Some initial guidance specific to models may also be given by online resources as follows:

http://www.rrcc.org/download.php

http://www.b2streamlines.com/plotters.html

http://www.winfoil.com

http://adamone.rchomepage.com/index2.htm

Information specific to designing and building model aircraft may also be found in the following publications:

Appendix B cont'd……

Model Aeroplane Building: Sketch by Sketch (Paperback)
by Peter Holland (Author)

- Publisher: Special Interest Model Books; 2Rev Ed edition (31 Dec 1998)
- ISBN-10: 1854861484
- ISBN-13: 978-1854861481

Designing Model Aircraft (Paperback)
by Peter Miller (Author)

- Publisher: Traplet Publications (Aug 1995)
- Language English
- ISBN-10: 0951058967
- ISBN-13: 978-0951058961

Radio Controlled Sports Aircraft from Scratch (Remote Control Handbook) (Paperback)
by Alex Weiss (Author)

- Publisher: Special Interest Model Books (31 Dec 1998)
- ISBN-10: 1854861409
- ISBN-13: 978-1854861405

Building and Flying Radio Controlled Model Aircraft (Radio Control Handbooks) (Paperback)
by David Boddington (Author)

- Publisher: Special Interest Model Books; 3Rev Ed edition (31 Dec 1998)
- ISBN-10: 1854861352
- ISBN-13: 978-1854861351

Basic Aeronautics for Modellers (Paperback)
by Alasdair Sutherland (Author),

- Publisher: Traplet Publications Ltd (Jun 1995)
- ISBN-10: 0951058940
- ISBN-13: 978-0951058947

Model Flight (Paperback)
by Martin Simons (Author)

- Publisher: Special Interest Model Books (31 Dec 1998)
- ISBN-10: 085242938X /ISBN-13: 978-0852429389

**APPENDIX C**

# Entry form for 2012 Heavy Lift Challenge

Note: Please copy this form and complete one form per team entered

Name of university or school:

_____

---

Names of team members:

_____
_____
_____
_____

---

Name and contact address of team manager (to include e-mail addresses and telephone numbers, please):

_____
_____

---

All correspondence relating to the 2012 Challenge will be conducted through the addresses and numbers given on this form.

---

Do you require technical assistance from local aeromodellers? YES/NO

---

Do you require pilots? YES/NO

---

# APPENDIX D:

# ENGINE NOTES.

Eligible engines for the Heavy Lift Challenge are the Irvine Q40 or the standard Irvine 40 (any model).

The British Model Flying Association have undertaken negotiations with Ripmax to supply the Irvine 40ABC R/C MK4 engine at a much reduced price to those teams entering the Heavy Lift Challenge.

These engines are available at a price of £43.40 plus carriage and VAT (RRP £79.99) directly from the BMFA office in Leicester.

For further information or to place an order refer to the contact details earlier in this brochure.

# Appendix E: Heavy Lift Flight Score Chart