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"A Flying Start"

BRITISH MODEL FLYING ASSOCIATION

RADIO CONTROL FLIGHT TRAINING MANUAL

Power/Electric (FW)

2021

Jan 2021

CONTENTS

BMFA
Flight Training Manual

Introduction

If you are reading this as a prospective trainee pilot of flying models, welcome to the challenging hobby of flying model aircraft, gliders, helicopters or multi rotor craft and the various derivatives of them. People come to this hobby for a variety of reasons and whichever reason has motivated you, there is nothing more rewarding that learning a new skill and taking the time to perfect it to a level where you feel confident in your abilities and may even want to undertake the BMFA flying achievement scheme tests, go on to do demonstration flying or competition flying to hone those skills even further. Or, you may just be happy to get your reward from a round of applause from club mates when you pull off the perfect ‘greaser’ landing.

Learning to operate flying models properly is not necessarily going to be easy for everyone. The operation of such craft brings with it both a moral and legal responsibility to operate them in a safe manner, so that they do not endanger people or property.

Hopefully , this training and guidance document will provide you with some helpful guidance, structure and tips on progressing from the ‘just interested’ stage to the competent pilot, able to control a flying model in most, if not all circumstances, including emergency situations such as engine/motor failure etc.

Legal Responsibilities

There are clearly defined legal requirements for the operation of Small Unmanned Aircraft or model aircraft (SUA) from passing a CAA (or BMFA) legal & safety knowledge test before you fly a model, to registering with the CAA as an SUA Operator (can also be done via the BMFA) if you own and intend to operate a model aircraft, then ensuring your operator identity number is attached to your model. There are also restrictions on where you can fly a model and the heights and distances from people, property, vehicles and structures you can operate that model. There is also a legal requirement to operate the model safely e.g. ensuring the model is 'fit for safe flight' and you as the pilot are in a fit state to undertake that flight and the site and weather conditions are suitable.

There are a number of documents that you can study to enhance your knowledge of these legal and safety requirements. The CAA publish an Unmanned Aircraft System code, CAP 722, of which the most relevant parts form the basis of the BMFA’s ‘Article 16 Authorisation’. BMFA members should read the ‘Article 16 Authorisation’ rather than CAP722 as there are differences for non-members. The BMFA Achievement Scheme website also have test guidance videos and the 'A' Test video can help you better understand the pre and post flight checks and flying field communication that are necessary.

What this guidance sets out to achieve

This training/guidance document is primarily aimed at providing support and some structure to would be model pilots who are undertaking flying training and it is hoped that it will assist both the steady progress through the various stages of learning and aid club instructors to provide a reasonably consistent and structured approach to learning the basic and slightly more advanced skills.

The document does not attempt to make you a competent pilot on its own but assumes it will be used by you alongside regular instruction from a flying instructor at your local model flying club or one of the commercial flying training schools.

If you are reading this as a flying instructor, the document does not provide a 'how to do it' guide as it assumes you have a very good level of flying and training competence to have been appointed by your club and to be recognised by the BMFA to be an instructor. What it is hoped this document can do is support you in providing a consistent and structured approach and possibly across different instructors/clubs, so that if a student is being instructed by multiple instructors, or at different clubs/schools they are not confused by totally different approaches to training.

It is recognised that flying training often falls to a few willing volunteers in any club who can have their own flying enjoyment limited by the demands of multiple students to get into the air on a regular basis. The responsibilities of an instructor are significant when you consider they are helping to set the standards and level of competence by which students will spend the rest of their model flying careers operating their models. However, the rewards can be great when those students develop to become responsible club members who take a great joy in operating their models and possibly become future world champions or display pilots. To those of you offering your services to help others learn, **a big thank you** for all that you are and will contribute.

As a student you owe it to your instructor to turn up when you say you are going to, listen carefully to what they have to say and accept that sometimes the weather conditions may not be suitable for flying training. However, when the weather is not so good for flying these circumstances offer an opportunity to learn a bit more about the theory and basic rules for safe operation of models or just to enhance your understanding of aviation and flying in general.

Previous knowledge/experience of trainee

The structure in this document assumes students start with little or no knowledge or experience of flying models or aviation in general. Each module will start with previous knowledge/experience required before embarking on the particular learning contained in the specific module.

If you already have some knowledge/experience or are returning to the hobby after many years absence this will assist you to assess how much time/effort you need to spend revising/enhancing your existing knowledge etc. before embarking on the next module.

We all learn at different rates and some of us find hand eye coordination easier than others. Age also plays a big part in the time it takes to train our brains to control our hands instinctively. Whatever your learning preferences it is important that you try to train regularly (weather and instructor availability permitting) this will ensure a steady progress through the various stages of learning and ensure consolidation of learning from previous sessions, rather than relearning the skills due to a significant time lapse since the last session.

As you progress along your learning journey you will go through the four stages of learning, which hopefully these descriptions will help you to recognise;

a) **Unconscious Incompetent (UI)** - *doing it wrong and you don't know you're doing it wrong*
b) **Conscious Incompetent (CI)** - *doing it wrong, but you know you're doing it wrong*
c) **Conscious Competent (CC)** - *doing it right, but you have to think about it*
d) **Unconscious Competent (UC)** - *doing it right and you don't have to think about it.*

There are a lot of terms used in aviation which have specific meanings and are not always evident, if they have not been properly explained. It is very easy for experienced model flyers/instructors to assume that everyone understands the terms they are using and many forget the confusion and uncertainty they experience when they first heard the terms. DO NOT BE AFRAID TO ASK if you do not understand, gradually you will become aware of the language of aviation and feel all the more confident and included in the hobby as a result.

Theory to complement practical

As much as flying a model is a practical skill to learn, involving good hand eye co-ordination and a level of practice that makes actions (at least partly) instinctive, there is a reasonable amount of theory to learn also.

This theory is important to help understand how and why certain things can happen and more importantly supports the safe operation of models. The theory will also make your enjoyment of the hobby greater and may even enable you to join in the theoretical debates that can occur in many club's flight line pit areas or over the inevitable cup of tea/coffee when some model does not perform quite as expected!

Learning styles

We all have different learning styles and some instructors are more capable than others in supporting the different learning needs of various students. It is important that instructor and student understand each other's needs in this respect and adapt, as best they can, to ensure good communication and good learning progress. If you are finding it difficult to understand what the flying instructor is trying to explain to you, or asking you to do whilst flying, explain this to them and ask for them to explain it in a way that you feel you could understand it a little better. This may be by way of practical demonstration or anecdotes of how I learnt to do this. Never ever feel foolish about asking basic questions, if you do not ask in the early stages how can you expect to build on the basics if they are not there in the first place. Also, do not forget that many experienced model flyers take a great pride in being asked for help and guidance. You will however find as many opinions as people you ask, so just take time to assess who you think is both a competent and responsible flyer and make your own mind up about which opinions to give more weight to.

The learning process

Once you start to undertake flying training you may well feel that an awful lot is happening at once and you may also think you will never be able to get the hang of it. This is because you will have to think relatively fast about the actions you have to take and the instructions to follow. Good instructors will gently introduce you to the various elements of flying a model so that you are not overwhelmed and slowly but surely your actions will become more instinctive and you will have to think less about your actions and the models reaction to your input, leaving you free to be more proactive than reactive.

During these early stages most of the decision making will be done by your instructor(s) and communicated to you but as you progress they will allow you to make more and more of the decisions as you demonstrate your knowledge, experience and judgement.

In the early stages of learning your flight times should be no greater than 10 minutes and your instructor may even give you a short break every five minutes, as your concentration will have been very intense. Fatigue can quickly set in and concentration levels falter if short breaks are not taken.

Instructors should stick to terminology that is unambiguous and as standard as possible, which is especially important in the heat of the moment when things are not always going as planned, (e.g. using the phrase 'Up, Up!' which can be misinterpreted by the student in the early stages as 'push the stick up' having the opposite effect to that intended) .There is also sometimes a tendency for some instructors to take control back a little too early when things are not going so well, rather than talking the student through the recovery process. Whilst the instructor has to make many judgements about the safety of the model/people/property, during the later stages of learning it is important that students get the chance to recover from unusual situations themselves to enhance their learning and positive reactions. Modern day buddy box systems allows an instructor to delay taking control a little longer than in the days when the transmitter had to be handed back to the instructor for recovery.

It is important that you understand the ‘why’ of specific actions and any good instructor will often give you the ‘why’ during pre flight briefing or post flight debriefing, if they do not and an action you have been asked to do does not seem logical or you do not fully understand, ask the question " Why?"

Do not be downhearted if a younger member is making better progress than you, we all learn at different rates and many of the younger people of today have been brought up on a diet of computer games, significantly enhancing their reactions and hand eye coordination. The old adage ‘practice makes perfect ‘ is never more appropriate than in learning to fly but be aware that even the top model flyers, no matter how long they have been flying, are still learning!

A good instructor will provide a pre flight briefing allowing discussion of what it is hoped to achieve during the flight and what their expectation is of you, as a student. This is the time to ensure you really do understand what is expected and to ask for clarification if it is not fully understood.

The use of small hand held models to demonstrate model attitudes and control inputs can be useful in explaining the plans for the flight. Likewise, a post flight debrief is essential to consolidate learning, give explanations why the model did not necessarily react as the student expected and identify any areas that need additional focus on the next flight.

As a student you may well be asked "How do you think that went?" this is your opportunity to give yourself an honest appraisal of what went well and not so well and highlight any areas you feel you are struggling with, so that your instructor can give you any additional tips and guidance to overcome any problems in those areas.

It is well worth keeping a log of your learning objectives, flight by flight, with the instructor adding comments for your own thinking/practice/study between sessions and to assist other instructors who may be asked to step in when your primary instructor is not available *(see example Training Log at Appendix A).*

When learning to fly a model, particularly in the early stages, it is quite normal to fly a model at some height, usually about 200 - 300 ft, often referred to as ‘two mistakes high’. This can lead to difficulties for students in the early stages being unable to judge if the model is climbing or descending during turning manoeuvres, so instructors will often demonstrate the manoeuvre to help the student judge this, as well as giving them tips on making the judgement, such as changes in engine or prop noise or model relative speed as the model dives or climbs.

One of the secrets to making steady progress in your learning is to consolidate what has been learned, so that your next steps are based on solid foundations. You can do this by thinking through the flight and instructors comments, practicing specific elements on a simulator between sessions and accepting sometimes that the instructor is not allowing you to move on as fast as you may wish because he is establishing the consolidation of your learning to make the next stage easier for you. Your instructor may well set you some learning objectives before the next flying session which will aid this, or help you prepare for the next step in your learning. Please try hard to follow through on the suggested study to enable your instructor to keep your progress on track.

It is all too easy to focus in on what is not going so well, however the things that are going well still need to be recognised and practiced to make them more and more instinctive so that spare thinking capacity is available for dealing with the things that are not going so well. This is also a great motivator, as we all get a bit more fired up when we get that sense of achievement from the things that are going well.

Finally, whilst at the flying field do not waste your recovery time between flights, watch the other members flying and use this time to assist you with orientation, recognising climbing or descending turns, communication with other pilots and helpers, pit and flight line etiquette etc. etc.

Simulators

Modern radio control flight simulators are very good and some people have spent many hours teaching themselves some of the basics of flying a model using these, reducing quite considerably the time it has taken to learn to actually control a model in the real world. They are particularly good at overcoming the one thing that catches most people out in the early stages of learning, which is the perceived reversal of wing levelling (roll control) when the model is flying towards you. What simulators do not teach is the safety protocols and the procedures at flying club sites, where many other models can be in the air at the same time. Do not think however, that you can learn to fly on a simulator and go straight to flying a model without supervision, for both safety and practical reasons it is still important to undertake some real world training with a supervising instructor.

Simulator software can be quite expensive (but nowhere near as expensive as crashing a model). Modern day simulators have very good aerodynamic modelling of many commercially available models to help understand the best type of training model for you. If you are undertaking this hobby on a budget then some clubs have arrangements for the use of a simulator on a laptop at the clubhouse, or second hand software is sometimes advertised on the BMFA website classified section.

One of the keys to becoming more instinctive with your flying is to anticipate what a given amount of control input will do to the model and allow your thinking to be a few metres ahead of where the actual model is, simulators can be very useful for helping you to develop this and can also allow you to practice specific elements of your training in between practical flying sessions.

Modular approach

This guidance document has been prepared to support a modular approach to your learning and each module will start with the assumed previous knowledge/learning necessary to make your progress through any particular module easier. This may well be a reference to specific parts of an alternative document, such as the BMFA Handbook and Guidance, for which an up to date version can be readily found on the BMFA Website. It may also be previous learning from this document or further study from internet sources.

Module 1 – Aviation/Aircraft Terminology

Assumed previous knowledge/experience.

Apart from the fact you have a general interest in model aircraft, helicopters or flying models of some sort then this module assumes you have only very limited Aviation/aircraft terminology knowledge. Having a basic understanding will help when it comes to learning to fly, as you will hopefully understand a little better what people are saying to you. It will also help in complying with responsibilities with regard to general safety and full size aviation safety, when operating models.

As with all specialisations they usually come with a whole language associated with them and aviation is no different. Many of the terms used in full size aviation are applicable to model flying. There is much reference material on the Web and on You Tube, so if you want to enhance your knowledge in this area there is plenty of opportunity for study between flying sessions. These are just some of the basics you will need to get started:

Aerodrome Traffic Zone (ATZ) - The ATZ of a notified full size aerodrome at which the length of the longest runway is notified as 1,850 metres or less shall be, the airspace extending from the surface to a height of 2,000 feet above the level of the aerodrome within the area bounded by a circle centred on the notified mid-point of the longest runway and having a radius of 2 nautical miles. Where the ATZ would extend less than 1½ nautical miles beyond the end of any runway at the aerodrome the ATZ shall be that specified below as though the length of the longest runway at the aerodrome were notified as greater than 1,850 metres.

The ATZ of a notified full size aerodrome at which the length of the longest runway is notified as greater than 1,850 metres the airspace extending from the surface to a height of 2,000 feet above the level of the aerodrome within the area bounded by a circle centred on the notified mid-point of the longest runway and having a radius of 2 ½ nautical miles.

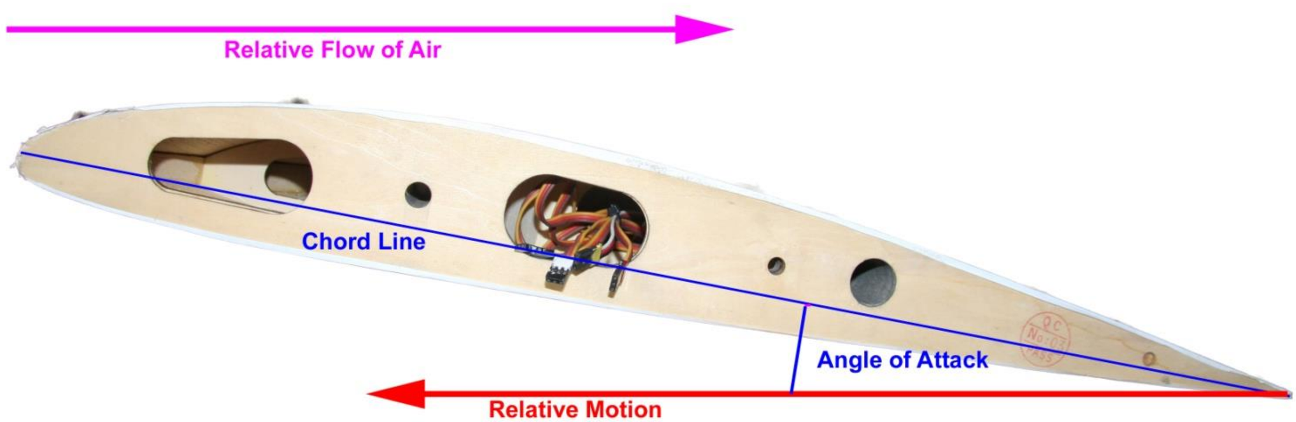
Flight Restriction Zone & Protected Aerodrome - See CAP 722 for definitions

Aircraft parts and primary controls

Note: The effects of the primary controls will be covered in a later module.

Altitude – The distance above a nominal Sea Level, measured in feet in the UK.

Angle of Attack – In aviation, **angle of attack** (**AOA**, or α) is the angle between a reference line on an airfoil (line drawn between the centre of wing leading edge curve and the sharp edge of the wing trailing edge, often called the **Chord Line**) and the vector representing the relative motion between the body (wing) and the air through which it is moving. e.g. Angle of attack is the angle between the body's reference line and the oncoming flow of air.



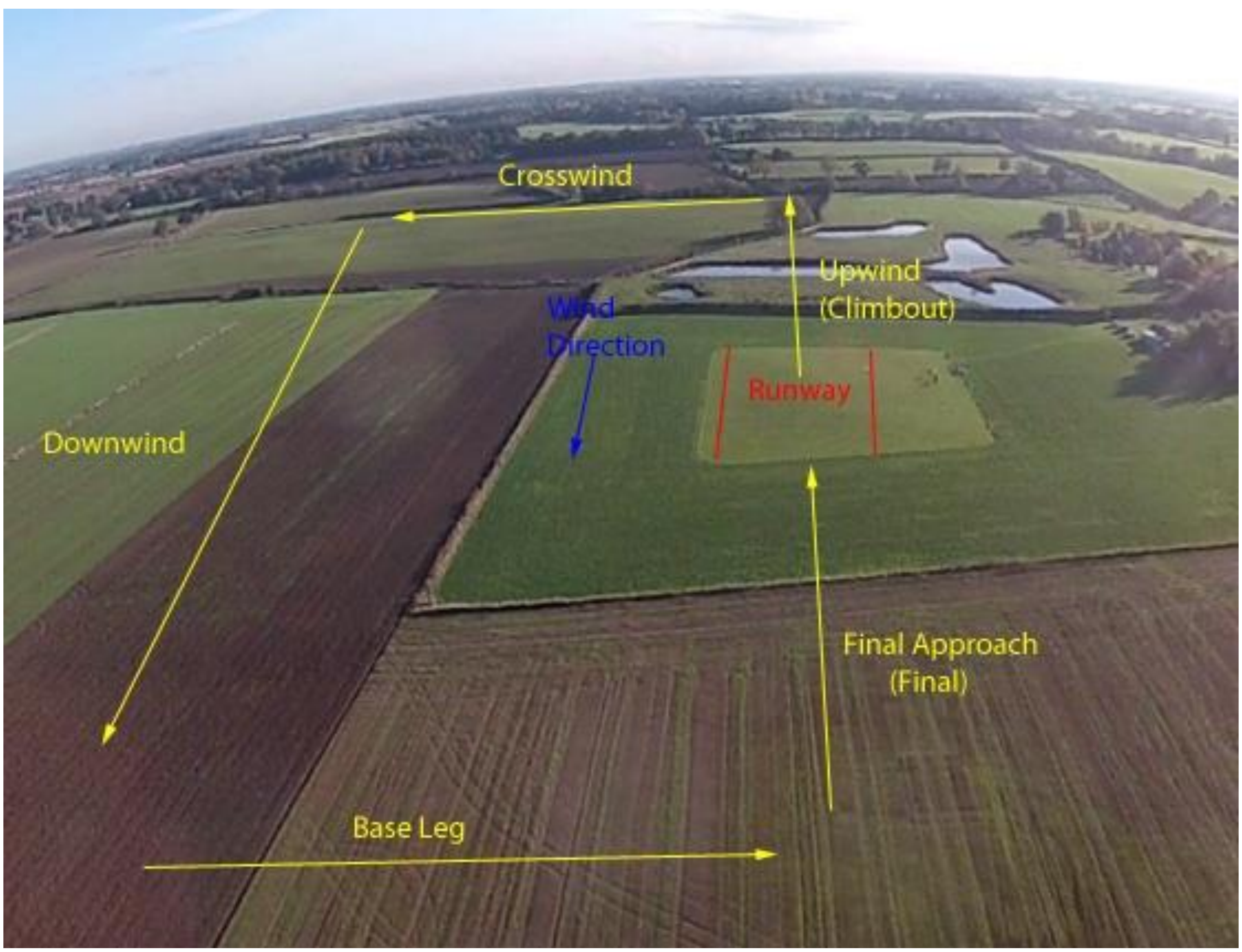
ARTF - *Almost Ready to Fly* this usually means a model that is already constructed and covered but requires some final assembly such as joining wing halves together, fitting tail and control surfaces and installing engine and radio equipment etc. The advantage is that most ARTF models are jig built so that if assembled carefully they should fly reasonably straight and true.

BEC - *Battery Elimination Circuit* this is usually an additional part of the ESC (although can be a separate circuit) to take the relatively high voltage of the electric propulsion motor battery and reduce it to a suitable voltage to power the radio receiver and servos. This eliminates the need to carry a separate battery for the radio receiver and servos, reducing the models weight.

Buddy Box System – This is where two Radio Control Transmitters are linked together, either hard wired or via a radio link, with the instructor having the Master Tx and the student having the Slave Tx this allows the Instructor to hand control to the student or take it back from the student without having to physically hand over a Tx. The Master transmitter can sometimes be set up to only transfer certain selected primary controls to the Slave Tx.

Centre of Gravity (C of G) – The Centre of Gravity of an aircraft is the point over which it would balance. This is particularly critical in the front to back line as the C of G has a major impact on the flight performance of a model and if significantly outside the defined position will make the model unflyable.

Circuit – This is the pattern usually flown when manoeuvring to land but the positions are often referred to in communications between instructors and pilots of models during general flying. Such as when describing where another model is relative to your own, or when a pilot calls the position of his model and his intention to make the model do a particular manoeuvre such as “Final for Touch and Go” etc.



Note: The direction of a circuit may be right or left dependent upon site conditions, no fly areas and wind direction etc. *(A left hand circuit is shown)*

Note: Some flying sites require all models doing general flying (particularly at lower heights) to fly in the circuit direction when multiple models are in the air to minimise the risk of midair collisions.

Control Throw – The total amount of movement (relative to transmitter stick movement) on the controls surfaces of the model or the amount of motor rpm relative to the throttle stick movement/position.

Crosswind – When the wind is not blowing towards the exact direction of take-off or landing causing a model to want to turn towards the wind.

Deadstick - A term called out by a pilot when his/her model's engine or motive power has failed and he/she is committed to land the model.

Dihedral – The upward angle of a fixed-wing aircraft's wings where they meet at the fuselage. The dihedral effect is to make the aircraft more willing to return to the level in the roll axis, however too much can make the model appear to rock left and right with the slightest upset.

ESC - *Electronic Speed Controller* this is the electronics that sit between the radio receiver and motor to convert the radio signal to electrical supply (electrical impulses for brushless motors) to the motor to allow proportional throttle control of the motor.

Fail Safe – If a models receiver goes out of range of the transmitter or is only receiving corrupted signals due to interference for a set period of time the receiver will set the servos and associated controls surfaces to positions preset by the user when setting up the radio system. It is currently a legal requirement for this to mean the throttle moves to low power (motor off - for electric powered aircraft and gliders) so that the model will descend and not fly off. The situation with Multi rotor models fitted with return to home GPS systems may be subject to alternative interpretation of the legal requirement (check the BMFA website for the latest situation on this).

Groundloop – When directional control of a model is lost whilst on the ground (usually during take-off or landing) and the model completes at least a 360 degree horizontal turn.

Height – The distance above Ground Level, measured in feet in the UK.

Knots- Speed measured in nautical miles per hour . (1 Nautical mile = 1852 meters, 1 Statue Mile = 1609 meters) therefore 1 knot is slightly faster (approx 1.15) than 1mph

Overshoot – (correct full size terminology is **Go Around**) When a model approaching to land has power applied and the model climbs away just before touchdown. This may be intentional for training purposes or it may be that the approach and landing is abandoned due to some problem, such as a gust of wind, or an obstruction on the runway etc.

Pitch - A model aircraft in flight is free to rotate in three dimensions: **pitch** is nose up or down about an axis running from wing to wing. *(See also roll and yaw)*.

Pits – The area set aside for the preparation, checking and maintenance of models for flight.

Roll - A model aircraft in flight is free to rotate in three dimensions: **roll** is rotation left or right about an axis running from nose to tail. *(See also pitch and yaw).*

RTF - *Ready to Fly,* as above, but the final assembly and motor/radio equipment installation are already completed, the model will usually just require the radio equipment being set up and batteries charging before flight.

Runway or **Flying Strip** – this is the area set aside for the safe take-off and landing of aircraft.

Rx – Radio Receiver

Stall – A condition in aerodynamics and aviation where the angle of attack (see above) of a wing increases beyond a certain point such that the lift begins to decrease. The angle at which this occurs is called the critical angle of attack.

Tail Dragger – This is a type of aircraft undercarriage, or landing gear, arranged so that the main wheels are slightly ahead of the centre of gravity and a small wheel or skid at the rear of the fuselage, often just below the fin/rudder.

Thermal - Thermals are areas of air which, because they are warmer than the surrounding air, are actually rising. If a model or more specifically a glider is passing through air which is rising faster than the glider is descending then the model will actually climb on the glide. So long, that is, as the model stays within this thermal

Thermal turn - The normal manoeuvre used to keep the model in an area of rising air is the thermal turn. This is basically a series of continuous 360 degree turns in either direction, left or right. If this manoeuvre is correctly performed then the model will fly at constant speed in a gentle turn and will gradually drift along in the direction of any wind. If the model is within a thermal it will gradually climb. If it is not then it will descend steadily.

Touch and Go - To land a model and quickly apply power to speed up the landing/takeoff roll and get the model airborne again, without stopping the model.

Tricycle Undercarriage – This is a type of aircraft undercarriage, or landing gear, arranged in a tricycle fashion. The tricycle arrangement has one wheel in the front, called the nose wheel, and two or more main wheels slightly behind the centre of gravity.

Tx – Radio Transmitter

Yaw - A model aircraft in flight is free to rotate in three dimensions: **yaw** is turning left or right of a model (wings remaining level) around a vertical axis through the centre of the model. *(See also pitch and roll).*

Module 2 - Basics of Radio Control Systems, Limitations and Procedures.

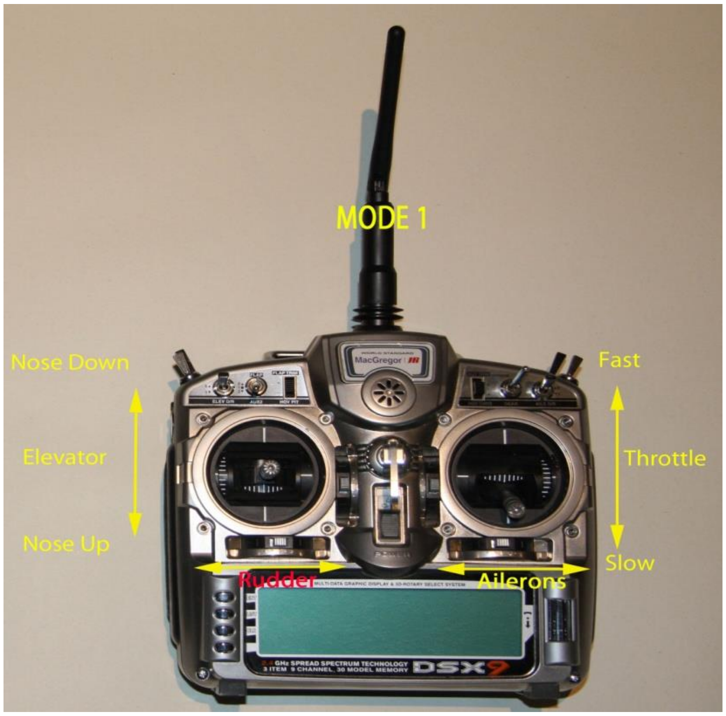
Assumed previous knowledge/experience.
A basic understanding of aircraft control system terminology

Before you rush out and buy yourself a shiny new set of radio control equipment, check with your local club and see what the more experienced members use. From a quality point of view there is little to choose between all the sets that are available, although be aware there have been some cheap copies/clones of established manufacturers equipment, which have not always used the same quality components. Modern R/C equipment is reliable and good value, whichever make you choose, although in terms of facilities offered by a set, you do tend to get what you pay for. By this we mean that the more expensive sets offer increased channels, mixing facilities, computer control, failsafe, telemetry etc.

You may well ask what facilities do I need? Whilst it is quite possible to learn to fly with fewer channels, we would recommend that, as a minimum a 5 or 6 channel set (to control at least elevator, throttle, rudder and aileron) is purchased. You can learn to fly on a 4 channel set but you may find that such a set is difficult to buy these days and a 5, 6 or more channel set will give you more options in the future.

Another key choice is the transmitter Mode *(which controls are on which control sticks)*, once again your local club would be able to help you identify the best for you, as it is sometimes better to choose the one that the majority of the club members use.

MODE 1, (sometimes called ‘throttle right’) the right-hand stick controls the throttle and ailerons (or rudder when only 3 functions are in use) and the left-hand stick operates the elevator and rudder (or elevator alone when 3 functions are used). This mode is used less today than in the early days or radio control.



MODE 2, (sometimes called 'throttle left') the right-hand stick controls the elevator and ailerons (or rudder when only 3 functions are in use) and the left-hand stick operates the throttle and rudder (or throttle alone when 3 functions are used). This is the mode used by the majority of model flyers.

There are two other modes for transmitter layout called 3 & 4 but as these are very rarely used and are only available from most suppliers to special order we will not go into the detail here.

There are a number of different frequency bands allocated in the UK for control of models, however not all of them are suitable, or legal, for the control of flying models. The two main frequency bands used in the UK for model flying are 35MHz (34.945 to 35.305MHz = 36 channels) and 2.4 GHz frequency (2.400 to 2.4835GHz).

The 35MHz frequency is a UK only frequency and reserved for airborne models only. It is the frequency that has been in use for a number of years but is beginning to be overtaken by more recent 2.4GHz equipment. There is often relatively cheap second hand 35 MHz equipment available as many model pilots continue to upgrade to 2.4GHz equipment.

35 MHz radio control is still in use by quite a few model flyers and can provide a good reliable radio link with the model, if used correctly and with good discipline by all. There are however, some limitations when compared to the more modern 2.4 GHz radio control equipment and the various technological developments in this particular field of radio control.

35MHz transmitters and receivers operate on one of the fixed (narrow band) channels allocated within the frequency band. If someone else within range transmits on the same frequency (channel) by mistake complete control of the model can be lost, with disastrous results, often referred to by model flyers as ‘being shot down’. For this reason all clubs will operate a 35MHz channel control system many of which use a peg to indicate when the channel is occupied and only the person having been allocated the channel can switch on their transmitter. Not all clubs use the same system, in the same way, so it is important to get a thorough briefing on how the system works at the site(s) where you intend to fly and then discipline yourself to use it properly every time.

There are principally two types of signal modulation for 35MHz transmitters Pulse Position Modulation - PPM and Pulse Code Modulation - PCM (many transmitters are switchable between the two dependent upon the receiver used).

Another limitation of 35MHz (and some 2.4 GHz) equipment is that if multiple models are set up on a computer based transmitter and an incorrect model is selected on the transmitter the receiver will still operate but the controls may not operate in the correct direction, which can lead to a crashed model if pre flight checks are not properly conducted.

35 MHz transmitters should show an Orange flag/ribbon attached to the antenna with the channel number. When using a 35MHz transmitter for flying it is important that the antenna is fully extend and should not be point directly at the model as the signal is radiated from the side of the antenna and pointing it directly at the model gives the minimum radiated energy to the receiver, potentially reducing the range and control link reliability.

2.4 GHz radio control equipment uses a spread spectrum (**Direct Sequence Spread Spectrum - DSSS**). or channel hopping **(Frequency Hopping Spread Spectrum - FHSS**) techniques to avoid interference with each other and any other 2.4 GHz transmissions present. The main idea behind spread spectrum is to spread the radio transmission out over a wider range of the radio spectrum. This makes a spread spectrum signals much less likely to run into interference or jamming that could occur with narrow band radio transmissions.

With many spread spectrum radios all transmitting at the same time they are very unlikely to interfere with each other as the spread of radio signals are random, changing, or coded. In most cases any signal conflict happens for such a brief moment, the receiver does not appear to notice it.

This removes the need for transmitter control systems for 2.4 GHz transmitters at club sites as it means that multiple transmitters can be switched on at the same time and they will find enough suitably clear paths for the signal to get to the receiver to ensure the signal gets through without corruption. Different manufacturers use additional techniques to enhance the signal and data reliability.

Because of the propagation properties of radio signals at such high frequencies, another requirement of such systems is diversity. Diversity is required because the radio signals at 2.4GHz behave quite differently to those used on lower narrow band frequencies, such as 35MHz.

Whereas the narrowband frequencies will pass right through most objects such as trees, fences etc. 2.4GHz propagates much more like light, being either absorbed or reflected by some objects in the environment.

The absorbing and reflecting of the 2.4GHz signal results in occasions when the receiver antenna may be shielded by parts of the model, or may be subject to the arrival of multiple reflected signals at slightly different times due to the varying distances travelled, this is called multi-pathing. The effects of shielding and/or multi-pathing mean that it is quite possible the receiver will be unable to receive the transmitter signal clear enough to extract the data being sent. The solution to this problem is to use more than one antenna and/or more than one receiver in the model. Mounting of these antennas or receivers in different places in the model allows the processor that is part of the receiver system to continuously identify the best and cleanest signal from which to extract the data.

2.4 GHz systems also have failsafe systems as standard and many have coding systems that ensure the receiver can be 'bound' *(when the Tx and Rx identify themselves to each other)* to the transmitter, which will store the receiver identity and will transmit the identity code with every stream of data so that the Rx will only respond to uncorrupted signals from that specific transmitter. Another benefit of the two way signals possible between the Tx & Rx allows the addition of telemetry data from the model to the transmitter. This can be extremely useful for things like monitoring battery voltage on electrically powered models, significantly reducing the risk of over discharging batteries and damaging them.

There are other frequencies available for model use such as 27MHz and 459MHz on the UHF band but there are very few sets available and since it is unlikely to be your first choice, we will not refer to these bands in detail. However, **beware** of 40 MHz transmitters that look like model flying equipment. There are still some about and you may be sold one but they are **ILLEGAL** for model flying.

Virtually all modern radio control systems are capable of operating in a Buddy Box configuration usually being hard wired together via plug in leads but the two way communication possible with some 2.4 GHz systems allows wireless linking of the transmitters.

Most modern radio control systems have multiple set up options including the ability to set different (Tx selectable) servo travel relative to control stick positions and exponential movement of servos (Tx selectable) relative to control stick position, along with servo reversing, servo speed and sequencing, channel mixing etc. Each manufacturer provide different set up screens on their transmitters and some even use different setting parameters. Although your radio equipment will come with comprehensive instructions about setting up your transmitter/receiver it is important to get help understanding how to do this from someone who understands your particular equipment as the systems can be quite complicated and any mistakes can be both dangerous and costly. As with all facilities on modern equipment you may never use many of the facilities available but it is important over time to learn the basics.

One final point about radio control systems. Traditionally, radio systems were designed to use nominal 4.8volt batteries for the airborne system e.g. the receiver and servos. Some aero modellers building larger models started to use 6 volt battery systems to ensure that the higher current drawn by the servos did not cause the voltage to drop to dangerous levels, which is especially important with micro processor receivers *(which may shut down and reboot if the voltage drops below a certain point momentarily)* as most modern 2.4 GHz receivers are. However, some manufacturer's receivers and servos were not happy operating at these voltages and when fully charged a 6 volt battery could produce more than 7 volts causing electronic circuits to fail. The advent of Lithium Polymer batteries, which have a nominal cell voltage of 3.7 volts and fully charged can be 4.2 volts, plus two cells are required *(to ensure minimum voltages are not reached for the micro processor based receivers)* so the voltage can be as high as 8.4 volts. Many manufacturers have now developed electronic circuits for receivers and servos that can cope with these voltages and these are usually designated by HV in the servo type designator.

Module 3 - Selection of a Suitable Model and Equipment

Assumed previous knowledge/experience.
A basic understanding of aviation/aircraft terminology and of the types of radio control systems available.

The choice of suitable training aircraft is wide to say the least. Some are more suitable than others: a few are excellent.... but some are poor. In the early stages of learning you will probably be flying quite high 200-300ft so too small a model will be difficult to see and judge attitude. The ideal trainer is a high wing aircraft of around 1.4 (55") to 1.53 mtrs (60") wingspan or a high wing electric gilder of around 1.53 (60") to 2mtr (approx 79") wingspan. The high wing makes it very stable so that it is easy to fly and the reasonably-sized wingspan means that it can be seen clearly at a fair distance. It should be of simple construction, yet robust since it will have to withstand some rough handling. It is, perhaps, best if it has a tricycle undercarriage for easy ground handling and straightforward landings. The exception being for a glider which will almost certainly have no undercarriage being intended for hand launching and landing on grass using the fuselage underside. The wings may be held on by rubber bands or breakable nylon bolts to enhance its crash-proof qualities. The model may be designed for 3 functions (throttle, elevator and rudder) or may have ailerons in addition. Whilst you can learn equally well, whichever type is selected, aileron equipped models can be a little easier in windy conditions. Finally, and importantly, it should not be too heavy and be relatively inexpensive!

To some extent, your choice depends on whether you wish to build it yourself, complete an 'Almost Ready to Fly' (ARTF) part-built aircraft or simply buy an aircraft already completed. Building the aircraft yourself from a kit or plan is good if you have already had some experience of model construction or if you have experienced help readily available. There are now an excellent range of very reasonably priced ARTF trainers available and many can be sourced from your local model shop where you will get the opportunity to look at the model and assess is suitability of construction etc.

Each club will have its own ideas on a suitable trainer and you should look around on the flying field and seek advice from one or more of the senior club members. Some clubs and most flying training schools have dedicated training models, which they will allow new members to learn the basics on, provided it is flown under dual (buddybox) control. If this is the case it may be worth your while delaying the purchase of your own training model until you have had some experience of flying and watched other models perform.

Also seek help and advice with the building and/or fitting out of your model as there are a host of little tips and tricks that experienced modellers have acquired to ensure a successful *(and importantly safe)* flying model.

THE ENGINE OR POWER SYSTEM

Whatever aircraft you buy, make sure that your intended engine or increasingly now electric motor will provide adequate power to fly it. There is nothing more disappointing than to present yourself at the flying field with an aircraft upon which you have lavished hours of loving care only to find that it won't get off the ground at full power. Have power in reserve; it will be there when you need it and you can always throttle back when you don't. For virtually all commercial training aircraft a range of engine/electric motor sizes are recommended and it will pay to go for the largest engine/electric motor size recommended for your aircraft. There is a bonus in choosing a largish engine/electric motor in that it will be suitable to power more advanced aircraft when the time comes.

Virtually all club flying sites have noise limitations, as model aircraft are referenced in the Noise Pollution Act *(see BMFA website for noise limit guidance)* plus they may have noise sensitive areas close by their flying site. Your model will have to comply, take advice from club members and make sure that the silencing and propeller choice arrangements on your model are adequate. Some manufacturer's silencers are very good but some are not and you may need to do extra work to meet the club noise levels. Any electric model should have no difficulty with this but you should still have your model checked. Most clubs have members that have learned through experience with various engine, airframe, propeller combinations what works best.

There are many different types of internal combustion engines available now, powered either by Methanol (Glow Fuel) or Petrol and both are available as two stroke or four stroke engines. Once again talk to your local club about which would be most suitable for the type of model and the noise limitations for the site you will be flying from.

New internal combustion engines may need running in before they can be run at full power if you have no experience with model internal combustion engines it is worth doing this at your club flying site so that club members/instructors can show you the safe and proper way to undertake this and you can gain experience and confidence in starting and setting the engine before attempting to learn to fly.

This aspect of electric powered aircraft and gliders needs careful consideration. If you have had some previous experience of IC powered models there are some aspects of electric flight which need additional care. If an IC motor stops running it will remain so until it is deliberately re-started by the modeller. An electric motor can burst into life anytime it is supplied with electrical power.

You should always treat an electric model (or an electric power train if you are bench testing) as if it were about to burst into full power. Keep the propeller clear of all loose objects and particularly clear of yourself and other persons. *Propellers and rotor blades should be removed for any indoor testing.*

A folded propeller on an electric motor does not look dangerous, but if it is connected to the flight battery then in a fraction of a second it can open and begin to spin at several thousand revolutions per minute. It can inflict severe damage to you and others. In spite of safety controls such as fuses, cut-outs, arming switches and procedures, any fault which occurs can result in full power being applied. **The number one safety rule** in all electric flying is that the only time an electric motor can be considered safe is when it is not connected to a battery pack.

PROPELLER

You will also need a suitable propeller (and some spares). The instructions with the engine or electric motor will provide size guidance in both a diameter and pitch. The propeller for an internal combustion engine should normally be of glass-filled nylon for strength and safety. Electric Motors usually use propellers that are specifically designed for use on electric motors and electric motors tend to be more specific in diameter and pitch choices as overloading the motor can cause overheating and burnout. Whilst it is possible to use a propeller designed for an internal combustion engine on an electric motor, a propeller designed for an electric motor should NEVER be used on an internal combustion engine. However, noise considerations will almost certainly play a part in your eventual choice as prop noise is a significant part of the overall noise your model makes and you may have to use a slightly different diameter and pitch to meet the required club noise levels. Again, take advice from club members before you commit yourself to buying your stock of propellers.

By the way, when referring to propeller sizes the first number refers to the diameter of the propeller in inches or millimetres and second is the pitch, or distance it theoretically moves forward in one revolution. When you buy your propellers, clean off the ‘flash’ on the edges with fine sandpaper and get the propeller balanced - a club member will do this for you or show you how. Balancing is essential and you should never fly with an unbalanced propeller.

FUEL

Methanol based fuel can sometimes be purchased through your local club but more often your model shop will meet your requirements. The fuel you will most probably need is either ‘straight’ or ‘5%’. ‘Straight’ denotes a mixture of around 80% methanol and 20% oil (slightly lower oil content for four stroke engines) and ‘5%’ denotes that 5% of Nitro methane has been added for higher performance and easier starting. The oil content can be either castor oil, a synthetic blend or a mixture of both although most commercially available fuels now use mostly synthetic oils. Refer to your engine’s instruction leaflet for guidance on which to choose and if you don’t have it then ask an experienced club member for advice. Just bear in mind that high Nitro methane content can add quite a bit of cost to the fuel.

Fuel Safety - As well as being highly flammable, requiring careful handling of batteries and other potential ignition sources in close proximity, fuels and oils are also toxic substances. Methanol in particular accumulates in the human body if ingested or too much long term exposure to the skin or significant inhalation is experienced. Swallowing as little as 50 mL of methanol or less than ¼ cup can be fatal. Therefore treat the fuel with care, wipe off skin exposure quickly and seek immediate medical assistance if splashed in eyes, inhaled or swallowed.

BATTERY

The ‘fuel’ for an electric motor is a battery and developments in battery technology along with the advent of outrunner brushless motors has revolutionised powering of flying models. You are recommended to have at least two battery packs to save time recharging between flights on the flying field. The current main choice of battery to power a model is Lithium Polymer or LiPo as they are usually called. These are often chosen above other battery technologies because they have a high power density, which is ideal for flying models as weight can be an issue with batteries. However, LiPo batteries can be **VERY** dangerous if not handled, charged and discharged with great care. The BMFA have produced a separate guidance document *'Lithium Polymer Battery Safety Booklet' (available on the BMFA website to download)* on the use of LiPo batteries and it is highly recommended that you read this before even buying a LiPo battery.

FPV (First Person View)

The inclusion of a camera on any model changes the legal requirements for safe operation whether used in First Person View mode or not. The operation of any model in FPV mode also legally requires a competent observer/safety pilot who, dependent upon the weight of the model (>3.5kg), may also have to be the pilot in command via a buddy box system (the master Tx).

Stabilisation/Control Systems

One of the significant developments in model flying in recent years is the advent of electronic stabilisation. The early simple electro mechanical or electronic gyros used in model helicopter flying, usually for making the tail rotor/yaw control a little less skittish and more controllable has now developed into full 3/4 axis stabilisation, especially since the reduction in the cost of MEMs (Micro Electromechanical System) sensors. The stabilisation technology has also advanced with the advent of on board computers and more sophisticated software algorithms, which now enable interactions between control, through the transmitter and the onboard stabilisation, to the point where some model systems have ‘Panic Recovery’ for returning a model to straight and level flight or ‘Geofencing’ sometimes in conjunction with onboard GPS, which prevents the model flying too far away from the transmitter or entering airspace that it is not permitted to fly in (e.g. restricted full size aviation airspace). The ultimate incarnation of stabilisation and computer control is the fully autonomous operation from take off to landing of some types of model particularly multi rotor models (often referred to as 'Drones', although technically all remote control model aircraft are Drones).

Whilst various forms of electronic stabilisation (as distinct from aerodynamic/gyroscopic stabilisation, e.g. wing dihedral/helicopter flybar) can be useful in the very early stages of learning to fly any sort of model aircraft, in the longer term it does not always aid the development of the instinctive reactions necessary to become a fully competent model pilot able to go onto flying various size/model types.

Unless a model type is inherently unstable like most helicopters and virtually all multi rotors then artificial/electronic stabilisation would not normally be necessary. However there are increasingly available radio systems with stabilisation built into receivers, which with careful use can make a model feel more 'locked in' or be flown in windy/ turbulent conditions when normal pilot abilities would potentially put the model at risk. Many of the small foam scale models now widely available as RTF models have simple 3 axis electronic stabilisation systems in them, which makes them more flyable at such small scales. At the other end of the spectrum the model jet fraternity are increasingly using 3 axis stabilisation systems (particularly in scale jets) that can be automatically varied in sensitivity dependent upon speed (usually via GPS sensing) to accommodate the wide speed range and resulting variation of control surface effectiveness/sensitivity.

It has been the rapid growth in multi rotor models and the development of their stabilisation control systems that is now spreading out into other areas of model flying. However, the challenge for the beginner is that these systems take a significant amount of knowledge and experience to set up correctly and each manufacturers system can have different processes and systems to achieve this. In the unfortunate event of getting something wrong (like gyro rate/corrective action being set opposite to that required) it can make a model unflyable, even for a very experienced pilot, usually resulting in demise of the model.

The **failsafe** modes when using stabilisation/flight control systems also become more critical and complex as the options/set up requirements can increase. They can be anything from reduce or shut off power so that the model descends (or plummets with some rotary wing models) to the ground, through to fully autonomous return to 'Home' and gently land. Once again there are numerous careful considerations when selecting mode, setting up and arming these systems. An example being 'Home' is usually where the GPS system was last armed (switched on) and locked onto sufficient number of satellites, which if not properly conducted and checked at the start of each flight, in a safe landing location, could be where the systems was previously successfully armed/switched on and/or locked onto a sufficient number of satellites (your or the manufacturers workshop?)!

The advent of out of the box multi rotor/helicopter and some fixed wing models, often sold through non modelling suppliers, means that little knowledge can be necessary to set up and fly such models. However, that lack of knowledge can lead to issues of safety/non legal operation and problems with things like failsafe mode setup and operation.

The various stabilisation/control system modes (and name/acronym for modes) can vary from one manufacturer to another and as the technology and software develops further more will undoubtedly appear. However, a brief description of some of the modes employed in many multi rotor (and some helicopter) systems are available in the multi rotor guidance in the BMFA Handbook. There is also a BMFA video available on You Tube which hopefully helps to explain these in practical terms. https://www.youtube.com/watch?v=yqo2u8FexdI

SUPPORT EQUIPMENT

This term covers the essential equipment you need to get your aircraft into the air on the flying field. The basics that you will need will include:

a) Some form of restraint for the model to enable safe starting of engines or connection of batteries.
b) For internal combustion engines a fuel bottle/container and pump either hand or electric as you also need a means to get your fuel from the container into the aircraft's tank. At a push a squeezy bottle will do, with a length of suitable tubing to squeeze the fuel into the tank.
c) For glow fuel (Methanol) powered engines a 2-volt rechargeable battery or a 12-volt battery and power panel to provide 2 –volt power to operate the engine glow-plug, together with a suitable charger and a glow-plug lead and clip. Spare glow plugs are also useful. With a 12 volt battery it is also possible to use an electric starter, which is usually pushed onto the spinner or propeller to turn the engine for starting. If an electric starter is not available use a 'Chicken Finger' *(a plastic/rubber finger protector to avoid cutting your finger when flick-starting your engine)*
d) For electric motor powered aircraft and gliders you will require suitable batteries to power the motor and an intelligent charger designed for the type of battery you are using. It is often worth buying two or three batteries for the model, along with a separate charging battery, which can avoid flattening your car battery. This should be a good capacity 12 volt lead acid battery and it is recommended that you obtain one classified for "Leisure" use rather than a standard car battery. The capacity should be 50 ampere hours or above and it should have terminal posts which allow bulldog clips to be fitted. Also a small voltmeter to check cell voltages and circuits (voltmeters designed to check individual cell voltages on LiPo batteries are readily available and relatively cheap).
e) Tools - small and medium screwdrivers, plain and cross-point, spanners for the propeller nut (and the glow-plug/spark plug on i/c powered models), plus
f) Spare propellers to suit your models power system.
g) Some rags or kitchen towel roll to wipe down the model after flying. A spray bottle of soapy water will help here too.

h) If using 35 MHz radio equipment the appropriate frequency marker (your club will advise you on this) for your Tx.
i) Something to hold all the tools, fuel, batteries, spares etc.

BATTERY CHARGING

Before you take your aircraft to the flying field you must ensure that your transmitter and receiver batteries are fully charged.

Your radio gear instruction booklet will give you all the information on connecting up your batteries for charging and you should follow this advice meticulously. If your radio batteries are Nickel Metal Hydride or similar battery, then the day before you intend to use the radio for the first time, give both batteries a full 18 hours on charge. If, as most people, you only fly at the weekend, give your batteries a full overnight charge (10 to 12 hours) before you fly. As a fairly broad 'rule of thumb', every 20 minutes of 'switch-on' time requires 1 - 2 hours of charging time *(dependent upon charger output)* to top up the batteries. So if you have, say, four flights in a day you will need to charge for at least 4 - 8 hours before your next day's flying.

Even if you do not fly at all, the batteries will still discharge slowly when not in use. The batteries will require 15 - 30 minutes charging time for every day out of use. Therefore, if you do not use your radio gear for a week, it will need a minimum of 30 minutes x 7 days = $3^1/_2$ hours of charging time *(for low current e.g. 60MaH output chargers)* to bring them back to full charge provided that they started the week fully charged. If you had a flying session before the week of non-use, then you should give the equipment a full overnight charge of 10 to 12 hours.

In the unlikely event, you have dry cell torch batteries in your radio gear you should begin each flying session (say a weekend) with fresh batteries. The main danger with using dry cells is that you never know how much power is left in them and a power failure in the air can only lead to disaster. Radio control equipment with rechargeable batteries are a much better choice from the beginning.

Module 4 - Legal and Moral Obligations

Assumed previous knowledge/experience.
A basic understanding of aviation/aircraft terminology and of the types of radio control systems available. You have identified and joined a local model club and have established the type model you wish to learn to fly.

BMFA Handbook

The BMFA has produced a Handbook and Guidance document that sets out the best practice for the preparation and operation of model aircraft. This is an important document to study before attempting to fly a model. Although some of the content of the BMFA Handbook is covered in this flight training manual it is just enough to get you started and the Handbook should be studied in detail.

Insurance

You will require third party insurance before attempting to operate your model. If you have joined the BMFA (via a BMFA affiliated club or directly as a country member) then your membership will provide you with third party insurance, provided you operate your model responsibly.

Air Navigation Order & CAP 722

The UK Civil Aviation Authority is the body responsible for formally regulating all aviation in the UK and dependencies, although much of the regulatory preparation and decision making has been gradually moving to the European Aviation Safety Authority (EASA). There are legal obligations under the Air Navigation Order for model aircraft and these have been summarised in Civil Aviation Publications such as the Drone and Model Aircraft Code, CAP 722 which can be found by searching the internet and do not forget the DMARES Regulations for registering as an SUA operator and completing a pilot knowledge test. For members of the BMFA and few other organisations there are less restrictive regulations under what is known as the "Article 16 Authorisation". These are essential reading before you purchase or operate your model.

Safety Codes and Management

Most model flying clubs will have some sort of safety & environmental management system in place. These usually manifest themselves in the form of club rules i.e. no fly areas, location of pits and pilots during flying, flying time limitations, number of models in the air at once etc. Whilst many of these will be explained to you by your instructor and/or other club members it is important that you establish what all the rules are for yourself, so that you do not inadvertently break any of them. A guide to the sort of things such rules will include are contained in **Module 6.**

Considerations for other flyers/members/public etc

Whilst the safety of others should be common sense, there are some issues that impact safety without you fully realising it, an example may be running an engine at full power on the ground for long periods of time close to where pilots are flying their models, making it difficult for them to hear their own engines etc. Also, some flying sites have issues with public access creating additional lookout requirements so that pilots are warned if members of the public inadvertently wander onto runway/landing strips etc. The general rule is to ask before doing anything that will affect pilots that are flying models. You must also communicate with fellow pilots, as you are flying, stating your intentions such as “downwind to land” and listening to any responses in case someone has a higher priority need, such as they have had an engine failure or someone is collecting a disabled model from the landing strip.

Keeping Up to Date with Legislation

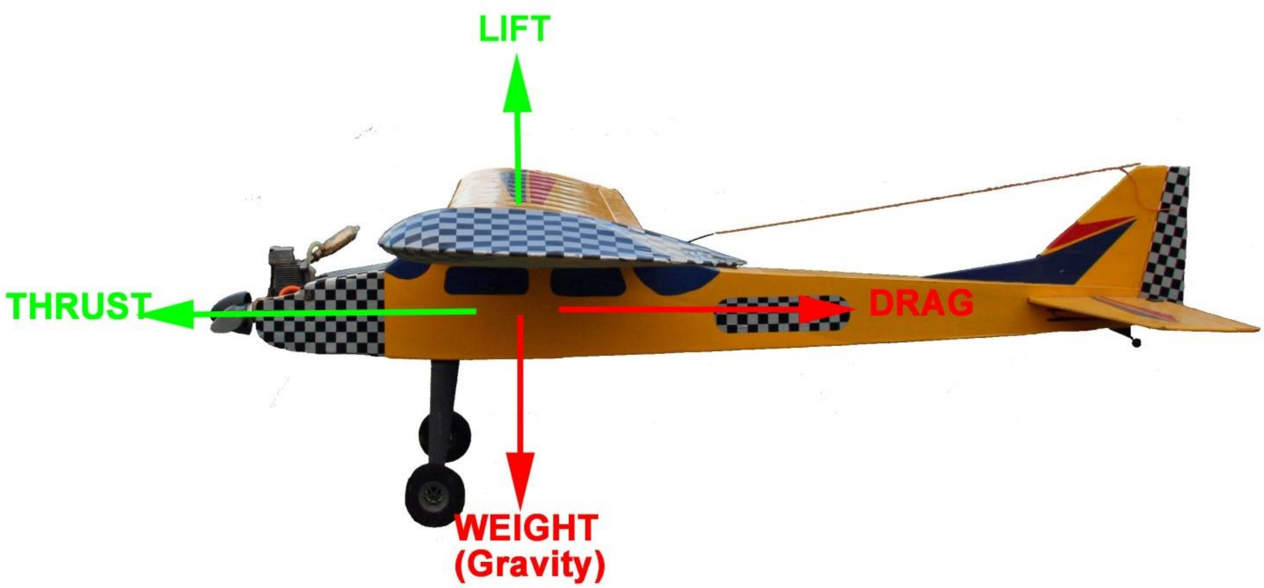
With the ever increasing publicity around 'drone' incidents, legislation is going through a series of changes to attempt to control the 'risk'. Whilst many of these changes are specifically aimed at lone multi rotor operators, or the illegal use of multi rotor aircraft the legislation inevitably does affect our own model aircraft operations as they fall within the legal definition of a Small Unmanned Aircraft (SUA), which covers most of the various forms of model aircraft, helicopter and multi rotor or 'drone' models, although thankfully Authorisations or exemptions are often given for members of model associations, such as BMFA, due to the good safety record achieved to date. It is important that you keep up to date on any legal changes and validity of any exemptions or Authorisations issued by the CAA, that may affect the operation of your model. These will be publicised on the CAA or BMFA websites, as well as being discussed on various social media platforms. Once again discussion with your instructor will help you to understand any changes that are being proposed, or have occurred.

Module 5 - Principles of Flight & What The Controls Do

Assumed previous knowledge/experience.
A basic understanding of aviation/aircraft terminology and of the types of radio control systems available. You have identified and joined a local model club and have established the type model you wish to learn to fly. Importantly you have studied the BMFA Handbook, the "Article 16 Authorisation" issued to the BMFA by the CAA, and are aware of your local flying club rules.

There are four key forces acting on a model aircraft: **Thrust** which is pulling the aircraft through the air but the air flowing over and around the aircraft creates **Drag** trying to stop it moving forward. As long as the thrust is greater than the drag the model will move forward. The more thrust compared to drag the faster it will move.

Secondly, the air flowing over and around the wing will create **Lift**, which must be greater than the **Weight** for the aircraft to fly. The faster the wing moves through the air, the greater the lift created and the more the aircraft will climb. Likewise if the wing is moving too slowly then the weight will exceed the lift and the model will start to descend.



How Lift is Created -

How lift is created can be a little complicated and does not easily stand up to over simplification. However, the following explanation has been kindly provided by Prof. Ian Poll of Cranfield University, with additional explanation from Bob Ellis.

How does a wing create lift?

Consider an aircraft flying at constant speed in straight and level flight with the wing at a fixed angle of attack (*see Module 1*). As it moves, the inclined wing surface continuously deflects air downwards, i.e. at right angles to the direction of flight. According to Newton's Second Law of Motion, and by common experience, this downward deflection requires the application of a continuous force. This force is largely provided by the weight of the aircraft. According to Newton's Third Law of Motion, action and reaction are equal and opposite and so the air must exert a corresponding continuous force on the aircraft that acts in the opposite direction to the weight. It is this force that is known as the "aerodynamic lift".

However, we can deduce that, for a wing at fixed angle of attack, the lift force will increase as the flight speed increases. Also at a fixed speed, the lift increases as the aerofoil camber increases and, for a wing of fixed camber, the lift force will increase as the angle attack increases. This is provided that stalling does not occur. The aerofoil thickness distribution makes only a minor contribution to lift generation.

So just to reiterate: Newton's Third Law – for every action there is an equal and opposite reaction.

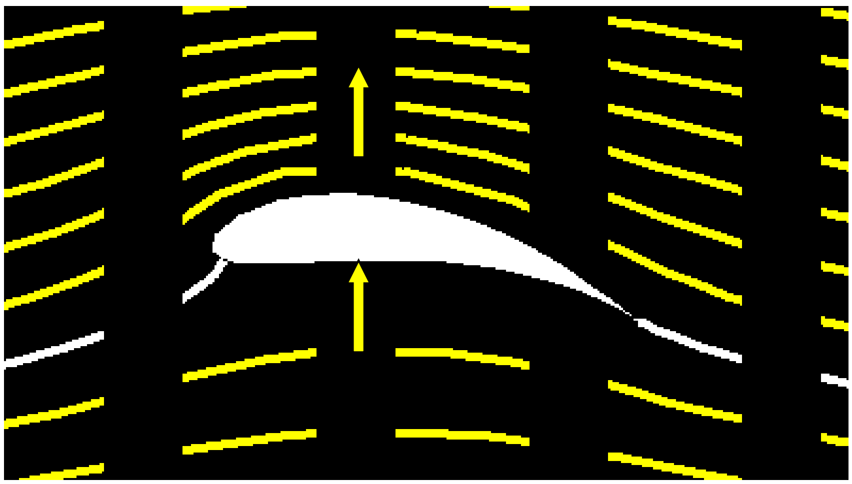
A wing is simply a non-rotating propeller/rotor/fan and due to its camber and/or angle of attack it turns the direction of the airflow, with lift being in the opposing direction to that flow. In the kitchen experiment photos below you will see the flow attach to the spoon, this is called the Coanda effect, but in this experiment the flow is turned due to the aerofoil (camber) shape of the spoon; more importantly by holding the spoon lightly you will feel it move into the water flow (in the direction of the Yellow arrow) - the opposing force of turning the flow."

See this practical experiment using a tap and a teaspoon that shows this clearly:

Using the same principle the upper camber on the top surface of the wing imparts a downward motion of the flow of air that continues after the training edge.

In a symmetrical aerofoil the flow would not be deflected downwards; in order to do that we would have to apply up elevator – this deflects air up at the aft of the tailplane, this creates a force down thereby causing the tailplane to lower, which creates a positive angle of attack for the symmetrical aerofoil, which in turn deflects airflow down and creates the opposite force up (lift).

In a non-symmetrical aerofoil the camber (top and bottom in this example) causes the airflow to go down. Newton's third law - an opposite reaction creates an up force (lift). However, there is work done to induce the air to flow down and this results in drag– lift induced drag; more lift = more drag.



Picture from NASA

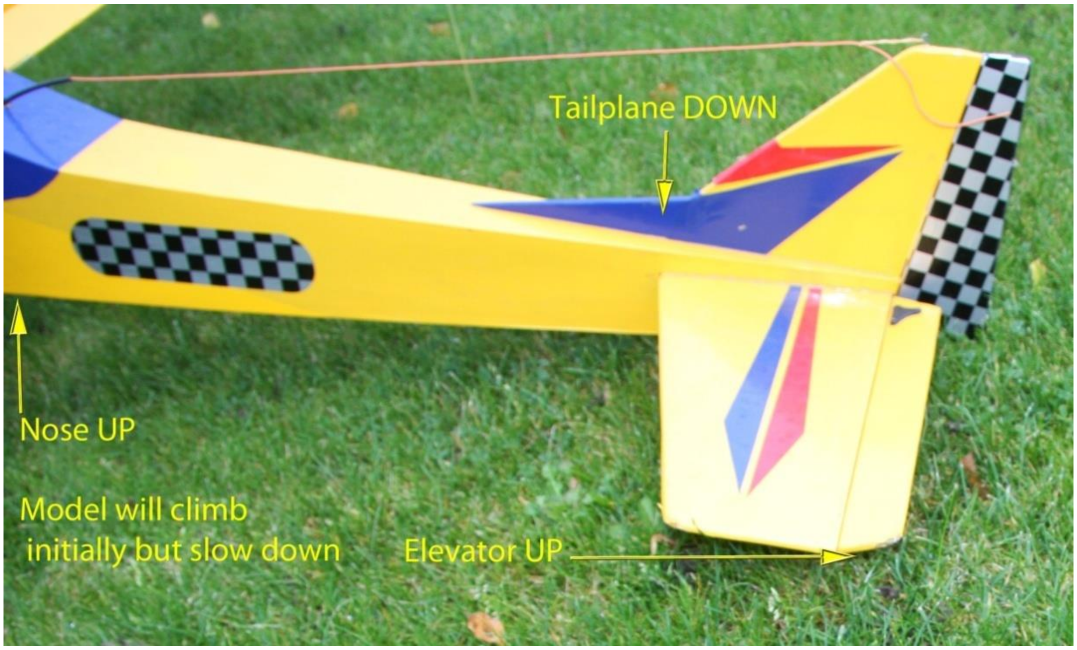
If the downward flow suddenly stops (airflow fails to stay attached at critical angle of attack) so does the opposite reaction i.e. the wing will stall.

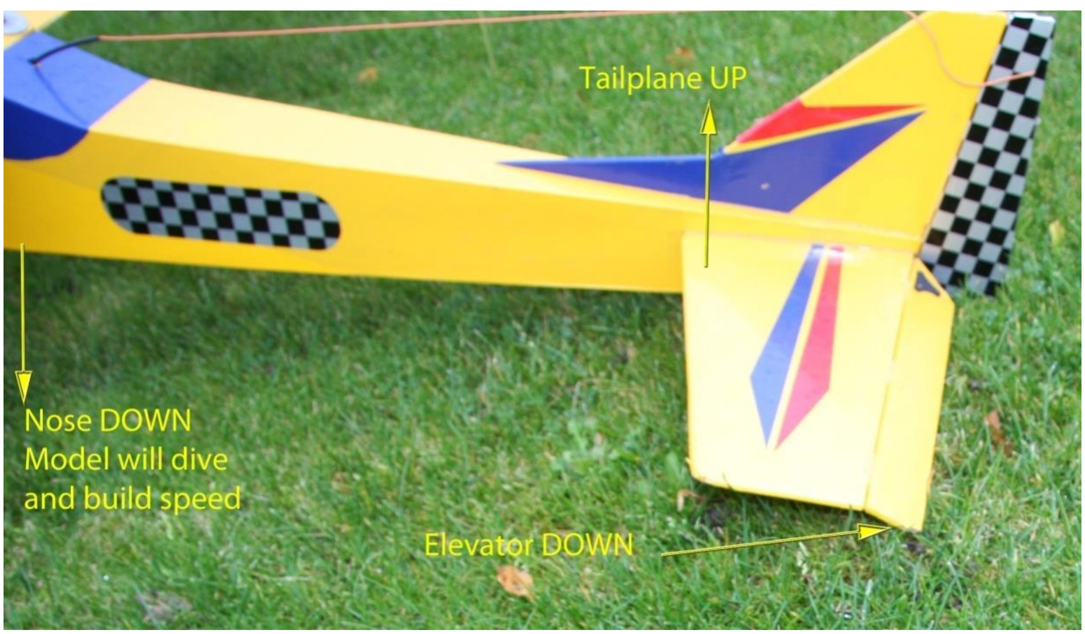
Aerodynamic theories (as previously mentioned) are quite complex but by using Newton's Law, as the principle to explain how lift is created by turning the airflow, it is far easier to understand as it applies in any attitude and not just to the aerofoil but also to each control surface. Next time you are a **passenger** in a car and the road is clear wind the window down and place your hand into the airflow with zero angle of attack. Then apply an angle of attack - positive or negative - and you will feel the force created by turning the airflow. It is much easier to understand things we can see or feel and if it is good enough for Cranfield University or NASA it should be good enough for model flyers too!

WHAT THE CONTROLS DO

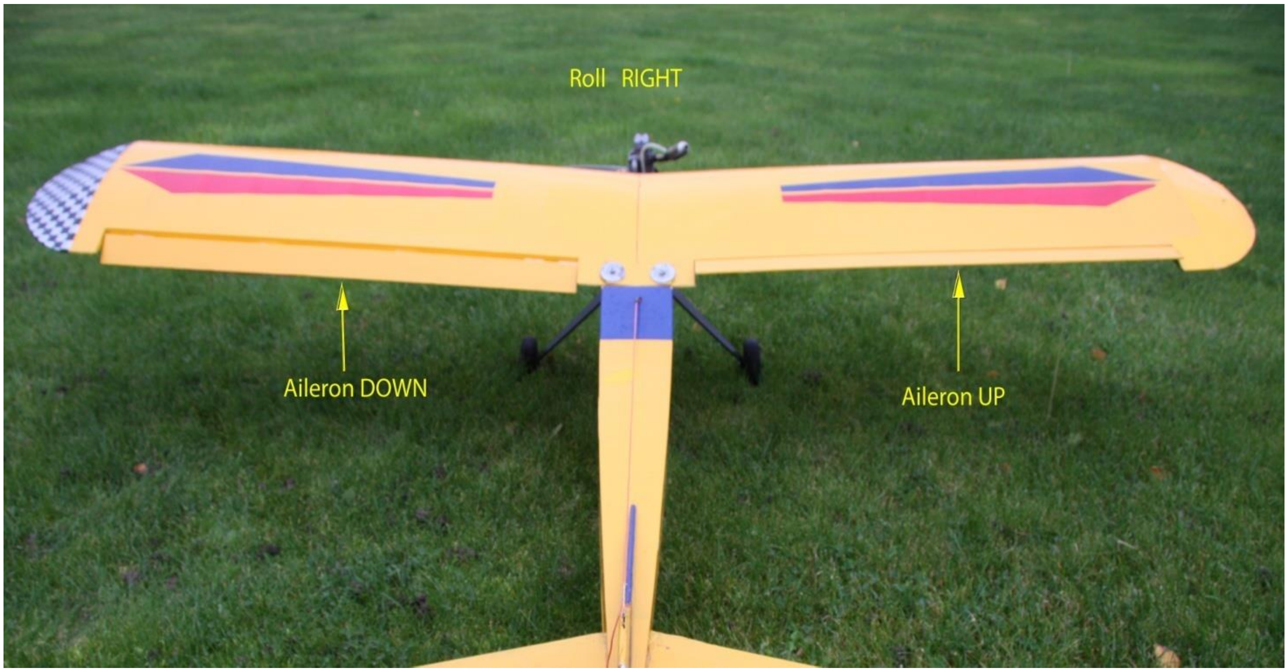
On a **Mode 2** transmitter the right-hand stick controls the elevator and the ailerons (rudder in 3 channel mode). This particular stick is the equivalent of the control column in a full-size aircraft and is therefore often referred to as 'the stick'. These controls are spring loaded so that they always return to the neutral position when released.

Moving the stick towards you will apply *Up Elevator* and raise the nose of the aircraft from level flight: moving it away from you will apply *Down Elevator* and lower the nose.

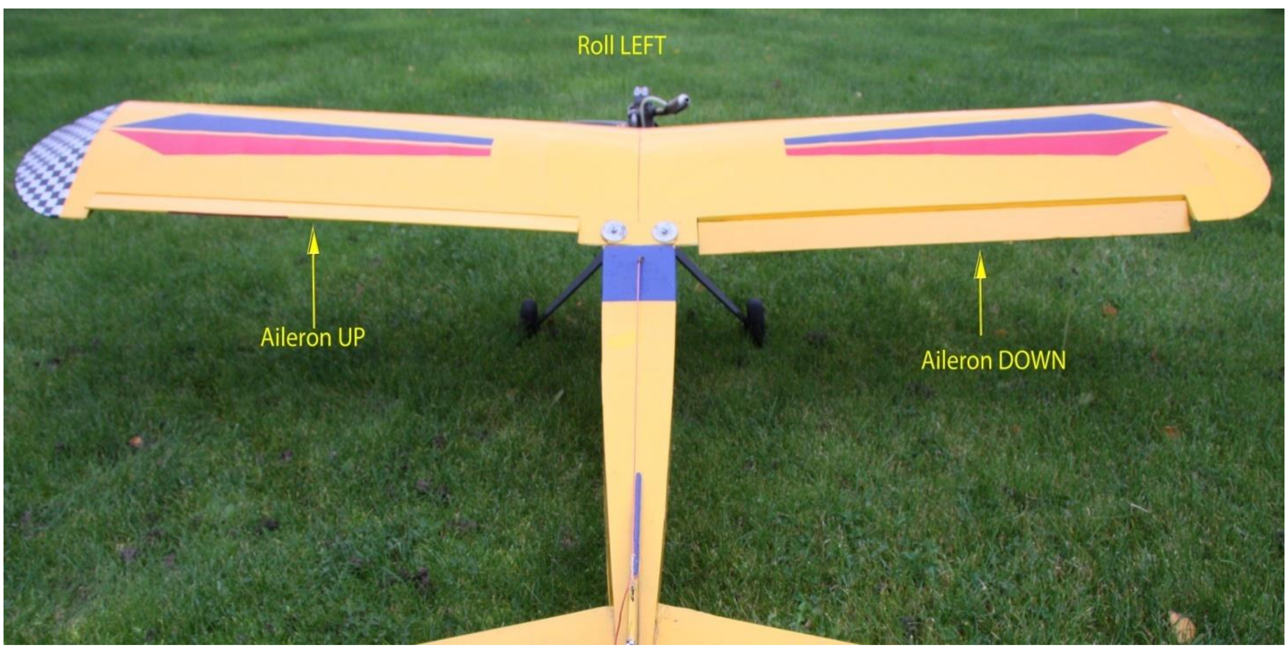




Moving the stick to the **right** will cause the ailerons to move, **right aileron up** reducing lift on that wing and the **left aileron down** increasing lift on that wing and the aircraft will bank to the right and turn - that way.



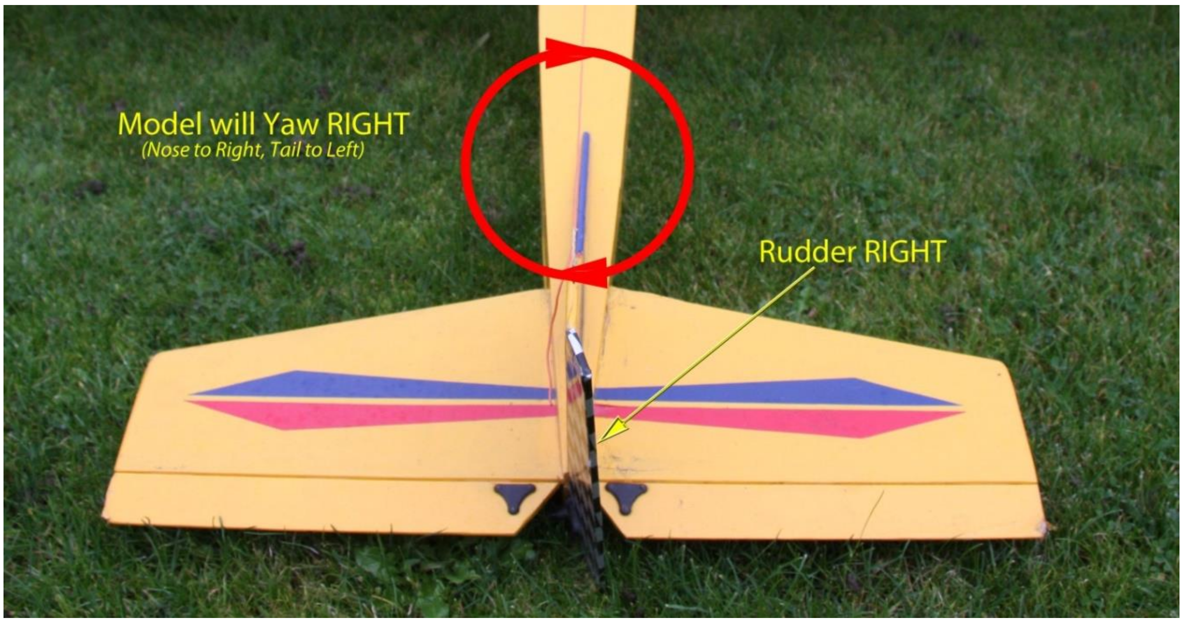
Moving the stick to the **left** will cause the ailerons to move, **left aileron up** reducing lift on that wing and the **right aileron down** increasing lift on that wing and the aircraft will bank to the left and turn - that way

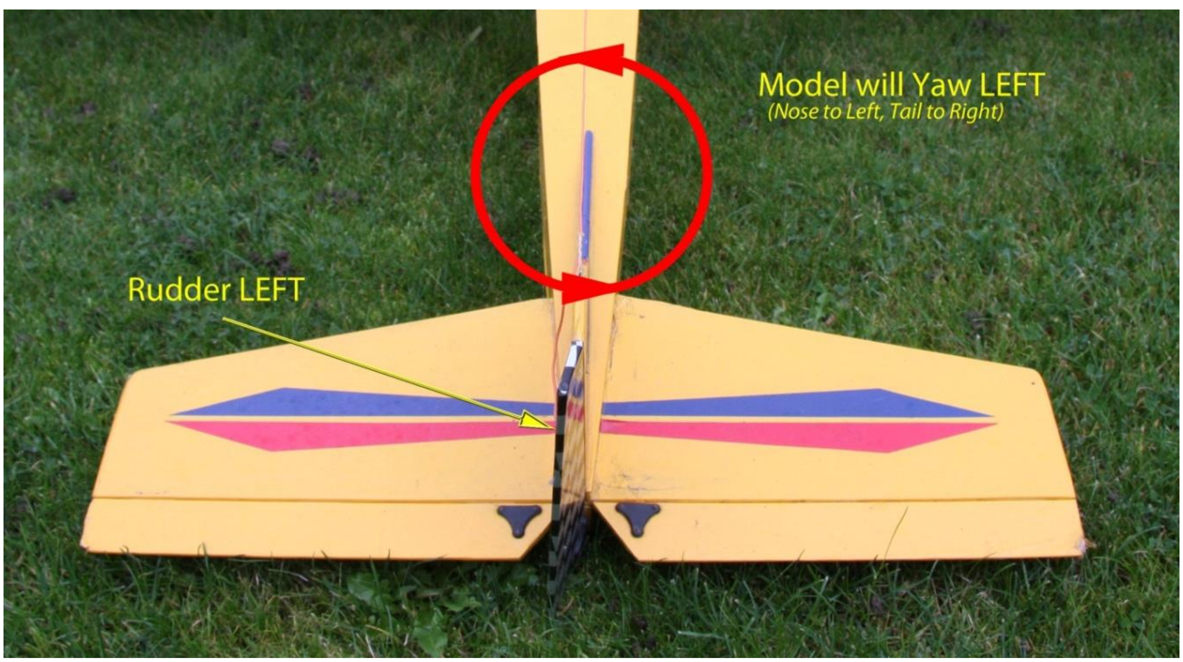


On the left-hand control stick, back and forward movement operates the **throttle**. This control is not spring-loaded but operates on a ratchet so that it remains in whatever position it is set. Moving the stick away from you will increase engine/motor speed and moving it towards you will reduce engine/,motor speed. With the stick fully forward and the throttle trim also fully forward, gives full power: fully back stick but with the trim still fully forward, gives flight idle for i/c engines (the engine runs at a safe idle speed and should not cut in flight): with the stick fully back, with the trim also fully back, will stop the engine running. For electric motors just moving the stick fully back should stop the motor (and for gliders apply the prop brake if the ESC has one). You will need to set this all up on the ground and you should ask your instructor for help doing this.

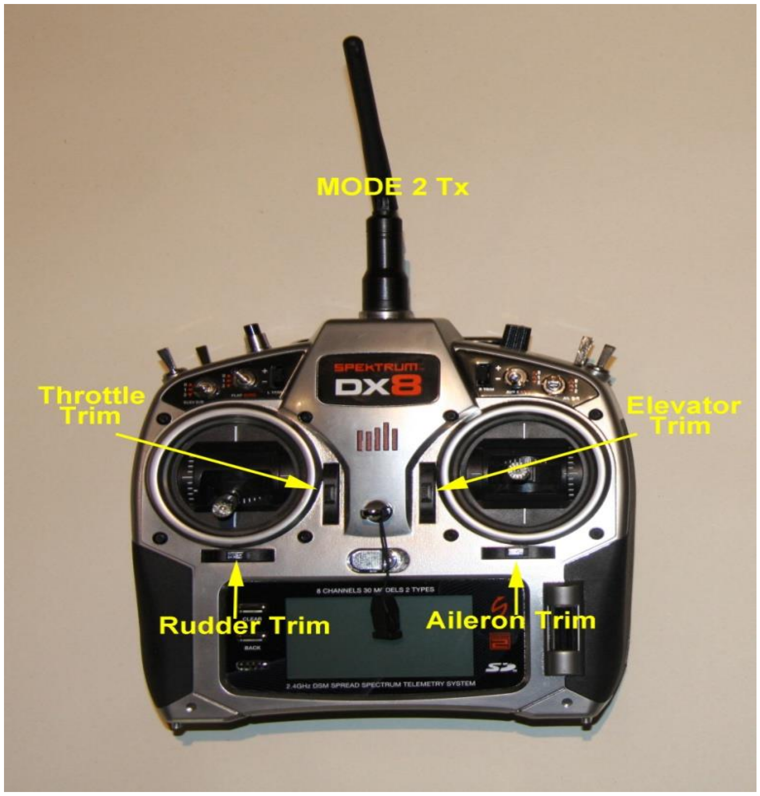
On some more advanced electric gliders the motor may be controlled by a switch and the left throttle lever used to control airbrakes. However, this is unlikely to be the case for the usual trainer models.

Side to side movement on this left-hand stick operates the rudder in the appropriate sense on 4-channel aircraft. On 3-channel aircraft (elevator, rudder and throttle) it is usually left unused as the rudder is connected to the 'aileron' control on the right-hand stick.





Alongside each of these four primary controls on the transmitter are sliding or clicking levers which are the trims for each control. These effectively alter the neutral position of the related control so that by using them, when the aircraft is in the air, you can cancel out any out-of-balance forces which make the aircraft tend to climb/dive or bank/turn. They work in the same sense as the stick they are associated with. If you pull or click repeatedly the elevator trim towards you the nose of the model will rise and vice versa.



Get very familiar with your transmitter. Hold it as if you were flying and get to know where all the controls are by touch. When you are actually in the air there will simply not be time to look at the transmitter to find out where a particular control is located - and you'll probably be unable to find your aircraft or work out its attitude when you look back up!

Let us now look at how these controls actually control the model whilst flying.

Elevator

The elevator is used to hold the aircraft level. Backward movement on the stick will cause the nose to rise and the aircraft to climb, although not for long unless power is increased. Similarly, forward movement on the stick will cause the nose to go down and the aircraft will dive, building up a lot of speed unless power is reduced. So you see, the throttle and elevator controls affect one another to an extent. An increase in power in level flight will cause the aircraft to climb unless the stick is moved forward to hold the aircraft level, in which case the aircraft will fly faster. Similarly, if power is reduced the aircraft will descend unless the stick is held back, in which case the aircraft will fly more slowly.

If you find that to hold the aircraft level you need a constant pull or push on the stick, you need to use the trim facility. Just move the trim lever in the same direction as the pressure you are using to hold the aircraft level until the aircraft will fly level with the stick in neutral. After trimming you will, of course, still have to make the necessary stick movements to 'fly' the aircraft or hold it level.

Aileron

The aileron control is used to keep the wings level when in level flight. The stick is moved away from the wing which is down *(e.g. if right wing is down then left movement on the control stick is required to level the wings).* You will find that if you can keep the wings level the aircraft will fly in a straight line. However, if you fly in a straight line for very long the aircraft will soon be out of sight. You must continually make turns and to do so you use the aileron control - whether it is linked to the ailerons in a four channel aircraft or to the rudder in a three channel aircraft. Moving the aileron control to the side will cause the aircraft to bank in that direction. When the aircraft has banked about 20º use the control to stop the aircraft banking *(either backing off the control input or applying slight opposite control momentarily, dependent upon aircraft characteristics)* further and to hold that steady angle of bank. The aircraft will now start to turn, but it will also tend to drop its nose so be ready to apply a little 'up' elevator to keep the nose up. This will also help the aircraft to turn. To straighten out from the turn, simply apply opposite stick control to bank the aircraft back until the wings are level (relaxing the back pressure on the elevator as the aircraft wings return to horizontal) and the aircraft is once again in level flight.

If you have a four channel trainer you will have discovered that you do not need to use the rudder at all to turn - it is done entirely by use of the ailerons and the elevator. With three channel aircraft and gliders (rudder connected to the 'aileron' control) the control is exactly the same. Stick left and the aircraft will bank and turn left, stick right and the aircraft will turn right. However, the big advantage of having separate aileron and rudder controls in an electric glider, where efficiency is important, comes when the aircraft is in a turn and the combination of the two controls helps to "harmonise" the turn. It will turn reasonably using either control but the combination allows for a smoother manoeuvre.

The reason why these controls are interchangeable is due essentially to the high wing position and the dihedral angle of the wing. Your instructor will explain the 'whys and wherefores' of this to you. But the big advantage of having separate aileron and rudder controls comes when the aircraft is on the ground and it can be steered whilst taxiing by use of the rudder which is usually also linked to the nose or tail wheel to give accurate ground manoeuvring. The rudder also has an important function in the air, mainly in aerobatics though.

As we have already said, the throttle control determines the amount of power the engine is providing to fly the aircraft. Full throttle is used for take-off, overshooting and many aerobatic manoeuvres. Low throttle settings give glide, taxiing power and, with the trim fully back, ‘engine stop’ facility. Intermediate throttle positions are used for different conditions of flight and that power setting which gives a pleasant, relaxed flying speed, neither too fast nor too slow, is known as ‘cruising power’. The setting for this varies between aircraft, but is normally rather less than half throttle.

In practice you will need to move control surfaces (control sticks) much less than you first expect to change direction or attitude of the model therefore in the early stages of learning you will probably find yourself over controlling the model and this can quickly develop into a panic stirring of the control sticks in an attempt to regain level flight if this instinct is not checked. Similarly, many models require a little more movement to initiate the roll or pitch change and then the control needs to be backed off almost to neutral or in some cases a little opposite control momentarily needed to stabilise the turn or climb/dive etc. Of course another effect to take into account with control input is that the faster a model is flying relative to the air around it the more sensitive a control surface will be, requiring less movement for a given effect and of course the opposite is true for slower flight.

Module 6 – Pre-Flight & Post Flight Checks

Assumed previous knowledge/experience.
Understanding of Aviation and Aircraft Terminology.
Basic understanding of radio control systems and how they operate.
Basic understanding of the model controls and how they should operate.
Understanding of legal and safety requirements.

FINAL CHECKS

Before you take your aircraft to the flying site for its first flight there are certain checks which must be carried out.

BALANCE (Centre of Gravity)

Make sure that your aircraft balances at the Centre of Gravity point shown on the plan with any fuel tank empty but if electric motor powered with the battery installed. If you do not know where this point should be, balance your aircraft so that you can pick it up level with your fingertips under each wing at a point approximately one-quarter to one-third back from the leading edge. Check also the lateral balance to ensure that one wing is not heavier than the other (balance on the spinner or prop nut and the fuselage near the rudder). If it is, make it balance by adding weight to the 'light' wing's tip.

CONTROLS

Ensure that the control surfaces move in the correct direction and that they operate smoothly and there is no binding of any of the control linkages. At home, switch on the transmitter, then the receiver, and move the sticks to check the controls, while standing behind your aircraft: stick forward - elevator down: stick left - left aileron comes up, right aileron goes down: rudder left - rudder moves left. If your check is done at the flying field, you must ensure that the frequency control system is complied with **BEFORE** switching on. (*Note: if your model is electric and uses a BEC it is safer to remove the propeller from your motor to conduct these tests at home, or ensure the model is fully restrained at the flying field, as your motor will be live and any fault, incorrect setting or stick operation could cause the engine to go to full power).*

WHEEL TRACKING

Push the model along the ground and see that it runs straight, without any wheel binding. If it veers off right or left, correct this by adjusting the nose or tailwheel.

ENGINE/MOTOR

If you have only 'bench run' your engine, now is the time to test it in the aircraft. With the aircraft suitably restrained, start the engine and check that the transmitter control operates the throttle correctly without any trace of stiffness. Check that 'fully forward' on the throttle control gives full power: 'fully back' gives a satisfactory idle: 'fully back' with the throttle trim also fully back stops the engine. If any of these controls are out of adjustment re-set them to ensure safe and proper operation.

If your model is electric powered it is best to remove the propeller for initial tests in the aircraft. Check that the transmitter control operates the throttle correctly without any trace of stiffness. Check that ‘fully forward’ on the throttle control gives full power: ‘fully back’ (with the throttle trim still fully forward) stops the motor. Also check the rotation of the motor which should be anticlockwise (looked at from the front) for a standard propeller on the front of the model.

VISION

If you have any eyesight correction requirements, especially at distance, remember it is critical that you can see the model clearly at all stages of the flight, so ensure you take your corrective glasses or lenses with you. If the weather is going to be sunny or very bright you may also want to take sunglasses with you.
You are now ready to go to the flying site for your first flying lesson.

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PRE- FLIGHT CHECKS
Before your model is flown for the first time your instructor will repeat all the basic checks you have carried out at home, along with necessary pre-flight and post-flight checks on your aircraft for its first few flights and explain to you what he is doing. Your instructor will use the all the safety guidance from the BMFA Handbook, including the 'SWEETS' & 'SMART' checks, then ask you to do these for yourself and let them become a matter of ingrained habit.
Your sequence of checks before you fly (pre-flight checks) should be:

a) On arrival at the flying field you should carry out the 'SWEETS' checks as described in the BMFA Handbook. Your instructor can help you through these and explain the importance of them and your need to pre plan for various eventualities.

b) Check the aircraft thoroughly for any damage which may have occurred in transporting it: wings and fuselage for surface damage, tail for damage and security.

c) Check that all linkages are secure, both at the control surfaces and at the servos (a bang on the tail can often unhook a clevis). Check that all servo mounts are secure. Assemble the aircraft for flight.

d) Check the undercarriage for correct alignment, security and tracking.

e) Check that the engine or electric motor is securely mounted and that no screws or bolts have vibrated loose. Check throttle linkage for security. Ensure that the propeller is undamaged and securely bolted on.

f) Check your receiver battery has sufficient charge/voltage for the flight you are about to undertake. If you are using 35MHz equipment obtain your correct frequency peg or clearance, *(if model is electric see (i) below)* then switch 'ON' the transmitter followed by the receiver. Carry out the SMART checks as described in the BMFA Handbook. Once again your instructor can assist you in explaining the importance and relevance of these checks to the particular Transmitter you are using.

g) Now check all controls for full movement in the correct sense. Check that the control surfaces are in their correct position with the transmitter trims at neutral.

h) Carry out a range check at the beginning of every flying session, or if you have any doubts whatsoever about it (after a crash, for example or when the aircraft has been repaired). Your instructor will show you how to do this and you will also find advice in the radio manufacturer's instructions**. DO NOT ATTEMPT TO FLY IF YOUR RANGE IS BELOW THAT REQUIRED**. Have your radio checked and repaired if your range is down. If your model is powered by an electric motor it is advisable to carry out the range check with the motor running (with the model suitably restrained) to ensure no ill effects from Electro Magnetic Fields produced by the high current involved. You are looking for all the controls to continue working correctly and smoothly, with no jittering of control surfaces.

i) If your model is powered by an electric motor ensure that it is suitably restrained before installing the battery. Many clubs require that the motor's battery is not connected up until the model has been moved from the Pits to the flight line ready for taxi out and takeoff.

j) If your radio equipment has failsafe facility, check that this is correctly set at the beginning of every flying session. With an i/c engine aircraft you can do this by checking the throttle servo moves to throttle closed when you switch off the transmitter without the engine running. If your model is powered by an electric motor your will have to ensure the model is suitably restrained, install a battery and power it up to about 1/3rd power then switch off the transmitter (be extremely careful doing this as the model will go to full power if the failsafe is incorrectly set). The motor should stop if your failsafe is correctly set.

k) For an internal combustion engine powered aircraft, fuel up the aircraft and, after making sure that the model is properly restrained and checking no one is within harm's way of any potential propeller failure, start the engine. After allowing it to warm up, open the throttle fully and check that the engine picks up cleanly to full power. Pick the aircraft up carefully and hold it with the nose pointing up at about 70 degrees.

Ensure that the engine does not falter or cut. If it does it will almost certainly be set too lean and you should re-tune by opening the main needle a little and then retesting until the engine runs happily with the model's nose pointing up.

l) With the aircraft held securely on the ground, open up to full power and re-check all flying controls once again.

m) Close down the engine. Switch OFF the receiver, then the transmitter and lower the aerial if you do not intend to fly for a time. Clear your frequency control system. Refuel if necessary.

n) Once the engine has been set for the day, as in (i) above, don't fiddle with the mixture needle on the engine's carburettor. If you find that the engine won't run reliably then the problem is almost certainly elsewhere, usually dirty fuel (fit a cheap add-on car petrol filter to your fuelling rig), faulty plug (try your spare) or a mechanical fault in the engine such as an air leak in the carburettor. Your instructor should be able to advise on this one.

o) If you require eye protection or correction glasses/lenses make sure you have them on.

With these checks are completed your aircraft is ready for its first flight of the day. Always remember to switch your transmitter on first and allow it to boot up fully then carry out your 'SMART' checks before switching on your receiver.

POST FLIGHT CHECKS

a) After landing taxi the aircraft clear of the runway/landing strip but not into the Pits, shut down the engine and then carry or wheel the model into the Pits.

b) If the model is powered by an electric motor, disconnect the motive power battery. *(If fitted with a BEC system this will also switch off the receiver)*

c) Switch the Receiver OFF, then the transmitter OFF.

d) If using 35MHz radio equipment ensure your Tx antenna is retracted and clear your frequency on the control system in use at the site.

e) Check the propeller, undercarriage and airframe for any damage sustained in flight or on landing.

f) Check all fastenings for security (wings firmly attached, engine and silencer secure etc.).

g) Check control linkages/horns are still intact and not bent or damaged.

h) Clean down the aircraft checking integrity of all flying and control surfaces as you go. *It is important to remove all oil and fuel residue on glow and petrol powered models as this can damage painted and film covered surfaces and lead to oil soaking into wood with possible subsequent failure of glued joints etc.*

i) If electric motor powered, remove the battery, insulate any exposed battery contacts and store the battery safely. It is useful to have a system for noting that the battery is now depleted so that you do not accidentally install it back in the model for the next flight.

Subsequent Pre-Flight Checks

For subsequent flights you will need to perform post-flight checks after every flight and after refuelling or changing the battery you will need to do a full and free control movement check before taxiing out for take-off and ensure you are wearing your eye correction or protection if this is required.

Module 7 – First Flight & Straight and Level Flight

Assumed previous knowledge/experience.
Understanding of Aviation and Aircraft Terminology.
Basic understanding of radio control systems and how they operate.
Basic understanding of the model controls and how they should operate.
Understanding of legal and safety requirements.

Now that you have the model and the necessary support equipment you will be just waiting to get the model airborne, albeit probably with some trepidation. Your instructor will get the appropriate frequency control sorted out and check your model over.

He will check:

a) Sound construction of the model ;
b) Wing for warps;
c) Wing and tail square to fuselage;
d) Attachment of the wing to fuselage for security (minimum of 3 strong bands on each side for banded- on wings);
e) Radio installation, security of all plugs and sockets, security of servos, clevises and all hinges.
f) Radio range & failsafe operation;
g) Correct position of the Centre of Gravity (balance point);
h) He will connect up and check the Buddy Box system for correct control movement from both transmitters.
i) Correct rotation and throttle operation of an electric motor (if used).

He will then point out any corrections which are necessary. When he is satisfied that everything is in order he will then either start the engine himself, or ask you to do it and will ensure that the engine is correctly tuned, very slightly on the rich side. If a new engine is to be run in on these first flights he will set the mixture very rich to ensure that the engine four-strokes in flight. He will explain to you throughout what he is doing. If the model has an electric motor he will talk you through the club protocols for electric powered models.

He will now conduct a test flight, probably with the Slave transmitter disconnected. With the trims on the Master transmitter at neutral (throttle trim fully forward) he will check the aircraft's taxiing and, when satisfied, will take-off and climb to a safe height. He will then trim the aircraft out (using the trim controls on the transmitter) so that it flies straight and level 'hands off' at cruising power. He will also check the handling of the aircraft at high and low speeds, climbs and dives and may do a few mild aerobatics. He will tell you what is going on all the time. With an electric glider low throttle settings give level flight, and, with the motor stopped, the glide portion of the flight. Remember that with an electric glider the throttle can be used to start the motor at any time so that a flight can have alternating periods of power-on climb and power-off glide.

After landing and going through the post flight procedures, he will carry out any changes in the settings of the control surfaces, which have been shown to be necessary during the test flight and explain what he is doing, and why. He will re-set the elevator, rudder and aileron linkages, if necessary, to give straight and level flight ‘hands off’ with the transmitter trims at neutral.

Now it is your turn. He will discuss with you what you will be expected to do for your first flight and this is your opportunity to ask any clarification questions. He will go through the pre flight checks with you. He will probably then connect the Slave transmitter to the Master transmitter and hand you the Slave Tx. You may find it better to attach the transmitter to a neck strap, or into a transmitter tray to assist with holding, feeling and operating the control sticks. The engine will then be re-started, full, correct and free control checks done and the aircraft put back into the air again to check the trimming. The instructor may tell you roughly where to set the throttle control on your Slave transmitter and, at a safe height (around 200-300 ft) he will hand control of the model to you saying “You have Control” so that you can now have a go. You should confirm that you have now taken responsibility for the control of the model by saying “I have Control”.

Your instructor will show you how to use your fingers/thumbs on the sticks. Remember to face the aircraft at all times! At this early stage you will only be using the right-hand stick to fly the aircraft (Mode 2), but keep control over both sticks so that you become accustomed to the correct position of your hands. Stick movements are very gentle. Remember what we said in ‘CONTROLS’ moving the stick forward will lower the nose of the aircraft, bringing it back towards you will raise it. Moving the stick to the left will make the left wing go down: to the right, the right wing will go down. Always be ‘light’ in touch on the controls - it is pressures on the stick rather than large movements which will give the smoothness in flying which must be your aim.

However, you must apply sufficient control movement to make the aircraft respond in the way you want. How far do you move the controls? ‘Enough’ is the only answer! At low speeds you will require more control movement to effect a response: at higher speeds the controls become very responsive. If it is a glider your instructor may ask you to adjust the throttle so that you can experience the flight of the model in both the ‘power-on’ mode and the ‘glide’ mode. Note the way in which the controls are much more responsive with the power on.

Your instructor will probably just get you to fly the model straight and level to start with conducting the turns for you at the end of each straight run. This is an important starting point as getting the model back to straight and level is the recovery point for any flight upset either introduced by you or any turbulence. Don’t try to ‘fly’ it - just correct it when it banks and get the wings level: similarly try to stop it climbing or diving if it has a tendency to do so.

Your instructor will stand close by you to supervise your flying or to show you the necessary corrections to make. He will turn the aircraft from time to time to keep it in easy view. He will probably take control now and again to allow you to relax since you will be concentrating so hard that 2-3 minutes at a time is quite enough. After 10 minutes or so he will land the aircraft and taxi it to the edge of the runway/flying strip and shut down the engine.

It is at this point that you can take a deep breath

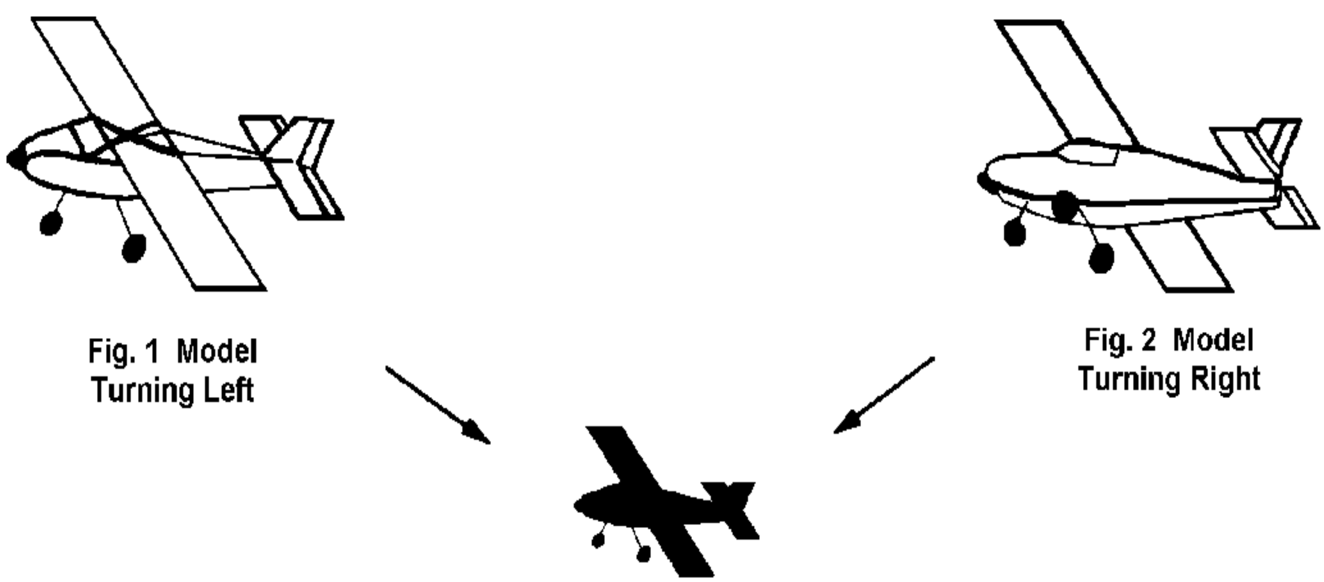
and slow the adrenaline down to a gallop!

He will then discuss the flight with you. Take the opportunity to ask any questions and clear up any points which may have bothered you. During your flying one thing will have become perfectly obvious.... it isn't as easy as it first looks or quite as easy as flying on a simulator! But don't despair - it will all fall into place quickly enough.

ORIENTATION

One thing you will discover on your first flight - how difficult it is at times to determine exactly which way the aircraft is turning - or even which way it is going! Your ability to control the model depends to a very large extent on being able to see it clearly and to understand its position in the air.

Let's give you an illustration:



Both Look the Same at a Distance

You can see that if your model was turning to the left (fig 1) and it got into a right-hand turn (fig 2) without you noticing it, you wouldn't realise it and think that the model was still turning to the left. You try to straighten up and, lo and behold, the aircraft steepens its turn and, before you know it, it is in a spiral dive to the right, and panic is about to set in!

The way to avoid this is to keep your eyes on the model at all times and to keep the model within an easy visual distance, plus keep a mental picture of what your aircraft is doing. Your troubles will only start when the model is at a distance. If, accidentally, your model has got towards the limit of visual range, all need not be lost. If you cannot tell if the aircraft is flying towards you or away from you there is a simple test. Move the transmitter stick to the left slightly. If the model banks in the same way as your control movement the aircraft is flying AWAY from you: if it banks in the opposite way it is flying TOWARDS you. If the aircraft is flying across your line of sight, turn it until it is flying towards/away from you and apply the same test.

You may also find it difficult to judge if the model is climbing or diving during turns, especially whilst close to overhead or flying quite high. Things like engine note ie propeller/engine speed will increase and the note will change in a dive, the controls will become a bit more sensitive as the models speed increases. Likewise, if the model is climbing the engine note may labour a little (although not to the same extent as it will increase in a dive) but the controls will feel a little more sluggish as the model slows down slightly. Do not worry as you will gradually get the hang of this and you will become more aware just what the model is doing as you progress through your training.

Taxiing

After the first few lessons, your instructor will start to get you to taxi the aircraft to the take-off point from which he will still do the take-off and initial climb. Your instructor may give you some taxi practice to ensure your left hand can get some practice with steering. This would normally be done when the flying strip is not too busy and if other members are taking a lot of notice you are not doing so well but once they stop taking notice you know you are getting the hang of it.

Taxiing is not difficult: but you must be careful with the application of power as there are no brakes! Hold full up elevator whilst taxiing, this reduces the risk of the model nosing over, or the nose wheel digging in. Use the throttle slowly and oly in short bursts until the aircraft begins to move, then, reduce the power. If you don't reduce power the aircraft will run away from you since the power required to get the aircraft moving is much more than it needs to keep moving. Steer the aircraft by the rudder control since this will have been connected to the nose or tail wheel. Control the speed by blipping the throttle. If you have problems, just close the throttle and let the aircraft come to a halt: then start again. You will notice that any cross wind will tend to weathercock the model into wind. As you become more proficient, the use of into wind aileron will help reduce any tendency for the wind to get under a wing tip and flip the model.

If you are asked to taxi the aircraft back from where it has landed to where you are standing, ALWAYS bring the aircraft up to you at the end of the taxi run with it coming INTO wind. The reason for this is that the aircraft will be moving more slowly and will stop more quickly when you close the throttle than if it had the wind behind it. This is part of safe flying!

A final point to remember - never taxi your aircraft back to the pits, or pointing directly towards the pits. It is very dangerous to attempt to manoeuvre directly towards or in a crowded area and any radio interference, engine throttle linkage failure or misjudgement can cause a great deal of damage and possibly serious injury too.

DON'T DO IT!!

The Effect of Wind on the Flight

There is probably more nonsense talked and written on this subject than any other connected with the practical side of flying! In reality, the matter is very simple - it is just that so many people find it hard to accept.

Provided that your flying area is clear of vertical obstructions (houses, trees, hedges, hangers etc. and the wind is not very strong) the wind will blow fairly steadily from a constant direction once the aircraft is above about 50 to 100 ft. Below this height, and depending on the surface of your flying site and the proximity of obstructions, there will be some turbulence both vertical and lateral.

Once you understand this principle you will see that a turn from an into wind tracking to crosswind will appear to be a fairly sharp turn when seen from the ground and a turn from downwind to crosswind will appear to be slow and elongated. You must accept these visual effects for what they are and remember at all times that if you have not altered your throttle setting and the aircraft is at constant height then your airspeed is constant and the aircraft is in no danger of stalling.

Once the aircraft has climbed out of this turbulent level it is, in effect, flying in a steadily-moving block of air. Thus, with a wind speed of 10 mph the block of air in which your aircraft is flying is moving downwind at a speed of 10 mph. So, your aircraft which flies at a speed of, say 20 mph will appear to be doing only 10 mph when flying into the wind (flying speed less wind speed) and 30 mph when flying downwind (flying speed plus wind speed). In point of fact your aircraft knows nothing about the wind speed at all and is flying at a steady 20 mph all the time!

You will often hear people say that their aircraft tends to climb when turning into wind and dive when turning downwind. What is really happening, of course, is that they are subconsciously trying to compensate for the apparent variation in speed and themselves causing the aircraft to climb and dive.

One major point to remember - don't try to keep your apparent speed constant or you will find that you will have your aircraft at full throttle when going into wind and stalling when it goes downwind.

If you find all this difficult to visualise, try to imagine yourself piloting a model boat from the bank of a fast-flowing river. In this situation you will find that you can understand the problems outlined above.

When flying in a wind of any strength you will find that your model can be carried away from you very quickly when it is travelling downwind. It is essential not to let it go too far. If you do, not only do you stand a good chance of losing control because you just can't see the aircraft properly, but it is a long and slow slog back to your position against the full strength of the wind. There is another major factor - if your engine stops it will be difficult or impossible to glide the aircraft back to your position if it is too far downwind.

So always try to keep your aircraft upwind of your position as much as possible. By doing so, you will save yourself from falling into some very difficult situations.

Some beginners try to fly by 'pulsing' the controls - giving short dabs of control and letting the stick flick back to neutral. Don't on any account do this - it is bad technique and you will never achieve the smooth flying you require by doing this.

Now, here is your first cardinal rule: **NEVER, BUT NEVER, TAKE YOUR EYES OFF THE AIRCRAFT WHEN YOU ARE FLYING**. If you do, you will certainly become disorientated and may even lose sight of your aircraft, or be unable to locate it quickly. It is a great temptation to look down at the transmitter when you have to re-trim, for example. Avoid this at all costs. Become thoroughly familiar with the layout of the transmitter controls so that you can locate any of them quickly by touch alone.

So, your first flight is completed and you should go over it several times in your mind, discussing any problems or queries you have with your instructor before you fly again. Don't be in too much of a hurry to get in the air again - assimilate the lessons you have learned, realise what you have to do to correct the mistakes you made the first time and be determined to make your next lesson a 'learning' one and not simply a repeat of the first one.

Module 8 – Turning

Assumed previous knowledge/experience.
Understanding of Aviation and Aircraft Terminology.
Basic understanding of radio control systems and how they operate.
Basic understanding of the model controls and how they should operate.
Understanding of legal and safety requirements.
You are getting the hang of keeping a model flying straight and level

Your next few flights will follow similar lines to the first, with your instructor doing the take-off and climbing the aircraft to a safe height. He will then hand over to you to continue practising straight and level flight and gradually introduce you to left and right turns. He will be right with you, as before, ready to correct any errors which may put the aircraft in a difficult or dangerous position. If you get too low or too high, he will take over from you to bring the aircraft back to the right height and probably position it so that your view is better for judging the turn.

You will find when you enter a turn that the nose of the aircraft tends to go down and the aircraft loses height and gains speed. Similarly, when levelling out the aircraft will tend to climb and lose speed.

To overcome these problems and perform level turns you should pull back gently on the elevator stick (RH stick Mode 2 Tx, LH stick Mode 1 Tx) when you have put on sufficient bank for the turn and use the elevators to hold the turn level. Don't allow the aircraft to over-bank, 20^{o} of bank is quite sufficient at this stage. You will also notice that as you apply the up elevator it appears to tighten the turn slightly.

Coming out of the turn, all you need to do is to relax the back pressure you have applied during the turn as the aircraft straightens up and you will find that it will remain in level flight - provided you have not built up any excess speed in the turn by diving slightly and the model was properly trimmed in the first place!

Your aim throughout the flight is to fly level and perform turns in both directions without gaining or losing height. This requires a great deal of concentration and, again, your instructor will take control from time to time to give you a break and have time to gather your thoughts. He will, of course, be talking to you through most of your flying at this stage and encouraging you to make the correct control movements to make the aircraft do what you want. He will also take control to prevent the aircraft from getting too far away. After landing, again, you should discuss the flight with your instructor and ask questions on anything you did not fully understand. This flight pattern will be repeated in subsequent flights until your instructor is satisfied that you can control the aircraft adequately.

REMEMBER Always be gentle on the controls and avoid rapid movements which can lead to over controlling.

Module 9 – Climbing, Descending & Trimming

Assumed previous knowledge/experience.
Understanding of Aviation and Aircraft Terminology.
Basic understanding of radio control systems and how they operate.
Basic understanding of the model controls and how they should operate.
Understanding of legal and safety requirements.
You are getting the hang of keeping a model flying straight and level.
You have become competent at making level turns with the model.

At this point you will have started to gain confidence in your flying ability and be able to turn the aircraft in either direction in level flight so that you can keep it in clear view at all times. Now that you are proficient in this you will be shown how to make the aircraft climb and descend under full control.

To make the aircraft climb, you have first to increase power. So, from level flight, open the throttle fully and you will find that the aircraft will start to climb automatically. Use the elevator control to maintain a steady angle of climb: not too steep. To return to level flight, simply lower the nose of the aircraft and reduce to cruising power. To descend, just reduce power: the nose will go down automatically and all you have to do is to regulate the descent angle with the elevators. To regain level flight, increase to cruising power and raise the nose of the aircraft.

Turns whilst climbing or descending are quite straightforward, but remember to keep the nose up in a climbing turn and down in a descending turn so that the airspeed remains constant.

One other point which is not always understood: it is the POWER setting which makes the aircraft climb and descend - not the elevators. They principally control the SPEED of the aircraft only. Try it for yourself – close the throttle leaving the stick where it is and you will find the aircraft will try to maintain its speed by losing height: open up to full power and the aircraft, again, will try to keep its speed constant by climbing. If you try to climb and descend just by using the elevator control you will stall the aircraft in the climb and build up a high speed in the descent.

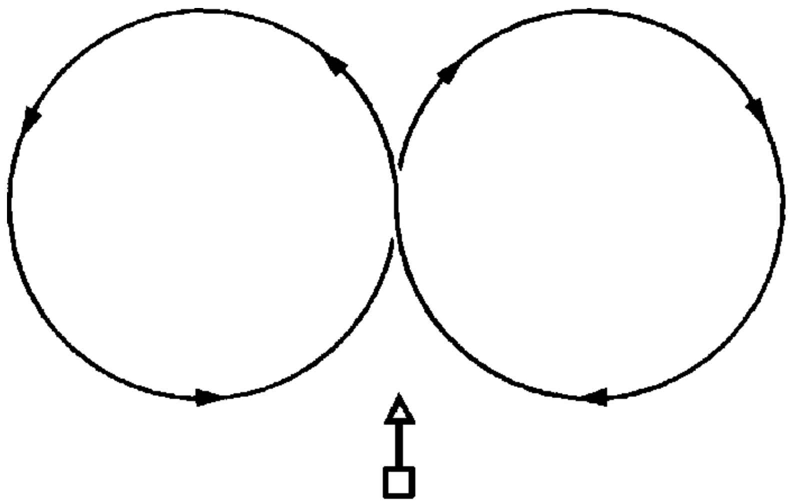
Now - trimming. The aircraft should be trimmed out to fly straight and level at cruising power. If it tries to climb with the power setting you have selected, move the elevator trim forward a notch or two until the aircraft stays level 'hands off' the transmitter. Vice versa, if it tends to lose height. If it tends to bank/turn in either direction, correct this by using the rudder/aileron trim. When you have the aircraft trimmed out properly it is more pleasant to fly and its stability improved. Once again - any problems you have should be put to your instructor.

As before, this lesson will be repeated until you can control the aircraft effectively in both climbing and descending at various power settings and in transitions to level flight. Your instructor will also get you to practise trimming the aircraft correctly by handing the aircraft over to you with it purposely out-of trim so that you can sort it out yourself.

Module 10 – Practice & Accurate Positioning

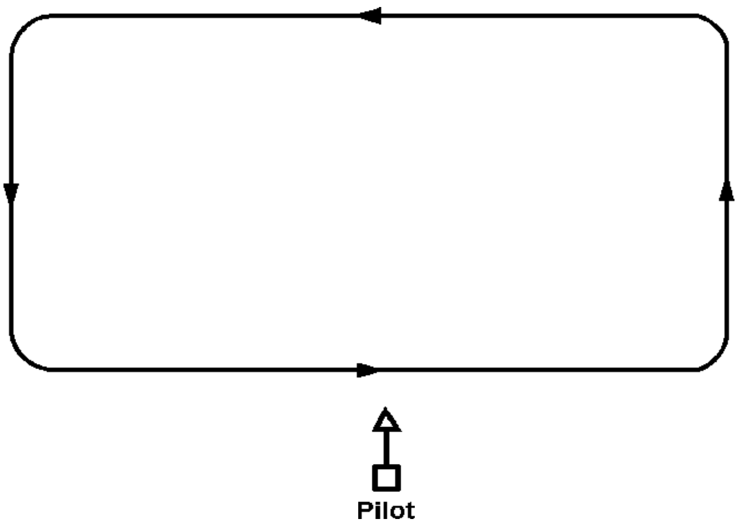
Assumed previous knowledge/experience.
Understanding of Aviation and Aircraft terminology with a basic understanding of radio control systems and how they operate.
You have a basic understanding of the model controls and how they should operate.
Understanding of legal and safety requirements.
You are competent at keeping a model flying straight and level.
You are competent at making level turns with the model.
You are competent at climbing, descending and trimming a model.

Now that you have the hang of basic control of the model it is important to carry on with the development of your skills by learning to accurately position the model in the air. Your instructor will probably ask you to fly a 'figure of eight', which will look like this, with the cross-over point directly in front of you:



The turns should be steady with the angle of bank not exceeding 30°. Height should also be constant. You will be making due allowance for the wind so that the cross-over point remains in front of you each time although this may mean varying the angle of bank to keep the diameter of the circles formed by the turns reasonably constant. Note that one half of the manoeuvre is a left-hand turn, the other is to the right.

As a variation, your instructor may ask you to fly in a rectangular circuits like this:



Fly these rectangular circuits with both right and left-hand turns. Don’t let the aircraft get too far away and let your instructor know if you have problems. At this time, now that you can handle the aircraft satisfactorily, he will not always be at your elbow, but may be a little further away (but keeping an eye on you!). He will always remain within easy earshot so that, if you call for help, he can be with you quickly.

After some practise with these circuits, try a modification. From level flight, on the furthest away long leg, climb the aircraft 50 ft. Fly the crosswind leg level at this new height and when you have turned onto the nearest long leg, commence a descent down to your original height, levelling out when you get there. Then repeat this until you can fly this pattern accurately and confidently.

Electric gliders should spend most of their flight gliding and one is usually hoping to find some thermal lift. The normal manoeuvre used to keep the model in this area of rising air is the thermal turn. This is basically a series of continuous 360 degree turns in either direction, left or right, and your instructor will ask you to practice this. If this manoeuvre is correctly performed then the model will fly at constant speed in a gentle turn and will gradually drift along in the direction of any wind. If the model is within a thermal it will gradually climb. If it is not then it will descend steadily.

Whilst this sort of flying may appear to be a little boring please stick with it, you are trying to get your brain operating more and more instinctively. This is so that you are getting to the point where you just think about what you want to do, or where you want to position the model next and your fingers automatically adjust the transmitter control sticks the right amount to achieve it.

REMEMBER - IF YOU GET INTO TROUBLE, LEVEL THE WINGS FIRST, THEN RECOVER

Module 11- Stalling & Recovery

Assumed previous knowledge/experience.

Understanding of Aviation and Aircraft terminology, with a basic understanding of radio control systems and how they operate. You have a basic understanding of the model controls and how they should operate.
Understanding of legal and safety requirements.
You are competent at keeping a model flying straight and level.
You are competent at making level turns with the model.
You are competent at climbing, descending and trimming a model.
You have been practicing accurate positioning of the aircraft and becoming competent.

Now that you can control the aircraft competently in normal flight, it is time for you to explore what happens when flight is not normal, so that you can recognise when this happens and know what to do about it.

In previous lessons you have been taught to concentrate on keeping the speed of the aircraft reasonably constant. Your instructor will now take you through what happens when the speed is allowed to slow down. *Remember that the speed is relative to the air not the ground for example flying into wind will appear slower than flying downwind.*

Your instructor will get you to position the aircraft in level flight at a safe height. You will then close the throttle and, instead of allowing the nose of the aircraft to drop and the aircraft descend, you hold the nose up with the elevators and try to maintain height. The speed will fall off and, as it does, the aircraft will get more and more nose up. Increased elevator will hold the nose up for some time, but the point will come when the speed has fallen to the stage where the aircraft will no longer continue to fly and the aircraft will 'wallow' (and the controls will feel 'sloppy' and quite ineffective), the nose will then drop sharply despite the application of full ‘up’ elevator. One wing may also go down quite sharply, known as a ‘dropping a wing’. This is the stall.

Recovery is straightforward. Release the back pressure on the stick, open the throttle, and allow the nose to drop and the aircraft to dive and accelerate back to flying speed. If the model has dropped a wing you will need to level the wings once the speed starts to build up again, then apply power, before levelling out from the dive.

You will find that you regain full control very quickly. Actually you will find that you have control almost as soon as you stop trying to hold the nose up, so don’t be worried about losing control for a few seconds.

The points to be learned from this exercise are:

If you allow the aircraft to slow down too much you can lose control. At a safe height this does not matter, but it can be serious near the ground.

a. Remember the recovery action - power ON, lower the nose then ease the aircraft out of the dive.
b. Don’t be afraid to practise the stall and recovery at a safe height. You will soon recognise when the speed is getting too low, controls becoming sloppy or ineffective and a stall is imminent. In this way you will appreciate the need to keep

a safe flying speed when the aircraft is near the ground.

Practise the stall and recovery in turns also. The behaviour of the aircraft may be slightly different in that a wing may go down fairly sharply and, if not corrected, the aircraft may enter a spiral dive, but the recovery action is the same.

REMEMBER - IF YOU ARE IN TROUBLE, LEVEL THE WINGS FIRST. THEN, RECOVER FROM THE DIVE TO LEVEL FLIGHT.

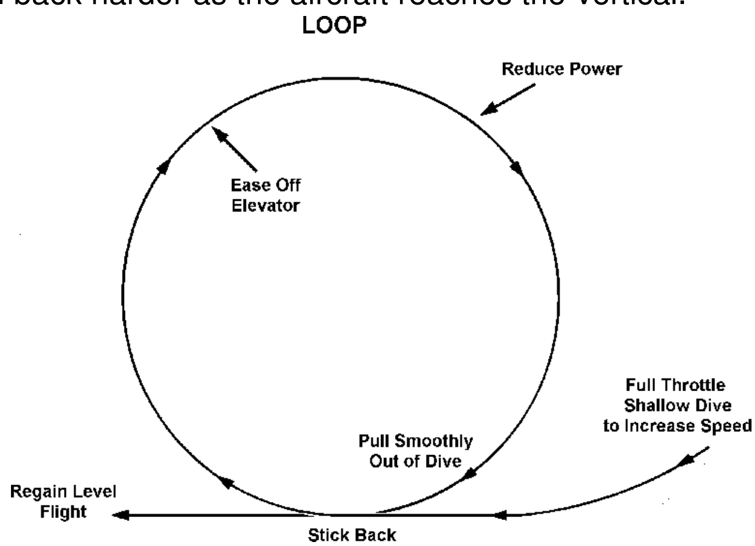
Module 12 – Recovery from Unusual Attitudes & Simple Aerobatics

Assumed previous knowledge/experience.
Understanding of Aviation and Aircraft terminology, with a basic understanding of radio control systems and how they operate. You have a basic understanding of the model controls and how they should operate.
Understanding of legal and safety requirements.
You are competent at keeping a model flying straight and level.
You are competent at making level turns with the model.
You are competent at climbing, descending and trimming a model.
You have been practicing accurate positioning of the aircraft and becoming competent.
You can recover your model from a stall situation with minimal loss of height.

You may be very keen to learn take-off and landing at this stage but much of your flying up until now has been at some height and your instructor will probably have recovered your aircraft from unusual attitudes for you, when you have got things slightly wrong. It is now very important that you become proficient at positioning the model and recovering from more unusual attitudes etc as once you start operating the model closer to the ground the time available for recovery becomes much less and you will have to push the control stick(s) in the right direction first time. To assist you with this your instructor will probably teach you some simple aerobatics such as a loop and a roll. This will not only help you to improve your control ability but will get you used to seeing the aircraft in some unusual attitudes.

LOOP

This is about the simplest of aerobatics. With the model at a safe height, open the throttle fully and make sure that the wings are level. Now push the aircraft into a slight dive to build up speed, then ease back on the elevator, keeping the wings absolutely level, and keep the aircraft going round the loop by a steady increase in back pressure on the stick. As the aircraft comes to the top of the loop, you can ease off the back pressure slightly and begin to throttle back to avoid picking up too much speed. Now recover to level flight by maintaining some up elevator until nearly level. You may not succeed in getting right round the loop at the first attempt, but keep trying and remember to pull back harder as the aircraft reaches the vertical.

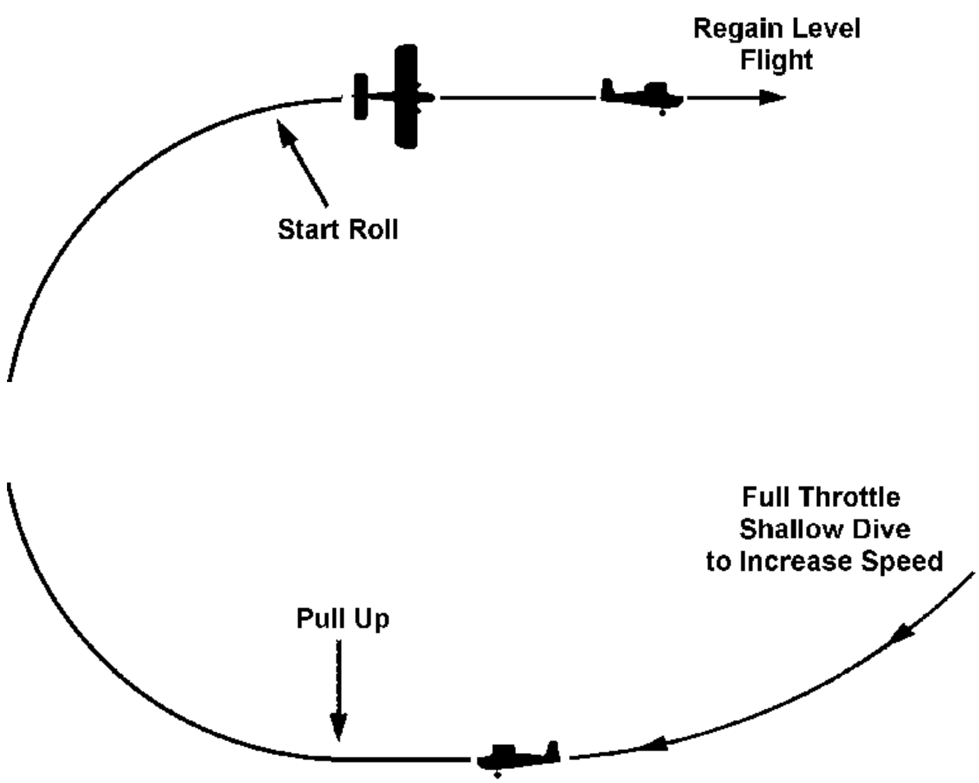


ROLL

This is a more difficult manoeuvre and can only be done effectively by a model with ailerons. That is not to say that a model without ailerons will not roll, only that it will be a somewhat ungainly manoeuvre. Start by flying level, then raise the nose slightly and apply full aileron in the direction you wish to roll. All being well, the aircraft will roll completely without too much trouble. However, you may find that when the model is inverted it may start to dive. Don't worry - keep full aileron on and the aircraft will complete the roll and you can then recover from the dive. Always make sure that you have plenty of height before practising this manoeuvre. To perform a good axial slow roll, you will need to use momentary 'down' elevator when the aircraft is inverted, but this will come with practise. It is not good practice to abort a roll half way round (whilst inverted) by pulling into a half loop as this can be catastrophic if insufficient height is available and you do not want to develop instincts for pulling out of an aborted roll in this way, because sooner or later it will cost you a model and could be dangerous.

ROLL OFF THE TOP

This consists of a half loop with the aircraft being rolled out level at the top of the loop. You will need a fair amount of speed to perform this manoeuvre and, of course, full power. Don't start to roll out until the aircraft is well on top of the loop. The illustration will help you to understand how this manoeuvre is performed.



Roll Off The Top

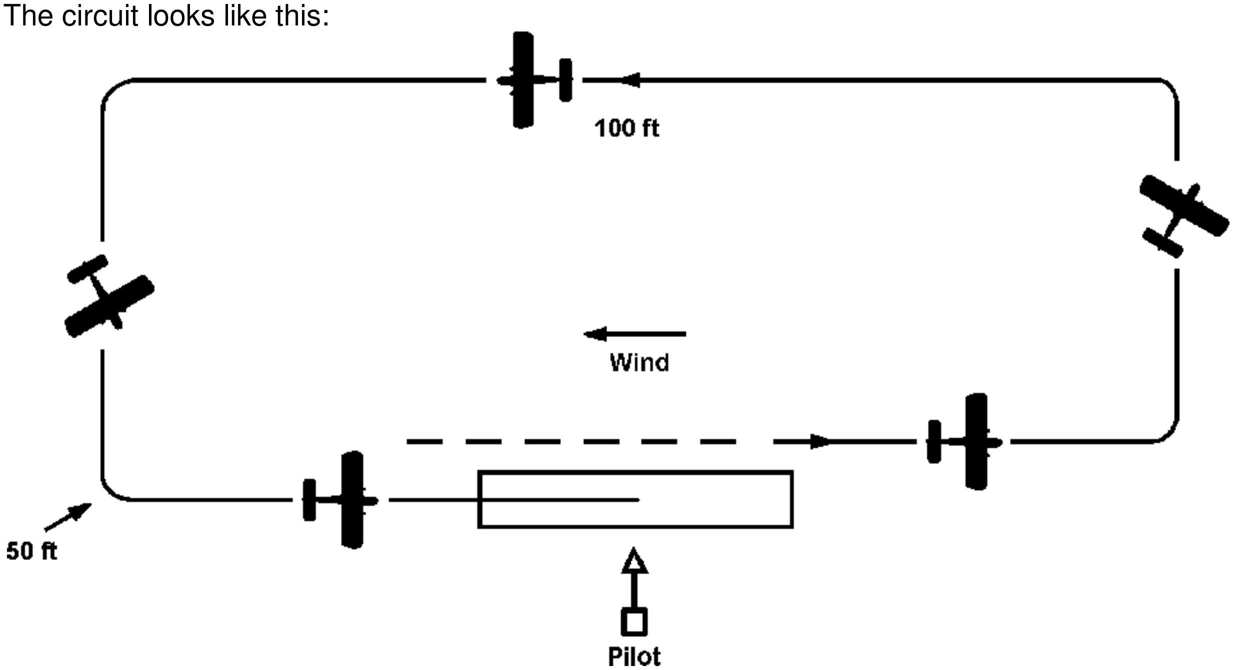
Module 13 – Circuit & Landing

Assumed previous knowledge/experience.
Understanding of Aviation and Aircraft terminology, with a basic understanding of radio control systems and how they operate. You have a basic understanding of the model controls and how they should operate.
Understanding of legal and safety requirements.
You are competent at keeping a model flying straight and level.
You are competent at making level turns with the model.
You are competent at climbing, descending and trimming a model.
You have been practicing accurate positioning of the aircraft and becoming competent.
You can recover your model from a stall situation with minimal loss of height.
You are able to recover from unusual attitudes and can perform some very basic aerobatics.

Now that you are becoming more confident and competent at flying & positioning the model exactly where you want it and you are able to recover from unusual attitudes, it is now time to begin tackling the circuit and landing.

To achieve a good landing it is important that the model is set up correctly from the start, by flying a rectangular circuit whilst adjusting the height to turn onto final approach at the correct height to then descend at a steady rate to arrive at the beginning part of the runway/landing strip about 10 - 15 ft high. With an electric glider you will almost always reach the end of the flight in a gliding mode. You may have some power left to enable you to climb to safety if you get into difficulties (it is good practise to reserve some power for this particular reason) but your aim should be to fly well enough to land the model safely whenever you intend to do so. The following principles apply to gliders as much as other models, but the heights and distances may vary a bit (see Module 14 on glide approaches and forced landings) as you will not normally be using power to correct them.

The circuit looks like this:



You join it where the dotted line starts since you will already be in the air. Circuit height is around 100 to 150 feet and your instructor will have shown you what the correct height looks like. Although a left-hand circuit is used to illustrate this lesson, the circuit can be either right or left- hand. You can use ground based references such as trees, hills on the horizon etc. that are within your peripheral vision to assist with this positioning.

After settling your aircraft at the correct height and positioning it correctly into wind, fly about 100 metres upwind of your position and turn *crosswind*. Remember that the wind will tend to blow your aircraft towards you so keep it tracking slightly away from you on this leg. When you reach the next point, turn downwind. The downwind leg is parallel to the landing direction and about 50 metres out.

Once established on the ***downwind leg***, reduce power by 2 or 3 notches and you may also need to hold in a tiny bit of up elevator, this will slow the aircraft down a little, ready for landing. Keep the height constant. When the aircraft has passed level with you and gone a further 50 metres, or so, turn onto the ***base leg***, again 'crabbing' the aircraft so that it does not drift further downwind. Now reduce power to a little above idling. Aim to turn the aircraft onto ***final approach*** to line up with the runway/landing strip at a height of about 50 ft at the end of base leg. Don't forget that this is a descending turn as you are on low power now and the nose of the aircraft will be noticeably down to maintain speed.

The aircraft should now be tracking straight for the landing point, more or less directly into wind, with the wings level and descending with a little power on. If the aircraft is undershooting the planned touchdown point, open the throttle a notch or two for a few seconds: if too high, close the throttle completely. In other words, regulate the descent by means of the throttle.

When the aircraft has passed the beginning of the runway and reaches a height of about 4 - 3ft, give a touch of 'up' elevator and fly level with the ground, closing the throttle completely if it has not already been closed. As the aircraft sinks, try to keep flying a few inches above the ground until it loses flying speed and touches down. As a tricycle aircraft it will probably not bounce very much, but remain on its wheels and you only need to keep it running straight with the rudder until it stops. Should it bounce, hold the controls exactly as they are - don't try to correct and you will find that the aircraft will settle down again without further help.

This is the whole landing sequence but your instructor will probably start you off by getting you to fly the 'rectangular' circuit at a constant height to get you used to the turns and positioning the aircraft correctly. As your skill improves he will get you to descend to the touchdown point so that you can practise approaches. He will tell you to overshoot at some point on the approach and to do this you simply open up to FULL throttle and climb straight ahead to circuit height. Then reduce power and continue with the next circuit.

You will soon find that you can tell when you are making a good approach: the wings are level, the aircraft seems to be on rails, tracking straight for the touchdown point and you feel confident. If an approach is not good you will find that you can tell this equally easily! On these approaches your instructor will be close to you, ready to help if things look like going wrong, but he will let you carry on with the approach as long as possible. As you begin to get it right he will let you come lower and lower before calling ‘overshoot’. Eventually he will not tell you to overshoot and you will find - somewhat to your surprise - that you have actually landed! Your instructor may take control of the model once it has touched down, apply full throttle and get the model safely airborne again, then hand control back to you, so that you can practice the circuit and landing again & again. Gliders do not usually have an undercarriage, so a touch and go is rarely possible with these models.

Landings are the one manoeuvre that you will continue to practice throughout your entire model flying career and whenever the flying strip has little activity it is a good time to practice these over and over again. This is also one of the most satisfying manoeuvres to get absolutely right, with the perfect ‘greaser’ touchdown.

REMEMBER - NEVER TRY TO LAND OFF A POOR APPROACH - A BAD APPROACH WILL MEAN A BAD LANDING. GO ROUND AGAIN AND HAVE ANOTHER GO.

***NOTE**: Although we have shown a ‘rectangular' circuit pattern, since it follows our teaching pattern, some instructors will prefer to round out the crosswind and base legs to make more of a ‘race-track’ circuit pattern.*

Module 14 - Glide Approaches & Forced Landing (Deadstick Landing)

Assumed previous knowledge/experience.
Understanding of Aviation and Aircraft terminology, with a basic understanding of radio control systems and how they operate. You have a basic understanding of the model controls and how they should operate.
Understanding of legal and safety requirements.
You are competent at keeping a model flying straight and level.
You are competent at making level turns with the model.
You are competent at climbing, descending and trimming a model.
You have been practicing accurate positioning of the aircraft and becoming competent.
You can recover your model from a stall situation with minimal loss of height.
You are able to recover from unusual attitudes and can perform some very basic aerobatics.
You are able to fly a circuit and land.

ENGINE FAILURE IN FLIGHT

Up to this point any problems caused by an engine failure in flight will have been handled by your instructor. Now that you are coming towards the point where you will soon fly solo it is time for you to learn how to deal with a 'deadstick' landing yourself. Engine failure can, of course, occur at any time in a flight: the most difficult times to cope with are:

a. Shortly after take-off
b. On the landing approach

If the engine should cut shortly after take-off before much height has been gained immediately call '**Deadstick**' loudly to inform other pilots, then just lower the nose of the aircraft to maintain flying speed and make the best landing you can straight ahead, making only very small turns to avoid any obstacles. Don't try to turn back to the landing area - to attempt to do this is to invite disaster.

If you lose the engine on the approach, much the same advice applies. Lower the nose, keep the speed up and land straight ahead as best you can.

Engine failure at height is another matter. Height gives you time to assess the aircraft's position relative to the landing area and to position the aircraft in a descending circuit aiming to touch down one-third of the way up the landing strip. Always remember that a lot of height is lost in a descending turn and that the nose must be kept down to maintain flying speed. Without any slipstream from the propeller the flying controls will be less positive, particularly the elevator, so keep the speed up at all times.

Your circuit should be planned so that the aircraft is at about twice normal circuit height halfway down the downwind leg (Key Position 1) and still about twice the normal turn-in height as the final turn to line up with the runway is begun, (Key Position 2). Other pilots need to know that an emergency is in progress so always call **'DEADSTICK'** very loudly as soon as you recognise that your engine has stopped. If you hear this call when you are flying, keep your aircraft clear of the circuit until the emergency is over.

It is worth noting that total engine failures in flight are not always inevitable. Often an engine will go 'sick', particularly shortly after take-off. The engine misfires, loses power and generally shows every sign of stopping - which it will if allowed to continue. However, by reducing power to about two-thirds throttle you may be able to retain sufficient power to continue the circuit and land safely. This, of course, means that your engine was set too lean to start with, so ensure that you open up the needle valve a little to give a richer run next time and do a ground check to ensure that your engine really is running slightly on the rich side. Electric powered models can lose power very suddenly if the battery is allowed to drain too low. The model needs to be flown as if the engine has failed. However, if the throttle is fully closed sometimes the battery can recover enough to give a very short burst of power on final approach to adjust the approach if necessary.

FLIGHT PATTERN – Glide Approach, FORCED LANDINGS

For safety reasons, your instructor will begin this exercise by teaching forced landings with the engine throttled back called a glide approach. This will enable you to avoid any potentially disastrous situations and also enable more practice approaches to be made since you can overshoot and climb back up to try again.

Your instructor will get you to climb the aircraft to a fair height upwind of the landing area and then throttle right back. At this point, put the aircraft into a normal nose-down glide and your instructor will take over control and demonstrate the descending circuit and the two 'key' positions - downwind and final.

You will be shown how to reach the first 'key' position halfway down the **downwind** leg at the right height, either by taking a short cut to get there if the aircraft is a little too low, or by extending the circuit if you are too high. Your instructor will continue on the downwind leg until the aircraft is just past the downwind end of the landing strip, then turn **base leg**. The point at which this turn is made will depend on the height of the aircraft and the wind speed. A low height or a brisk wind will require an early turn and too much height or a calm day will require a slightly later turn. Your instructor will demonstrate this to you.

The second 'key' position is the point where the turn onto the **final approach** path is made. Your instructor will show you the correct height but will also demonstrate that this will vary with the wind conditions. He will also show you that a lot of height is lost in this final turn to line up with the runway. Once the turn is completed it is only a matter of keeping the wings level and the flying speed up to complete the landing, although your instructor will perform an overshoot to save time on repeating the exercise. You will then have the opportunity to try the exercise out for yourself. Your instructor will be at hand to help you and to give you advice during the exercise.
When your judgement has improved sufficiently your instructor will get you to stop the engine in flight and perform the forced landing completely without power. You will find that the aircraft loses considerably more height in the glide and that descending turns require the nose to be well down to maintain flying speed and that the flying controls are quite 'sloppy'.

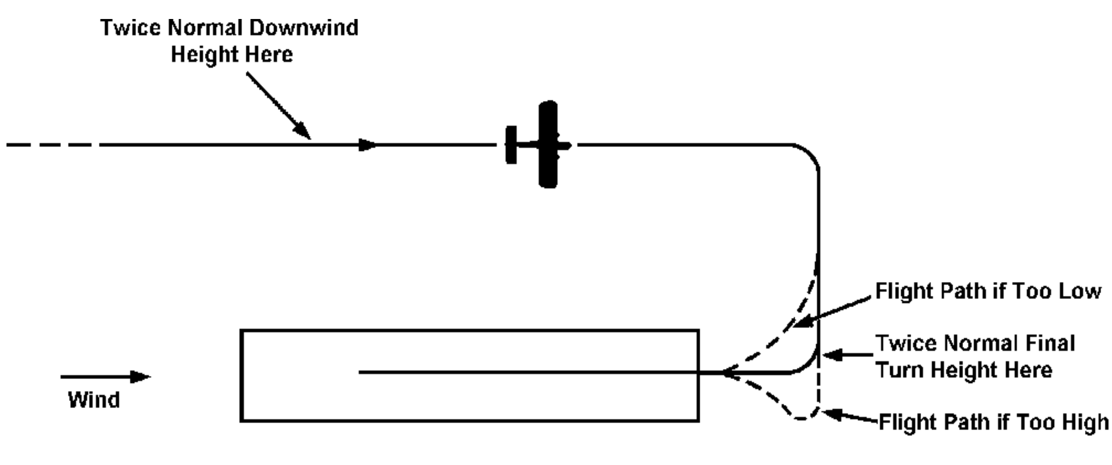
The exercise is exactly the same as before but, of course, this time you are committed to a landing. Always remember that height is your ally - it is better to land a long way down the runway than to have to land short in possibly rough ground. It is possible to rectify most errors of height by modifying the last part of the circuit. Your instructor will show you that if your aircraft is too high after you have completed the turn from downwind to crosswind you can lose height by extending the crosswind leg and turning in to the runway when your height is right. This may even mean flying beyond the landing path and making an ‘S’ turn to get back, but this is quite permissible in an emergency.

Similarly, if the aircraft is too low on turning crosswind, the turn can be continued directly onto the landing path.

This exercise should be practised until you can cope with an engine cut at various ‘safe’ heights at the upwind end of the airfield. Your instructor will then extend your skills by closing the throttle on you at different points in the air so that whenever an engine failure is experienced ‘for real’ you are safe and competent enough to get the aircraft down in the right place without endangering others.
Once the model has landed do not rush out to recover the model check with other flyers that it is safe to do so, hand your transmitter with another club member for safe keeping whilst your inform everyone very loudly that you are “On the Runway/Strip to recover a model”.

If for any reason a set of circumstances arise after a genuine engine failure where the model is unable to make a successful circuit and landing and the only way to get it down appears to be a landing towards the pits or people, it is better to land the model quickly in the rough at the far side of the strip or where a clear area is known to exist and accept any damage to the model, than to risk a semi controlled arrival towards people, risking injury or worse.

It is also important to conduct a post flight investigation to establish why the engine has failed and ensure that this is corrected before any further flights are attempted.



REMEMBER - ALWAYS CALL ‘DEADSTICK’ LOUDLY WHEN YOUR ENGINE STOPS SO THAT OTHER FLYERS ARE AWARE OF YOUR EMERGENCY AND CAN KEEP OUT OF YOUR WAY.

Module 15 – Take-Off and Climbout

Assumed previous knowledge/experience.
Understanding of Aviation and Aircraft Terminology.
Basic understanding of radio control systems and how they operate.
Basic understanding of the model controls and how they should operate.
Understanding of legal and safety requirements.
You are getting the hang of keeping a model flying straight and level.
You have become competent at making level turns with the model.
You are competent at climbing, descending and trimming a model.
You have been practicing accurate positioning of the aircraft and becoming competent.
You can recover your model from a stall situation with minimal loss of height.
You are able to recover from unusual attitudes and can perform some very basic aerobatics.
You are able to fly a circuit and land.

You are now, at long last, ready to learn to get the aircraft off the ground and up to your normal flying height. It's a lot easier than you think!

Your instructor may choose a quiet period on the runway or landing strip to give you some practice with accelerated takeoff runs but closing the throttle just before take-off speed is reached to ensure you are able to maintain a straight track during the take-off run. This is because you will be using your left hand to control direction via rudder/nosewheel/tailwheel (which you have not been using very much up to this point).

It is important that tracking is kept as straight as possible by anticipating a natural swing to the left (caused by engine torque) by applying a little right rudder and any effects of cross wind, which will tend to turn the model into the wind. This is important both from a safety point of view and to ensure the model is fully under control at the point of lift off, which is one of the most vulnerable points in any flight, as the wind and any turbulence starts to affect the model whilst it is still accelerating and controls are a little sluggish. It is also important to start the take off from a position in front of the pilot area, rather than backtracking to take off moving past the pilot area, as any swing on takeoff could put pilots in this area at risk.

When it comes to your first proper take-off, ensure that all trims are in their correct (neutral) positions - throttle trim fully forward then check with other pilots that it is safe to taxi out. Begin by taxiing the aircraft to the take-off point (in front of the pilot area) and stop with it pointing as directly into wind as the site layout and safety allows. Check that your take-off path is clear and that no-one is coming in to land or is on the runway or landing strip. Call "**Taking Off"** to the other pilots.

Open throttle smoothly to the fully open position and, as the aircraft gathers speed, keep it on a straight path by use of the rudder. *If you are flying a tail dragger model and the grass on your strip is a little long you may need to hold a little up elevator on initially to stop the model nosing over but as speed starts to build this can be released to avoid the model getting airborne prematurely.* When the aircraft has gained flying speed, a gentle backward pressure on the stick will lift it off the ground and into a climb. Once away from the ground your aircraft will tend to climb steeply - avoid this by using the elevators to hold a gentle, but steady climb - keeping the aircraft on a straight path even if it wants to turn.

Nearly all electric gliders are hand launched and whilst it might not be correct to classify the launch as a flight manoeuvre it is still a vital part of a flight. The model may be launched with the motor running or without. The procedure is to hold the model at shoulder height with the wings level and to push it forwards at flying speed directly into the wind with the nose slightly downwards. It may or may not be necessary to run forward slightly to achieve this launch. If the motor is running on full throttle the model should immediately begin to climb away and will soon reach a safe height. If the model is launched without the motor running then the throttle should be fully opened once the model has left the hand of the launcher and settled into a stable glide. It will then smoothly convert into the climb and proceed to height.

Never allow the model to be launched with it's nose pointing upwards.

Commence a turn in the desired circuit direction when the aircraft has reached 50 feet or so and continue climbing to your operating height - around 150 ft. Level out and reduce to cruising power. Now you can see the point of all the previous exercises!

You will need to practice take off under buddy box control in a variety of wind conditions to become proficient at dealing with accurate tracking and any upsets the model may experience whilst in the 'low and slow' state just after getting airborne.

Module 16 – Your First Solo

Assumed previous knowledge/experience.
Understanding of Aviation and Aircraft Terminology.
Basic understanding of radio control systems and how they operate.
Basic understanding of the model controls and how they should operate.
Understanding of legal and safety requirements.
You are getting the hang of keeping a model flying straight and level.
You have become competent at making level turns with the model.
You are competent at climbing, descending and trimming a model.
You have been practicing accurate positioning of the aircraft and becoming competent.
You can recover your model from a stall situation with minimal loss of height.
You are able to recover from unusual attitudes and can perform some very basic aerobatics.
You are able to fly a circuit and land.
You are able to taxi a model, track it straight during takeoff and climb the model out.
You have also demonstrated a good understanding of flying field protocols and safety.

You have now learnt all the basics of flying a model aircraft and your instructor will brief you on flying your first completely solo flight. The instructor will probably choose a day when the weather is good and the wind is nicely aligned with the runway to give you the best chance of a successful and trouble free flight. Although you will have done all the elements on your own, many times, this can be a nerve racking event, to say the least.

Your instructor will ensure that you have fully understood everything during the training and briefing and may even go through a few of the key safety issues again with you. The really important thing now is to just relax and enjoy the flight.

Take your time and ensure you have done everything correctly before committing your model to flight. Whilst your instructor will not be on dual control with you a careful eye will be kept on you and the models entire flight, including all your pre and post flight checks, so that you can be offered any further help, tips and guidance once you have completed the flight.

Congratulations

You have now gone solo - although you may not have fully realised it at the time, this is the accumulation of all you have learnt over recent weeks and is one of the biggest steps forward you will make in your model flying career.

Module 17 – Continuation Training and the BMFA ‘A’ Certificate

Your next few flights should continue to cover all that you have learned so far. Each flight should consist of:

a. Take-off (or hand launch a glider) and climb to safe height.
b. Level, climbing and descending turns, figures of eight, rectangular circuits and general flying.
c. Thermal turns if it is a glider.
d. Rectangular circuits and overshoots (both right and left-hand circuits).
e. Landings - including some practice forced landings.

Study also the Safety Code in your BMFA Members’ Handbook and make sure that you not only understand the rules and the reasons for them but follow them! Make sure that you are also familiar with your club rules in the same way.

When you (and your instructor) are confident with your performance in the air and your knowledge on the ground, you will be ready to take your ‘A’ Certificate of the Achievement Scheme. This test is carried out by a Club Examiner and your club should have at least two such Examiners. If your club does not have any Examiners then contact the Area Achievement Scheme Coordinator (details available on the BMFA Website) to make arrangements for a test.

The test is very straightforward and *(at the time of writing, check BMFA Web Site for latest)* consists of *(for non glider models)*:

a) Carry out pre-flight safety & legality checks as required by the BMFA Safety Codes etc., starting the engine when appropriate.

b) Take off and complete a left (or right) hand circuit and overfly the take-off area.

c) Fly a ‘figure of eight’ course with the cross-over point in front of the pilot, height to be constant.

d) Fly a rectangular circuit and approach with appropriate use of the throttle and perform a landing on the designated landing area.

e) If the engine stops during the landing the model may be retrieved and the engine restarted to enable the remaining parts of the test to be completed.

f) Take off and complete a left (or right) hand circuit and overfly the take-off area.

g) Fly a rectangular circuit at a constant height in the opposite direction to the landing circuit flown in (d).

h) Perform a simulated deadstick landing with the engine at idle, beginning at a safe height (approx. 200 ft) tracking into wind over the take-off area, the landing to be made in a safe manner on the designated landing area.

i) Remove model and equipment from take-off/landing area.

j) Complete post-flight checks required by the BMFA Safety Codes.

k) Answer correctly a minimum of five questions from the AS Mandatory questions list if you don't already have a current (post 1/1/2021) Registration Competency Certificate (RCC), plus a minimum of five questions on safety matters, based on the BMFA Safety Code for General Flying and local flying rules.

All manoeuvres must be carried out in front of the pilot.

*For **electric powered gliders** the test consists (at the time of writing, check BMFA Web Site for latest) of:-*

a) Carry out pre-flight checks as required by the BMFA Safety Codes. Particular attention should be given to airframe, control linkages and surfaces.

b) After complying with the site frequency control system, prepare the model for launch. The motor start and stop switch/speed controller sequence must be demonstrated to the examiner.

c) Check that the launch area and landing area are clear both on the ground and in the air. If a helper is used to launch the model they should be fully briefed as to what is required.

d) Clearly announce, "launching" and launch the model under full control. Any deviation from the expected launch path must be corrected smoothly and quickly. Climb to approximately 100m. Switch off power and transition to glide without stalling.
From this point on, power must not be used.

e) Stall the model into wind and recover smoothly with a minimum loss of height.

f) Perform 3 consecutive 360 degree thermal turns to the right or left ending on the same tracking as the entry with minimum loss of height. The turns should be under control with no tendency to stall or enter a spiral dive.

g) Perform 3 consecutive 360 degree thermal turns in the opposite direction to above ending on the same tracking as the entry with minimum loss of height. The turns should be under control with no tendency to stall or enter a spiral dive. *From this point on, power should be used as required*.

h) Fly the model up wind to prepare the model for the overshoot/landing phase. The model should be flown with no tendency to stall and with minimum loss of height.

i) Call “landing” and prepare the model for a landing with a downwind leg, followed by a base leg and final approach.

j) Overshoot from below 10 ft and climb back to circuit height. Note that this manoeuvre is an aborted landing, not a low pass.

k) Again, call “landing” and prepare the model for a landing with a down wind leg, followed by a base leg and final approach.

l) Land the model into wind within 2O metres of a predetermined spot.

m) Retrieve the model from the landing area, informing other pilots that the landing area is clear.

n) Complete post-flight checks required by the BMFA Safety Codes.

o) Repeat the above schedule a second time, giving a total of two flights.

Answer correctly a minimum of five questions from the AS Mandatory questions list if you don’t already have a current (post 1/1/2021) Registration Competency Certificate (RCC), plus a minimum of five questions on safety matters, based on the BMFA Safety Code for General Flying and local flying rules, at least two of which must be specific to electric flight.

All manoeuvres must be carried out in airspace pre-determined by the Examiner and Candidate prior to the commencement of the test flights.

The above complete two flight schedule is treated as one test attempt.

Detailed guidance on the assessment test(s) is provided in the Achievement Scheme Handbook, which is available as a free download from the BMFA web site. The 'A' Certificate is official recognition of the fact that you have achieved ‘safe solo’ standard and your club may now allow you to fly unsupervised. Remember that, whilst the gaining of this Certificate is an important milestone, it is a long way from being the end of the road. Your aim now should be to polish your flying and begin to explore the world of aerobatics. You should try to become fully confident in handling your aircraft in the air and on the ground, plus be able to perform accurately all the manoeuvres you have learned. You should only be satisfied with a perfect landing every time!

Now that you have got your 'A' Certificate, don't forget that your instructor is still there! He will be able to help you iron out any minor (or major!) problems and give you invaluable advice and help when you need it.

Next Steps

Now that you can fly your basic training aircraft competently you should continue to fly it for several months longer. Resist the temptation to step up to a more advanced model, it is better to consolidate rather than rush ahead, suffer setbacks and possibly lose confidence. Try out every possible manoeuvre with it; fly it inverted (if it will) and generally explore the limits of its performance. You will certainly get into difficulties from time to time. With plenty of height you will be able to sort out the proper recovery technique for any unusual situation you may create. If you crash, try to understand why, repair the aircraft and go on exploring.

Eventually the time will come when you will recognise that you have 'grown out of' the basic trainer and you are ready for the next step.

Your next aircraft should be an advanced trainer with a low or shoulder-wing with a semi- symmetrical or symmetrical airfoil section and, of course, ailerons. If you powered your basic trainer with a .40 cu in engine or similar sized electric motor, they will be quite suitable for your advanced trainer.

You may need some help in checking your new model over and giving it its first test flight. Don't hesitate to ask your instructor to assist at any time when you need help.
Your advanced trainer will have the capability to perform virtually everything in the book - and a lot more besides! However, always remember to keep to a safe height: you will make mistakes from time to time and when you do, that bit of extra height will make all the difference between a sigh of relief and a yelp of anguish!

Again, fly your model as much and as often as you can. Never fly aimlessly around. Try to set yourself targets - a perfect loop, a really good slow roll or practise the perfect landing. You should aim to take the 'B' Certificate of proficiency when you are able. Take a pride in following the rules: fly safely at all times and try to set a good example to your fellow club members, both in the air and on the ground. Beware of becoming over-confident.... it is only too easy to believe that you know it all! The result is always a bent aircraft.

THE THING TO REMEMBER ABOVE ALL

FLY SAFELY

&

CONSIDER OTHER FLYERS AT ALL TIMES.

NOTES FOR INSTRUCTORS

Advice to instructors can be of great benefit to both instructors and their students as both then know exactly why things are being done as they are. The notes published here are quite basic, an instructor with problems of any kind is encouraged to seek the advice of the local Chief Instructor or to contact the appropriate Controller of the BMFA Achievement Scheme via the BMFA Leicester Office or BMFA web site.

The Controller will also welcome any constructive comments on any aspect of the Scheme.

THE INSTRUCTOR'S TASK

Instruction is the art of imparting knowledge and it goes without saying that any instructor must know the subject he is going to teach. In order to teach a novice to fly an instructor must be able to fly the aircraft competently without showing off, be able to communicate effectively with the student and have sufficient background knowledge to answer the student's questions adequately.

COMMUNICATION.

Whilst we may know what we mean it is not always easy to put that precise meaning into words. The good instructor uses simple terms which the student can understand and avoids jargon. He will give his full attention to the subject in hand and not be easily sidetracked or allow diversions. He will always question the student on what he has just been taught to be sure that he has understood the lesson.

FLYING ABILITY.

The need for an instructor to be able to fly well is obvious - what may not be so obvious is the need for his own flying to be accurate and totally safe. The instructor who crashes his aircraft frequently is unlikely to inspire confidence in his student! Accurate and safe flying by an instructor is essential at all times - not just when actually instructing.

KNOWLEDGE.

A sound basic knowledge of how and why an aircraft flies is essential if the student's inevitable questions are to be answered. The student is entitled to expect his instructor to have all the answers and the instructor must be as well prepared as he can be to respond. If the Instructor does not know the answer (and he may not always) he should say so and be prepared either to find out the answer later or to refer the question to someone who does know. Nothing could be worse than trying to bluff their way through an answer - this is a very quick way to forfeit the student's confidence.

A knowledge of simple aerodynamics is essential – for example, why does the nose of the aircraft drop when entering a turn? The good instructor should be able to answer this and other similar questions straight away with a simple diagram if necessary. If your particular knowledge is not up to this there are plenty of books on the market which will help.

The instructor does not have to be a brilliant flyer nor an aerodynamicist - he does have to be competent, knowledgeable, patient, experienced and have a quiet authority.

An important part of the instructor's task is the preparation of the lesson. He should have practised the lesson himself and know exactly what he is going to teach and how he is going to teach it. Before the flight the instructor will have briefed the student on the lesson to be tackled and the problems which may be encountered and how to deal with them. After the flight he should question the student to be sure that the lesson has been understood.

In the air he will adopt the system of:

DEMONSTRATION IMITATION RECAPITULATION

DEMONSTRATION

The instructor demonstrates what he wants the student to do.

IMITATION

The student tries to copy what the instructor has shown him.

RECAPITULATION

The demonstration and imitation is repeated until the student has got it right.

The instructor should always bear in mind the fact that the student is concentrating so much on flying the model that much of what is said whilst he is flying will go over his head. Hence the need to go over the flight when the aircraft is safely back in the pits.
The instructor should aim to fly with his student regularly and give 3 to 4 lessons in a flying day. Lessons should not be much longer than 10 minutes and the instructor should not expect the student to concentrate for any more than five minutes at a time. Give the student a 2 or 3 minute break by taking control every 5 minutes or so.

Safety is a vital aspect of model flying and should be emphasised at every opportunity. The good instructor always practices sound safety procedures and instils them into his student. Follow the Safety Codes and abide by the Club rules and ensure that the student does too.
The Safety Code for General Flying is the most important one at this stage and the instructor should go through this with the student.

The use of progress cards or booklet is recommended and a basic sample is provided in this RC Flight Training Manual. The pupil may use this or the instructor could make up the cards or booklets himself to the same pattern.

The third column should be used to indicate when the student is ready for the next exercise. ‘Repeat’ means that he needs further practice. Detailed comments are not desirable.

The card or booklet should be retained by the student so that if another instructor takes the student he can see immediately the progress the student has made and what the next lesson should be.

Achievement Scheme Information & Communication

The BMFA Achievement Scheme provides every RC flyer the opportunity to set themselves an achievement target to aim for, and then have their progress assessed and confirmed by an examiner.

It is important that All those involved in training, examining and preparing for the tests, are well informed and up to date with all that the scheme has to offer. To this end, and to aid communication, important information regarding scheme developments, as well as details of all of the tests and their associated guidance documents, are made available to everyone via a number of sources, which include:-

- The Achievement Scheme website - http://achievements.bmfa.org/
- The BMFA website - http://bmfa.org
- The BMFA News
- The Achievement Scheme closed Facebook group

It's important to appreciate that **ALL** of the scheme documents are reviewed and updated on an annual basis. Whichever document your are using, you will know if you have the right one, simply by looking at the date on the front cover. If it's not dated with the current year, it's the wrong one !

Most BMFA Clubs have Club Instructors/Examiners who will be familiar with the scheme and what is expected of anyone thinking of participating. If your cub does not have a club examiner then each BMFA Area has an Achievement Scheme Coordinator (contact details can usually be found on the BMFA Area website) who can usually help in coordinating tests, or answering queries about tests etc. All BMFA Areas have Area Chief Examiners who would normally undertake Club Examiner tests, but are also available to help out with club tests, if requested. importantly, they are also very knowledgeable about the scheme and it's requirements. Area coordinators can often find an ACE that is close to your club, if you are having difficulty arranging for a test.

All BMFA Achievement Scheme & training documents are available to download from the BMFA Achievement Scheme website http://achievements.bmfa.org/ . You can also register your email address with the Achievement Scheme website and receive email notification of any news flashes, notification of scheme events and updates to documentation etc. as soon as they are published.

The Achievement Scheme also has a closed Facebook group (you just have to apply to be included) where comment and queries can be posted and examiners/instructors and members of the Achievement Scheme Review Committee can answer questions, or offer clarification.

If you have any query about the scheme or constructive comment on the scheme you can contact the Power/Silent Flight Scheme Controller (RCPAS@bmfa.org), or the Achievement Scheme Review Committee, via the BMFA Office.

BMFA R/C Power 'A' Training Log

Pupil……………………………………… Mentor…………………………………. Sheet /

Awards……………………………….

Date	Flight Training Programme														
	Pit & Field Safety	Pre take off checks	Straight & level	Coord. turns	Stalls & slow flight	Rect. circuits	Take off	Go Around	Landing	Figure 8	Trim	Taxi	Dead stick	Post flight checks	Instructors Sig.

To be signed by instructor at the end of each session - *Don't forget the de-brief* - Any comments over page

Code:	Satisfactory	–	Pupil is competent to complete to 'A' standard	–	**Sat**
	Repeat	–	Pupil needs further practice/ instruction	–	**Rep**
	Not Covered	–	Any elements not covered during session	–	**N/C**

BMFA R/C Power 'A' Training Log - Comments

Please also use this section for the sign-off of any parental consent for the training session.

Date	Comment	Signature

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